THURSDAY, APRIL 11, 1889.

BRITISH UREDINEÆ AND USTILAGINEÆ.

A Monograph of the British Uredineæ and Ustilagineæ. With an Account of their Biology, including the Methods of observing the Germination of their Spores and of their Experimental Culture. By Charles B. Plowright, F.L.S., M.R.C.S. Illustrated with Woodcuts and Eight Plates. (London: Kegan Paul, Trench, and Co., 1889.)

MR. PLOWRIGHT'S monograph will at once take its rank as the chief English authority on the interesting groups of parasitic Fungi to which it relates. The results of the author's important original investigations are here incorporated with those of other observers to form a work which brings our knowledge of these plants thoroughly up to date. The greater part of the book is systematic, the detailed description of species being preceded by a general account of the structure and life-history of the two orders. These introductory chapters will probably appeal most to the reader who is not a specialist in mycology, though the biological notes attached to the specific descriptions are also of great interest, and effectually relieve the dryness which is usually inseparable from purely taxonomic work.

In the first chapter a short summary of the biology of the Uredineæ is given. This is, perhaps, if anything, rather too short, but of course some previous knowledge in the reader is assumed. The Uredineæ, which are now probably the best known family of pleomorphic Fungi, are arranged by the author, in agreement with Schröter and Winter, in biological groups, according to the varying combinations in which their different forms of reproductive organs are present. These groups are made use of for the division of the larger genera into sub-genera. The system adopted may be illustrated by the classification of the species in the largest genus, Puccinia, in which all the modifications are represented. The sub-genera are six in number. First we have Eupuccinia, characterized by the presence of all the four reproductive structures: spermogonia, æcidiospores, uredospores, and teleutospores. This sub-genus is again divided into Anteupuccinia, which is autœcious, all the forms occurring on the same host-plant, and Heteropuccinia, in which heterœcism prevails, the spermogonia and æcidiospores being developed on one host, and the uredospores and teleutospores on another plant belonging to a distinct genus. The other sub-genera of Puccinia are all autœcious. In Brachypuccinia the æcidiospores are absent, while in Hemipuccinia the spermogonia also disappear, only uredospores and teleutospores being developed. In Pucciniopsis only æcidiospores and teleutospores are usually present, while in both the remaining sub-genera, Micropuccinia and Leptopuccinia, the teleutospores alone occur, the two groups differing from one another in the fact that the teleutospores of Micropuccinia are of the usual type, requiring a period of rest before germination, while those of Leptopuccinia germinate on the host-plant as soon as they are ripe. The essential character of the teleutospores is the production of a small promycelium which immediately bears promycelial spores (sporidia), the latter being the bodies which directly infect the host. Thus the spores of Endophyllum are classed as teleutospores, on account of their method of germination, though in all other respects they agree with the æcidiospores of other genera. The author regards the teleutospores as the constant characteristic of the Uredineæ, believing that their apparent absence in many forms is due to our imperfect knowledge of their life-history.

The second chapter is devoted to the mycelium of the Uredineæ. Here the description of the cell-contents strikes us as rather inadequate, but the subject is a difficult one to investigate. The often remarkable influence of the localized mycelium on the tissue of the host is well described.

In the next chapter those puzzling organs, the spermogonia, are described, and their functions discussed. The author and others have observed that in sugar-solution the spermatia pullulate, like yeast-cells. It was not, however, found possible to infect the host-plant with them. Still the author inclines to the view that the so-called spermatia are conidia rather than fertilizing bodies, a view which the observations of Möller on the spermatia of Lichens certainly render probable. If Mr. Massee's isolated observation of an antheridium in the Æcidium form of *Uromyces Poæ* should be confirmed, we shall have to seek the male organs of the Uredineæ elsewhere than in their spermogonia.

In the chapter on the æcidiospores there is a want of clearness in describing their development. The account given recalls the now exploded Schleidenian theory of "free cell-formation," whereas the æcidiospores are in fact formed by ordinary cell-division.

The uredospores and teleutospores are described in the two following chapters, which call for no special remark. Most of the facts brought forward will be familiar to those who know de Bary's work on the Fungi.

Chapter VII. deals with the interesting phenomenon of heterœcism, and the curious history of its discovery in the case of the mildew of wheat is well told. The old observations, dating back to the middle of the last century, on the influence of the barberry in producing this disease in corn, are described, and in an appendix the text of the "Barberry Law of Massachusetts" (published in 1755) is given. This law enacted that, "Whereas it has been found by experience that the Blasting of Wheat and other English Grain is often occasioned by Barberry Bushes," these bushes should be extirpated throughout the province. The true explanation of this mysterious power for evil of the barberry was first given by Sir Joseph Banks in 1805, and shortly afterwards a Danish schoolmaster, Schoeler, made the first successful experiments in infecting wheat with the barberry fungus. Naturally the purely systematic botanists held out for a long time against the popular belief; and it was not until 1865 that the connection between the Æcidium of the barberry and the Uredo and Puccinia of the wheat was finally established by de Bary, who thus at last brought the views of scientific men into harmony with those which had long been held by practical farmers. Forty-seven heterœcious species of Uredineæ are now known, and the life-history of eleven of these was first worked out by the author.

The remaining chapters of the introduction deal with the Ustilagineæ. The two groups have little in common, and it must not be supposed that their association in this work implies any near relationship between them. The bond of union is rather to be found in their common biological character as more or less injurious parasites.

In Chapter VIII., the mycelium of the Ustilagineæ is described, and attention is specially called to the fact that it usually spreads throughout the tissues of the host-plant, thus differing from the localized mycelium of most Uredineæ.

The next chapter treats of the development of the "teleutospores" (resting-spores) of the Ustilagineæ. The singular processes by which the "spore-balls" arise in such genera as Soroporium, Tubercinia, and Urocystis are clearly described in accordance with the researches of von Waldheim, Woronin, de Bary, and others. The facts are not, as a rule, new, but they are well put together. The germination of the teleutospores is described in the following chapter. The extraordinary processes of conjugation, in which both the promycelium itself and the sporidia so often take part, are described; and due weight is given to Brefeld's important discovery that these cell-unions do not take place when the spore is allowed to germinate in a food-solution, instead of in pure water. There are many points here which invite more detailed notice, but this may be the better dispensed with, as most of the facts have already been brought before English readers, in the translation of de Bary's work and in some of Prof. Marshall Ward's papers.

The subject of Chapter XI., the infection of the host-plants by the Ustilagineæ, is of great practical interest. In the case of the bunt (*Tilletia tritici*), it is well known that the sporidia borne on the promycelium of the teleutospores infect the embryo of the germinating grain, the germ-tubes penetrating the cells of the leaf-sheath. But how smut (*Ustilago segetum*) infects wheat has long been a mystery. The spores ripen in the young flowers, and have disappeared long before the grain is mature. Attempts at infection of the grain or seedling are almost always unsuccessful; and, on the other hand, the protective dressings of the grain, which are so effectual against bunt, are of no avail as against the attacks of smut. The experiments of Jensen render it most probable that the plant is infected by the spores while flowering, and that either the ovum itself is entered by the mycelium, or that the spores remain dormant in the grain until its germination, and that then the parasite "grows with the growth, and strengthens with the strength" of the young plant. It would appear, then, that the only remedy against the attacks of the Fungus would lie in the destruction of all affected ears at the earliest stage when the disease is visible, and before the spores have ripened.

The last two chapters of the introduction are among the most interesting to specialists, but do not require any analysis here. They deal with the culture of spores, and with the artificial infection of plants. Under the latter head it may be noted that only the Uredineæ are taken into account. The directions given are those of a master of the subject, and cannot fail to be a most useful guide to those who intend to undertake such investigations for themselves.

The longest, and no doubt the most valuable, part of the work consists in the description of all British species of the two families; pp. 119–271 being devoted to the Uredineæ, and pp. 272–301 to the Ustilagineæ. Attention has already been called to the admirable biological notes by which the descriptions of all the more important species are accompanied. In the specific diagnoses, the æcidiospores (when present) are first described; then the uredospores, and, lastly the teleutospores. Next follows a complete list of synonyms, and then the host-plant or plants are enumerated, after which the biology of the species is discussed. The account of the Ustilagineæ is completed by the description of a few genera, such as Graphiola and Protomyces, of doubtful systematic position.

A glossary is appended to the work, and in some of the explanations of terms there is room for criticism. Thus, in defining *conidium* as "an asexual spore," it seems to be too easily assumed that the other spores are sexual. The word *endochrome* is no longer required, and might perhaps be allowed to become obsolete. A *germ-pore* is not an "opening," but a pit, and a *hypha* does not necessarily consist of "an elongated cell." The word *periblem* means the young cortex itself, not "that part of the root of the host-plant which lies beneath the cortex," while *sterigma* is certainly *not* "the same as basidium."

The eight plates contain a great number of good figures, many original, others taken from the works of de Bary Brefeld, Woronin, &c.

A list of the authors quoted is given, and the book is especially well provided with indices, which are three in number. The first, a very useful one, gives the names of all the host-plants of the Uredineæ and Ustilagineæ respectively. Then we have a general biological index; and, lastly, an index of species, including all the synonyms.

The book is exceedingly well got up, but we must protest against the vivid yellow of the cover, presumably intended to recall the colour of the uredospores! Perhaps the decorous brown of the teleutospores would have been more becoming if symbolical colouring was wanted.

D. H. S.

THOMAS ANDREWS.

The Scientific Papers of the late Thomas Andrews, M.D., F.R.S., Vice-President and Professor of Chemistry, Queen's College, Belfast. With a Memoir by P. G. Tait, M.A., Sec. R.S.E., and A. Crum Brown, M.D., F.R.S., Professors in the University of Edinburgh. (London: Macmillan and Co., 1889.)

WE have here in a compact form the biography and scientific works of a man who has left his mark on the science of his time.

Born at Belfast in 1813, Thomas Andrews after acquiring the rudiments of his education at two excellent public schools in his native town, went at the age of fifteen to the University of Glasgow, where he attended the classes of chemistry and natural philosophy for one or two sessions; and in the following years he continued his studies at Paris, Dublin, and Edinburgh, taking the degree of M.D. at Edinburgh in 1835. He immediately began to practice as a physician at Belfast, and also to teach chemistry as Professor in the Belfast College, which was a higher department of the Belfast Academical Institution. In 1845, the scheme for the creation of the Queen's Colleges was launched, and their Presidents and Vice-Presidents were appointed as a preparatory step to the building of the Colleges. Andrews at this time received his appointment as Vice-President, and he was the first Professor of Chemistry, both which offices he retained till the failure of his health in 1879. His whole life-time was thus—with the partial exception of his medical practice from 1836 to 1845—occupied in scientific teaching and investigation; and from the early age of fifteen, when he published in the *Philosophical Magazine* a paper on the action of a blowpipe flame on other flames, he never ceased to devote himself to original research.

He was never in a hurry to rush into print, but took care to be accurate and thorough in an investigation before announcing his results. Regularly day by day he was to be found at work for hours in his laboratory, patiently conducting with his own hands every detail of his elaborate observations.

The most important of his researches relate to heat of combination, the nature and properties of ozone, and the transition of such substances as carbonic acid from the gaseous to the liquid state. But besides these, we find in the present collection brief papers on a variety of subjects. One contains an account of experiments on the conducting power of flame for electricity, showing that the current from a single cell could be transmitted through a circuit part of which consisted of an alcohol flame. Another describes the attainment of a very high vacuum by a good ordinary air-pump aided by the introduction of carbonic acid into the receiver and the absorption of the last traces of this gas and of aqueous vapour by caustic potash and sulphuric acid. Another gives a comparison of the conducting powers of different gases for heat, as shown by their cooling action on a platinum wire kept incandescent by a current. In all these subjects he was early in the field, and obtained results much in advance of those obtained by his predecessors.

An instance of his careful criticism is afforded by one of the latest papers in the volume—a lecture on recent improvements in magneto-electric machines—in which he points out that Paccinotti's machine, if the inventor's original description of it can be relied on, makes its contacts (for collecting the currents from the ring) in the wrong places. The criticism is certainly justified by the figure and accompanying description which are reproduced from Paccinotti's paper; but from inquiries which we made at the Paris Electrical Exhibition, where the machine was on view, we believe the fault was in the description and not in the machine itself.

As regards ozone, Andrews appears to have been the first to establish the following points:—

(1) That the peculiar substance obtained by the action of the electric spark on oxygen is identical with that obtained in the electrolysis of water, and with that obtained in the slow oxidation of phosphorus.

(2) That it is not a compound body, but is oxygen in an altered or allotropic condition.

In subsequent experiments, with the assistance of Prof. Tait (who was at that time Professor of Mathematics in Belfast), he compared the amount of contraction produced by the partial conversion of oxygen into ozone with the amount of ozone thus obtained as tested by chemical action, and hence deduced the density of ozone.

His researches in various branches of the subject of heat of combination were spread over many years, and were, for the most part, conducted at a date when an accurate thermometer for measuring small differences of temperature could only be obtained by making it for oneself. The subsequent researches of Favre and Silbermann, wherever they differed to any large extent from his, have since been shown to be erroneous, and his results agree fairly well with the latest and best determinations yet obtained.

But his permanent fame will rest mainly on his discovery of the continuous transition which can be made from the gaseous to the liquid state of a substance, or from the liquid to the gaseous. The main result which he established is best set forth by the geometrical illustration employed by his colleague, Prof. James Thomson. Let the volume, pressure, and temperature of a given mass of carbonic acid be represented by the three rectangular co-ordinates of a surface; volume being represented by height, while the pressure and temperature co-ordinates are horizontal. The surface will resemble the side of a mountain which is precipitous in one part, but in another part furnishes a gradual ascent by which the summit can be reached. The ground-plan of the precipice is the curve of boiling-points, and the height of the precipice at each point of the curve represents the increase of volume in passing from the liquid state to the gaseous. As the temperature increases, the precipice diminishes in height, and finally runs off to nothing at a point whose horizontal co-ordinates are the "critical temperature" and "critical pressure." At higher temperatures there is no boiling-point, and in place of the precipice there is a gradual ascent, by means of which the precipice can be rounded and the summit attained. Starting from the ground below the precipice (that is, from the liquid state), the ground above the precipice (that is, the gaseous state) can thus be attained without any kind of discontinuity.

Cagniard de Latour and Drion, who preceded Andrews in this field of research, failed to obtain this result, because their method of experiment placed only one independent variable at their disposal. The substance was inclosed in a sealed tube, and there was no way of altering its pressure except by altering its temperature. Andrews used a screw plunger, which enabled him to increase and diminish the volume independently of the temperature. By making simultaneous measures of volume, pressure, and temperature for various values of the two independent variables, he was able to map out the surface, and Prof. J. Thomson constructed a wooden model of it from the data thus obtained.

In subsequent researches he investigated the effect of mixing various quantities of nitrogen with carbonic acid, and found that the critical point was largely shifted by such admixtures.

Shortly before his health broke down, he devised an ingenious apparatus for making successive additions of a known column of mercury to the pressure of a gas confined in a long tube, hoping in this way to be able to test departures from Boyle's law at very high pressures without employing a column of mercury of unwieldy length. In the reference to this subject in the preface there appears to be an oversight. The effect of a certain cycle of operations to be performed with the apparatus is described and then we read :—

"A connected series of vessels of this kind will enable the experimenter to apply a measured pressure of an amount depending on the number of vessels."

Instead of a connected series of vessels, it is only necessary to repeat, time after time, with the one vessel, the cycle of operations which has been described ; and this we understood to be Dr. Andrews's intention. The apparatus was not brought into actual use, nor even constructed ; preliminary trials having shown that screw plungers working in mercury (which were an essential part of the design) could not be prevented from leaking.

The various papers in this volume, and especially the Presidential Address, show Dr. Andrews to have been not only an accurate and original worker, but a man of wide culture and refined literary taste. The editors have done their work carefully and well. J. D. E.

MACH'S "HISTORY OF MECHANICS."

Die Mechanik in ihrer Entwickelung historisch-critisch dargestellt. (An Historical and Critical Sketch of the Development of the Principles of Mechanics.) By Dr. E. Mach, Professor of Physics in the University of Prague. Second Edition. (Leipzig : F. A. Brockhaus, 1889.)

THE first edition of this work, which forms Vol. LIX. of the "International Scientific Series," appeared in 1883. With the exception of a few short appendices and the correction of misprints, it is identical with the original edition ; but we are glad to take the present opportunity of calling attention to a book which, while unpretentious in form, is one of exceptional value to students, and especially to teachers, of the subject with which it deals.

The book has not been translated into English, and we understand that the English publishers did not consider it sufficiently popular in form to be included in the English series. This is much to be regretted. The work is one which certainly ought to be translated, as it would be most helpful to a large class of students and teachers who are unable to read it in German.

In the course of rather fewer than 500 pages the author gives his readers a well-constructed outline of the development of the science of mechanics from Archimedes down to the present time, accompanied by well-reasoned criticisms and discussions of the significance and relative importance of the various steps which he chronicles. The first chapter is devoted to the development of the principles of statics, and we would specially direct attention to the masterly manner in which the author shows the fallacies underlying the attempts of some of the early philosophers to derive the principle of the parallelogram of forces, or an equivalent one, from *a priori* notions, without appeal to experiment. The proposition commonly known as the parallelogram of forces may either be proved by direct experiment or by deduction from some such experimental principle as Newton's second law of motion. The advantage of the latter method consists, as the author points out, in the fact that he nature and extent of the experimental evidence for Newton's second law, or its equivalent, cause it to carry with it a greater certainty of its accuracy than is possible for a direct experimental demonstration of the proposition. This is a point to which it is most important to call attention, for, although Thomson and Tait have long since cleared away from the better class of text-books, and from the minds of the higher class of students, the fog which had accumulated around this essentially simple proposition, much of our school teaching is still enshrouded by it.

The second chapter treats of the growth of the principles of dynamics, understanding this in the more restricted sense of what Thomson and Tait called kinetics. This is of great interest and value throughout, but there are one or two points to which we would direct special attention.

The deduction of the approximate time of swing of a simple pendulum vibrating in a small arc, from a rectilinear simple harmonic motion, is, or at any rate should be, well known to students who have had the advantage of instruction from a Professor at one of our Universities ; but it is quite time that this very simple method of obtaining an important relation should take the place of the artificial and cumbrous methods which still disfigure some of the elementary text-books in common use. The criticism of Newton's exposition of the ideas of time, space, motion, and mass, is also worthy of careful study. These two chapters are of quite an elementary character, and may be read with advantage even by students whose mathematical acquirements are of the slenderest.

The third chapter treats of the further application of principles, and the deductive development of mechanics. It does not, like the first two chapters, appeal to the beginner, but will be most helpful to a student who has already made some progress in the subject.

The fifth chapter bears the heading, "The Formal Development of Mechanics." It contains an interesting discussion of isoperimetric problems, and a brief account of the analytical method of treatment introduced by Lagrange. It also contains a section mainly devoted to an account of the theological vagaries of some of the great mathematicians and natural philosophers. This section is not of very great interest or value, and may have been inserted merely to give a popular flavour to what is essentially a scientific book.

The volume concludes with a very brief chapter on the relations of mechanics to other branches of knowledge. G. W. DE T.

OUR BOOK SHELF.

Das Klima des ausser-tropischen Südafrika, mit Berücksichtigung der geographischen und wirtschaftlichen Beziehungen nach klimatischen Provinzen dargestellt. Von Dr. Karl Dove. 160 pp. and 3 charts. (Göttingen: Vandenhoeck and Ruprecht, 1888.)

METEOROLOGISTS must welcome the reappearance of the name of Dove among the contributors to climatological knowledge, and the present work does no discredit to the name. It is an endeavour to give a conspectus of the climate of South Africa as a whole ; and the author ekes out the actual meteorological results, which are somewhat scanty in parts, by evidence derived chiefly from the indigenous flora of the several districts, which he has collected from the published records of various travellers, such as Livingstone, Serpa Pinto, Fritsch, and others.

He limits the area of his discussion by biological considerations, as he defines the extreme southern limit of tropical Africa to be that fixed by the cultivation of the date-palm and the existence of the tsetse fly.

We have said that the records of observations are somewhat scanty, and this remark will be justified when we point out that from many stations the results for two years, or even less, are printed. The figures, such as they are, have been, however, most conscientiously discussed.

The area is divided into four great districts, classified according to the period of occurrence of the rainy season, viz. (1) the winter rains, (2) the intermediate region of spring and autumn rains, (3) the heavy summer rains, (4) the West Coast. Under (1), as subdivisions, we have the South-West Province, the Western Karroo, and the Little Namaqua Land. Under (2), the South Coast, South Karroo, North Karroo, and the South-East Mountain Land. Under (3), the Table-land of the Upper Orange River, the North Transvaal, the Kalahari, and the Great Namaqua and Damara Land.

After treating of these several regions at considerable length, Dr. Dove proceeds to discuss the possible development of agriculture in the different districts. His panacea for the Kalahari and some other tracts, with pure sandy surface, in the northern part of the area, is to introduce the date-palm.

He concludes the work with a discussion of the rainfall and its distribution, with some remarks on the question of the alleged deterioration of the climate by the drying up of the country. This effect he considers, with Mr. Gamble, to be merely the outcome of reckless forest destruction.

He points out the brilliant results obtained, at comparatively small cost, by the construction of reservoirs, as at Beaufort and at Van Wyk's Vley. R. H. S.

Chambers's Encyclopædia. New Edition. Vol. III. (London and Edinburgh: W. and R. Chambers, 1889.).

It may be enough to say of the third volume of the new edition of "Chambers's Encyclopædia" that it falls in no respect below the high level maintained in the preceding volumes. The editor is working upon a well-conceived plan, and he has every reason to be satisfied with the manner in which individual subjects are dealt with by his contributors. Scientific subjects continue to receive the attention which properly belongs to them in such a work as this. Tbe treatment of coal, coral islands, and geology generally has been intrusted to Prof. James Geikie, and his articles are admirable examples of compact and lucid exposition. Mr. J. Arthur Thomson writes of caterpillars, cells, crabs, &c.; Dr. Leonard Dobbin, of chemistry; Dr. Alexander Buchan, of climate; Mr. R. T. Omond, of clouds; and Dr. R. A. Lundie, of colour-blindness. Mr. C. J. Woodward has an article on crystallography, and Dr. W. Peddie treats of dew and diffusion. Of the articles on Darwin and the Darwinian theory, the former is contributed by Mr. Grant Allen, the latter by Prof. Patrick Geddes. There are a good many geographical articles, among which we may especially note the article on China, by Prof. Legge; that on the Congo, by Sir Francis de Winton; and that on Constantinople, by Mr. Stanley Lane-Poole. So far as we have been able to test the various papers, we have found them carefully written and thoroughly trustworthy.

The Elementary Principles of Electric Lighting. By A. A. C. Swinton. Second Edition. (London: Lockwood.)

The author explains generally the different apparatus used in electric lighting, and the broad princples of their working, using the "water-works" theory of the electric current, but at the same time carefully explaining that this is only done for the sake of convenience. An unfortunate mistake has been made in the diagram of the continuous-current dynamo (p. 24), where the coils are shown as wound in a different *sense* on the two limbs of the field-magnet. The book is, however, a remarkably clear exposition of the subject, and at the same time a model of conciseness.

The Natural History and Epidemiology of Cholera. By Sir J. Fayrer. (London: Churchill, 1888.)

The above formed the subject of the annual oration delivered by Sir Joseph Fayrer before the Fellows of the Medical Society.

The author deals at length in a most interesting way with the history of the disease, and then proceeds to enlarge upon its geographical distribution, habits, conditions, and epidemic movement. The ætiology of cholera is then dealt with, together with a review of those general and special precautionary measures it is desirable to adopt.

Throughout, the essay is written in a clear and interesting manner, and from the vast experience of the author in the subject the oration will well repay a careful perusal. William Robert Smith.

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 intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Halo and Mock Suns.

This morning a very distinct halo accompanied by mock suns on either side was seen here. As the latter, owing to the altitude of the sun, were at a considerable distance outside the halo, I think the following details are worth putting on record. At 11h. 12m., Berne time, the sun's altitude being 48° 30′, the distance from the halo to the left-hand mock sun was 9° 15′. The parhelic circle was plainly visible, reaching from the sun slightly beyond the mock suns. Each of the latter consisted of a reddish patch shading off into white and then into blue on the side away from the sun. From the brightest red to the brightest blue was about 2°, and the measurement 9° 15′ was taken from half-way between these to the nearest point of the circle dividing the red from the blue of the halo. It is difficult or impossible to measure such faint objects with the sextant. So I held a pencil at *both* arms' length, and noted the length on the pencil corresponding to the desired angle. Holding the pencil with both hands gives it a very definite distance from the eye, provided the position of the body and the altitude of the object be not much altered. Paying attention to these points I measured the angle subtended at my eye by a certain length on the side of a house, both with the pencil and a sextant. The angle 9° 15′ was found thence by simple proportion. I think the error of this measurement can hardly exceed 30′. The halo of course was the common one of 22°. James C. McConnel.

Davos Platz, April 5.

On the Connection between Earth Currents and Changes in Solar Activity.

May it not be that, in the recent experiments of Mr. Hertz on the effect of ultra-violet light on electric discharge, we have an explanation of the relation existing between disturbances on the solar surface and disturbances in earth currents?

The evidence for such a connection is obtained from the Greenwich records.

If we make the not very violent assumption that two clouds differ in potential from each other and from the earth, it will be seen that the earth will act as a condenser, and underneath each cloud will be collected a charge of opposite sign.

With sunlight, Hertz failed to find any marked effect, probably on account of absorption in the cloud regions of our atmosphere, which, as Langley has shown, takes up with great avidity the violet and ultra-violet rays.

May it not be that in clouds we have conditions especially favourable to the production of the Hertz effect? If so, the discharge from one cloud to another would be accompanied by an earth current in the opposite direction, as in the theory proposed by Prof. Stokes, in which a decrease of resistance is produced by an increase of heat from the sun.

Hertz found his effect (*Wied. Ann.*, xxxi. p. 993) much more marked in a medium under diminished pressure.

Under 300 millimetres of mercury, he finds that the ultra-violet radiation will nearly *quadruple* the length of spark obtained without it, while under ordinary atmospheric pressure it would scarcely *double* it. But this is the very circumstance which is realized in the case of clouds.

There is also reason to think that solar outbursts are especially rich in these rays of short wave-length which are required to explain the phenomena. HENRY CREW.

Haverford College, U.S.A., March 22.

Hertz's Equations in the Field of a Rectilinear Vibrator.

RECURRING to Hertz's equations for the field of the rectilinear vibrator, it appears to me that, while his conclusions are sound as regards the forces at points very distant from the vibrator, they require modification for the rest of the field. In fact, the principles upon which the question is investigated require that the electromotive force in the direction of z should become evanescent close to the vibrator (the axis of z).

The general form of Π is either—

$$\frac{M \sin \frac{\rho}{\lambda}}{\rho} . \sin nt, \text{ or } \frac{M \cos \frac{\rho}{\lambda}}{\rho} . \sin nt,$$

where λ large, and $\lambda n = \frac{1}{A}$, or, of course, the sum of the two forms.

In assuming for points near the origin (say the middle point of the vibrator) the approximate expression—

$$\frac{M}{\rho} \sin nt,$$

Hertz, in point of fact, takes the second of the above forms for Π, for this reduces to $\frac{M}{\lambda} . \sin nt$ when $\frac{\rho}{\lambda}$ is very small.

But this assumption makes both Π and Z infinitely great close to the vibrator. Whereas, by assuming the former of the two forms, or—

$$\frac{M \sin \frac{\rho}{\lambda}}{\rho} . \sin nt,$$

i.e. near the origin $\Pi = \frac{M}{\lambda} \sin nt$, we get, as a general expression for Z—

$$Z = M \left\{ \left(\frac{1}{\rho^3} - \frac{3z^2}{\rho^5} + \frac{z^2}{\lambda^2 \rho^3} - \frac{1}{\lambda^2 \rho} \right) \sin \frac{\rho}{\lambda} - \left(\frac{1}{\lambda \rho^2} - \frac{3z^2}{\lambda \rho^4} \right) \cos \frac{\rho}{\lambda} \right\} \sin nt,$$

and, as ρ is indefinitely diminished, this reduces to—

$$- \frac{2}{3} \frac{M}{\lambda^3} \sin nt$$

as a limiting value.

For distant portions of the field, Hertz's results as to the laws and amplitudes of the forces electric and magnetic remain unaltered.

Of course, the whole investigation, with such a simple assumption as to the nature of the field, must be regarded as only approximate. For any given form of vibrator—as, for example, a straight wire connecting two spheres—the exact treatment will be very difficult. In the simplest conceivable case of a spherical metal sheet with an induced Q_n distribution left to itself, the analysis is intricate (see a paper by Prof. J. J. Thomson to the Mathematical Society of London, January 1884). H. W. WATSON.

Berkswell, March 29.

Early History of Lightning-Conductors.

CAN any of your readers refer me to the sources of some of the late Mr. Richard Anderson's information with regard to the early history of the lightning-conductor? (1) On p. 27 of the third edition (1885) of his book, "Lightning-Conductors," he states that Franklin, in the 1758 issue of "Poor Richard," gave directions for the erection of lightning-conductors. (2) On p. 25 he refers to Prof. Winthorp, of Boston, having, in 1755, defended the lightning-conductor against a parson who had attributed a Massachusetts earthquake to the innovation. I should be much obliged for any reference to a library where a copy of "Poor Richard" for 1758 could be found; or, again, for any information with regard to Winthorp's defence of the lightning-conductor.

Prof. Meidinger, of Karlsruhe, who is preparing a second edition of his "History of Lightning-Conductors," is extremely desirous of verifying these details of their early history, and I should be glad if any of your readers could supply me with information for him on these points. KARL PEARSON.

University College, April 9.

The Satellite of Procyon.

MR. J. M. BARR's suggestion (NATURE, March 28, p. 510), as to the use of photography to ascertain whether there is any close companion or satellite to Procyon, would be considered a very desirable one by astronomers, in order to set at rest the question whether a companion can actually be discovered near the assumed place of the hypothetical one, of which the elements were given by Dr. Auwers in 1861, from investigations of the irregularity in the proper motion of Procyon observed by Bessel in 1844, and by Mädler in 1851. The orbit was computed on the assumption of a circular motion in a plane perpendicular to the line of sight round a point about 1''·2 distant, having a period of about 40 years, the position angle for 1873 being about 90°, so that the present angle would be about 234°, or about 9° per annum.

I fear, however, serious instrumental difficulties would arise in obscuring such a brilliant object as Procyon in a large telescope by a screen, so as to get the impress on a plate of a probably faint companion at the extremely close distance of two to three seconds of arc.

This difficulty, no doubt, must have presented itself to the minds of the astronomers at the Lick Observatory, California, or they would have tried the sensitive plate with the 34-inch photo lens of the great refractor, instead of examining Procyon visually with the 36-inch glass, as was done by Mr. S. W. Burnham on the early morning of November 18 last, with the following record:—"*Procyon.*—Carefully examined with all powers up to 3300 on the 36-inch under favourable conditions. Large star single, and no near companion."

If this means that no companion was seen within 10'' or 12'' radius, it makes the matter very perplexing, as Otto Struve measured a supposed new companion in 1873 with the 15-inch refractor at Pulkowa—the mean of several measures for March 28 being P. angle 90°·24, and distance 12''·49, and for 1874 (April 10) P. angle 99°·6, and distance 11''·67. This companion was looked for at Washington with the 26-inch refractor on several occasions from November 1873 till January 1876, and by the three Clarks (father and two sons) with the McCormick 26½-inch refractor, then completed at Cambridgeport, Massachusetts, but Struve's companion could not be seen with either instrument, and I am not aware that it has since been seen by Struve himself with the new Russian 30-inch refractor. The Washington observers at that time, however, gave estimated places for three new companions, supposed to be seen by them as follows:—

No. 1. Position angle, about 10°, and distance about 6''.
,, 2. ,, ,, ,, 36° ,, ,, ,, 8''·8
,, 3. ,, ,, ,, 50° ,, ,, ,, 10''

These appear (if they have an existence at all) to have been missed with the 36-inch glass at the Lick Observatory, as above referred to.

It is a singular coincidence that the position-angles of the companion supposed to have been seen by Otto Struve in 1873 and 1874 agreed with the orbital places computed by Dr. Auwers, but its distance involved the assumption of an enormous mass to Procyon for the parallax assigned to the principal star. ISAAC W. WARD.

Belfast, April 1.

Factors of Numbers.

THE processes given by Mr. Busk at p. 413 of NATURE are an interesting step towards the *practical* solution of the difficult problem of finding the factors of any number. In this article the processes are put in an algebraic form, which both shows more clearly the nature of the processes, and brings out the conditions necessary for their *practical* success (*i.e.* with any moderate labour): it will appear that with high numbers the labour involved would be prohibitory except in [1] favourable cases.

Let N be the number to be resolved into factors. Rejecting even numbers as obviously divisible by 2, *odd numbers only* require to be considered. If two integers, A, B, can be found such that—

$$N = A^2 - B^2,$$

the problem is solved, the factors being (A + B), (A − B). There is one universal solution which includes primes, viz.

$$A + B = N,\ A - B = 1\ ;\ A = \tfrac{1}{2}(N + 1),\ B = \tfrac{1}{2}(N - 1).$$

The problem is to find other solutions, if any exist. Certain limits may be at once assigned to A, B, viz.

(1) A, B are *minima* together, viz.

$A = \sqrt{N}$, $B = 0$, when N is a perfect square.

$A = \sqrt{N + \alpha}$ (the integer next $> \sqrt{N}$), and $B = \sqrt{A^2 - N} = \alpha$, when N is not a perfect square.

(2) A, B are *maxima* together, viz. when they are successive integers. This gives the universal solution above.

This gives a very wide range, wider for B than for A, viz.

A from $\sqrt{N}$ to $\tfrac{1}{2}(N + 1)$, B from 0 to $\tfrac{1}{2}(N - 1)$.

The two processes of Mr. Busk, somewhat generalized, amount virtually to this. Try first if N be a perfect square: if so, the factors are $\sqrt{N}$, $\sqrt{N}$. Next, if N be not a perfect square, assume any trial integer value for either A or B (within above limits, of course). Then, if either $(A^2 - N)$, $(B^2 + N)$ be a perfect square, it is the other sought square B^2 or A^2, and the thing is done.

But, if not, let A be increased, or let B be decreased by some integer r, such that $(A + r)$, $B - r)$ lie within above limits; then, if either $\{(A + r)^2 - N\}$ or $\{B - r)^2 + N\}$ be a perfect square, it is the other sought square, viz. B^2 or A^2, and the thing is done.

To do this thoroughly, *i.e.* to make *certain of not missing* the right value of $(A + r)$ or $(B - r)$, it seems absolutely necessary to work systematically, *i.e.* either—

(i.) begin with the *minimum* value A = integer next $> \sqrt{N}$, and work upwards, or—

(ii.) begin with the *maximum* value $B = \tfrac{1}{2}(N - 1)$, and work downwards,

trying *all* integer values of r in succession, $r = 1, 2, 3$, &c., until a perfect square is reached, or until, finally, the maximum value of r is reached, given by—

(i.) $A + r = \tfrac{1}{2}(N + 1)$, which gives $B = \tfrac{1}{2}(N - 1)$,

(ii.) $B - r = 0$, which gives $A^2 = N$, which is by hypothesis not a perfect square,

which ends the process, and shows conclusively—if no perfect square be reached earlier—that N is a prime.

An important practical help in working either process is given by Mr. Busk, in a simple way of forming the successive quantities $\{(A + r)^2 - N\}$, $\{(B - r)^2 + N\}$ by the successive addition or subtraction of a series of simple "differences," thus—

(0) Write down the starting quantity, $(A^2 - N)$ or $(B^2 + N)$.

(1) Add $(2A + 1)$ or subtract $(2B - 1)$, giving results $\{(A + 1)^2 - N\}$ or $\{(B - 1)^2 + N\}$,

(2) Add $(2A + 3)$ or subtract $(2B - 3)$ *more*, giving results $\{(A + 2)^2 - N\}$ or $\{(B - 2)^2 + N\}$,

and so on; and as the rth step—

(r) Add $(2A + 2r - 1)$ or subtract $(2B - 2r - 1)$ *more*, giving results $\{(A + r)^2 - N\}$ or $\{(B - r)^2 + N\}$.

Nothing simpler could be wished than this as a process, especially as it is exactly suited to be done mechanically upon an arithmometer.

The labour liable to be involved in the work is a serious practical drawback. Both processes are rapid when r is small, and tedious when r is large. Process (i.) is most rapid when the factors are nearly equal, and process (ii.) when they are extremely unequal; but as these conditions cannot be recognized *a priori*, selection of either process is only guesswork. A *suitable* selection of the starting numbers A, B, *i.e.* by taking A higher than the minimum (and yet not too high), or by taking B lower than the maximum (and yet not too low), *may* of course immensely shorten the process; but such selection is at present pure [1] guesswork. In fact, if with such arbitrary starting values of A, B, a perfect square is not reached by the end of the process, *no conclusion can be drawn*, but the process must be tried again with values of A, B nearer to the really safe starting values. Both processes are most tedious of all for prime numbers, when the number of steps (r) required is—

$$\text{In (i.), } r = \tfrac{1}{2}(N + 1) - \sqrt{N + \alpha}\ ;\ \text{in (ii.), } r = \tfrac{1}{2}(N - 1),$$

a number so large as to be practically prohibitory for high numbers.

Some shortening process is much required. One such is proposed (on p. 414) for odd numbers, but (unless it has been misunderstood by the writer) it is certainly not so *in general*. It appears to amount to this:—

If N be not a perfect square, subtract it from the two next higher squares, thus forming $\{(A + 1)^2 - N\}$ and $\{A^2 - N\}$. If either of these be perfect squares, the question is solved by what precedes; but, if not, subtract them from any two successive higher squares of say (C + 1), C, such that (C − A) is an odd number, thus forming—

$$[(C + 1)^2 - \{(A + 1)^2 - N\}] \text{ and } [C^2 - (A^2 - N)],$$

and divide each of these by their difference, *i.e.* by 2(A − C).

If they be not evenly divisible, increase the number C by the even integers, 2, 4, 6, &c., successively, trying the divisions again at each step, until after say m steps, the two results

$$[(C + 2m + 1)^2 - \{(A + 1)^2 - N\}],\ [(C + 2m)^2 - (A^2 - N)],$$

are both evenly divisible by their difference, *i.e.* by $2(A - \overline{C + 2m})$. To the quotients so formed add the original quantity (A + 1) or A, as the case may be.

The two resulting quantities will be found (on reduction) to reduce alike to the simple form—

$$\tfrac{1}{2}\left(\frac{N}{P} + P\right), \text{ where } P = (A - \overline{C + 2m}) \text{ for shortness,}$$

and this turns out to be actually the larger of the two numbers whose square is sought, since its square exceeds N by a perfect square, for—

$$\left[\tfrac{1}{2}\left(\frac{N}{P} + P\right)\right]^2 - N = \left[\tfrac{1}{2}\left(\frac{N}{P} - P\right)\right]^2 \text{ a perfect square,}$$

and the two factors are now seen to be $\frac{N}{P}$ and P.

The process thus appears to be really a roundabout way of finding by repeated trial the smaller factor P or $(A - \overline{C + 2m})$. Direct trial division of N by the series of factors A, (A − 2), (A − 4), &c., would *probably be simpler*. In applying the author's process it seems essential—in order to *avoid missing the right value* of $(C + 2m)$—to start with the lowest value C = 0 or 1 (according as A is odd or even), and work steadily on until an even division by $(A - \overline{C + 2m})$ is reached, ending finally with the value $A - \overline{C + 2m} = 1$, which would show conclusively—if no even division be reached earlier—that N is a prime; but if the start be made with a higher value of C, and no even division be met with till the final step of $A - \overline{C + 2m} = 1$, then no [2] conclusion can be drawn, and a fresh start must be made with a lower value of C.

The process will be rapid when m is small—*i.e.* when the

[1] Mr. Busk's examples are favourable cases.

[1] Mr. Busk's example of process (ii.) (NATURE, p. 415) is a good instance of a purely *lucky* success in starting with B = integer next $< \sqrt{N}$. Let the same be tried on N = 69, 93, 123, &c., and it will fail (such a start being, in fact, illegitimate). Mr. W. H. H. Hudson's statement (NATURE, p. 511), that process (ii.) is "not one of general application," failing, for instance, for N = 323171, is a mistake: it fails solely from starting with B too low. The values in process (ii.) are: A = 2250, $B - r = 2177$, and $N = 4427 \times 73$; this process will of course fail if started with a value of B < 2177. This is a good instance of a case very tedious by either process: in fact, the number of steps necessary (if worked without guesswork) will be found to be $r = 1681$ by process (i.) and 159·408 by process (ii.), which are practically prohibitory.

[2] Mr. Busk's example on p. 414 of NATURE is a good instance of this. Applying it to the number N = 73, the start is made with the value C = 6; the process ends really with showing that $73 = 37^2 - 36^2$, and does not (of itself) warrant the inference that 73 is a prime.

factors are nearly equal, and will be tedious when m is large—*i.e.* when the factors are very unequal; and most tedious of all when N is a prime, when the number of steps (m) required will be $m = \frac{1}{2}(A - 1)$ or $\frac{1}{2}(A - 2)$, according as A is odd or even, which is obviously a very high number for high numbers N.

A different "shortening process" is proposed (by Mr. Hudson) on p. 511 of NATURE, which amounts to this. When the two numbers $(A + r)$ and $\{(A + r)^2 - N\}$, or, again, when the two numbers $(B - r)$ and $\{(B - r)^2 + N\}$, have a common measure, that common measure is (as is easily seen) one of the factors of N; and, if it can be recognized, at once solves the question. Unfortunately, this will be in general of little *practical* help, except when one of the four numbers operated on is quite small, as otherwise it is not easy to recognize (quickly) the fact of there being a common measure.

ALLAN CUNNINGHAM,
Chatham, March 30. Lieut.-Col. R.E.

THE GEOGRAPHICAL RESULTS OF MR. STANLEY'S EXPEDITION.

IT is evident from Mr. Stanley's stirring letters, which during the past week have cast all other topics into the shade, that pioneering in Africa is not yet at an end, and that that strange continent has not yielded up its last wonder to knowledge. The letters are suggestive of many things. Much could be said in admiration of the heroism and generalship displayed; much as to the difficulties encountered and the sufferings and losses sustained; much as to the route selected, and much as to the conduct of the party left at Yambuya. But in the first place this is hardly the proper place to speak of these aspects of the expedition, and in the second place it is only fair to wait for the full narrative before venturing upon criticism. No one who knows Mr. Stanley had ever any doubt of his success, or could ever believe that he would allow himself to die before accomplishing his work. It is clear that to anyone who has it in him to do heroic deeds there is still ample scope in Africa.

What we have to do with here are the geographical results of Mr. Stanley's expedition. And here again we are met by the fact that the expedition was not properly one of exploration; at least, this feature was only secondary to the main object of the expedition, the "relief" of Emin Pasha, himself a contributor to science of high rank. Again, even the communication to the Royal Geographical Society can only be regarded as a few preliminary notes on the additions made to our knowledge of one of the most interesting regions in Africa; for the full results, which cannot but be of high value and interest, we must wait for Mr. Stanley's full narrative, which will doubtless include the results obtained by the scientific members of his staff. As the region through which the expedition passed was previously entirely unknown, fresh additions to our knowledge were inevitable. As to the character of this region, it is evident that, so far as time and danger and difficulties are concerned, no worse route could have been chosen. It is now well known that the Committee and Mr. Stanley yielded to influences which ought not to have weighed with them, in view of the main purpose of the Expedition, and that Mr. Stanley's own preference would have been for the East Coast route. Had this route been selected, no doubt there might have been difficulties with the Masai; forests would have had to be traversed, deserts crossed, and swamps trudged through; but all these obstacles combined would have been trifling compared with the terrors of the Aruwimi jungles, and their suspicious and ferocious inhabitants. However, Science has nothing to complain of: the gain has been all on her side.

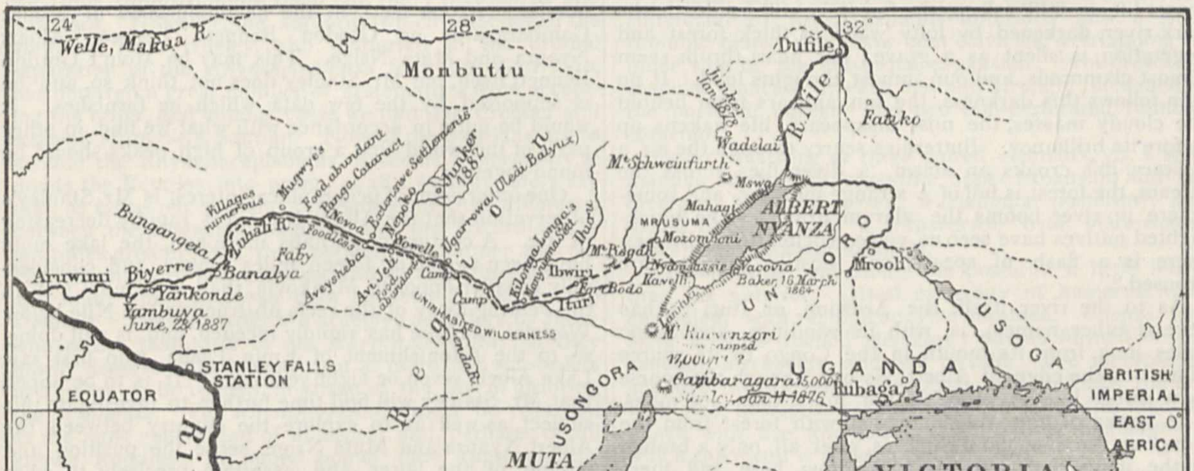
Mr. Stanley has passed through one of the great blanks of Central Africa. Much of it was untrodden even by the deadly foot of the Arab slaver. Dr. Junker just touched its northern fringe; he had reached the Nepoko River apparently in its upper course; but from about 3° N. to about 4° S., and between the Upper Congo on the west and the lakes on the east, we have virtually a great blank. It is the northern part of this blank which Mr. Stanley has enabled us to fill in; and when he comes home he will probably be able to tell us more than we yet know. In the particular region with which he was concerned we wanted to know the course of the Aruwimi and its tributaries; the character of the country and people through which it passes; the position and extent of the lake (Muta Nzigé) to the south of Albert Nyanza, and its relation either to the Nile or the Congo. Some of these problems Mr. Stanley has solved; others, no doubt, he will have solved by this time.

One thing is clear, the Expedition passed through the northern section of what is probably the greatest forest region in Africa, extending from about 3° N. to 4° S., and from about 23° to 30° E. Junker met with it on the Nepoko, and Livingstone in his weary journey from Tanganyika to Nyangwe. It was dense enough in both cases, but nothing apparently compared with what Stanley found it to be on the Aruwimi. The route, he tells us, was covered with creepers varying from ¼ of an inch to 15 inches in thickness, swinging across the path in bowlines or loops, sometimes matted and twisted together; also of a low, dense brush occupying the sites of old clearings which had to be carved through before a passage was possible. Where the clearings had been abandoned for some years was found a young forest, the spaces between the trees choked with climbing plants and vegetable creepers. This had to be tunnelled through before an inch of progress could be made. Mr. Stanley's description of the character and extent of this forest in his letter to Mr. Bruce is quite worth quoting:—

"Take a thick Scottish copse, dripping with rain; imagine this copse to be a mere undergrowth, nourished under the impenetrable shade of ancient trees, ranging from 100 to 180 feet high; briars and thorns abundant; lazy creeks meandering through the depths of the jungle, and sometimes a deep affluent of a great river. Imagine this forest and jungle in all stages of decay and growth—old trees falling, leaning perilously over, fallen prostrate; ants and insects of all kinds, sizes, and colours murmuring around, monkeys and chimpanzees above, queer noises of birds and animals, crashes in the jungle as troops of elephants rush away; dwarfs with poisoned arrows securely hidden behind some buttress or in some dark recess; strong brown-bodied aborigines with terribly sharp spears, standing poised, still as dead stumps; rain pattering down on you every other day in the year; an impure atmosphere, with its dread consequences, fever and dysentery; gloom throughout the day, and darkness almost palpable throughout the night; and then, if you will imagine such a forest extending the entire distance from Plymouth to Peterhead, you will have a fair idea of some of the inconveniences endured by us from June 28 to December 5, 1887, and from June 1, 1888, to the present date, to continue again from the present date till about December 10, 1888, when I hope then to say a last farewell to the Congo forest."

Here, then, we have a forest region very different from any other forest region of any extent in Africa. Prof. Drummond, in his recent book on Africa, describes very clearly the typical forest of Central and Southern Africa; the trees mostly standing apart, with very little brushwood, and in many places no difficulty in penetrating it even with a Cape cart. The rank exuberance of the Aruwimi forest can hardly be due to the abundance of water in the shape of lakes and rivers; for away south in the region recently traversed by Mr. Arnot, the region described by Livingstone as a great sponge, where the feeders of the Zambesi, the Congo, and other great rivers, take their rise, and on the east of which lie Tanganyika and Bangweolo lakes, we find, so far as we know at present, no such dense bush, though the grass is high, and rank, and thick enough. Mr. Stanley attempts to account for the abundance of water and the thickness of the forest by the moisture carried over the continent from the wide Atlantic, by the winds which blow landwards through a great part of the year. But as a comparatively cold current sweeps along the coast from the south, these winds may be colder than the surface of the land over which they pass, and so may decline to part with their moisture. But this is a point for careful investigation; and it may after all be found that the rain of the rainiest region of Africa comes not from the Atlantic but the Indian Ocean, with its moisture-laden monsoons; and so we should have here a phenomenon analogous to that which prevails in the South American continent, the forests of which resemble in many features those of the region through which Mr. Stanley has passed.

The forest itself is not more interesting than its human denizens. Mr. Stanley mentions the names of many tribes living along the river, and judging from their names they seem all more or less of Bantu affinities. But we are here



verging on the limits of the Negro peoples, so that when we obtain full information it may be found that the Aruwimi tribes are much mixed. But it will be of the greatest interest to ascertain what has been the effect upon these peoples of their sad and depressing and ever-saturated surroundings; and to compare the results with what we find to be the case in more open country with people of the same type. That there have been changes in the population of the region is evident from the great heaps of oyster-shells met with by Mr. Stanley, some of them covered by several feet of earth. One important piece of information Mr. Stanley gives us concerning these forest tribes. Nejambi Rapids, about 250 miles above the junction of the Aruwimi and the Congo, marks the division between two different kinds of architecture and language. Below, the cone huts are to be found; above the rapids we have villages, long and straight, of detached square huts surrounded by tall logs, which form separate courts, and add materially to the strength of the village. Many precautions are adopted against attacks by poisoned arrows. Mr. Stanley lost several men by these arrows, and Lieutenant

Stairs had a narrow escape. It was afterwards found that the poison is manufactured from the dried bodies of red ants or pismires ground into powder, cooked in palm-oil, and smeared over the wooden points of the arrows. As might have been expected, the forest is haunted by myriads of insects of every variety, and it is to be hoped that a harvest of these have been gathered for the delight of the entomologists at home.

Mr. Stanley's description of the daily course of things in the forest region is worth quoting:—

"The mornings generally were stern and sombre, the sky covered with lowering and heavy clouds, at other times thick mist buried everything, clearing off about 9 a.m., sometimes not till 11 a.m. Nothing stirs then; insect life is still asleep, the forest is still as death, the dark river, darkened by lofty walls of thick forest and vegetation, is silent as a grave; our heart-throbs seem almost clamorous, and our inmost thoughts loud. If no rain follows this darkness, the sun appears from behind the cloudy masses, the mist disappears, life wakens up before its brilliancy. Butterflies scurry through the air, a solitary ibis croaks an alarm, a diver flies across the stream, the forest is full of a strange murmur, and somewhere up-river booms the alarum drum. The quick-sighted natives have seen us, voices vociferate challenges, there is a flash of spears, and hostile passions are aroused."

As to the river itself, the Aruwimi, or Ituri (it has several other names), is, with its windings, about 800 miles long, from its mouth in the Congo to its source almost on the edge of Albert Nyanza, though the course in a direct line is probably not more than 400 miles. The banks of the river, covered with forest from the Congo to the Nepoko (which is, after all, only a branch of the main river), are uniformly low, here and there rising to about 40 feet. Above the Nepoko, hills begin to crop up more frequently, palms are more numerous, and the woods show the tall, white-stemmed trees so characteristic of the slopes of the Lower Congo. While there are rapids at several places above Yambuya, above the Nepoko navigation becomes much more difficult, and rapids more frequent, while two considerable falls are met with. The land rises steadily until about 400 miles above Yambuya, the river is contracted into a rushing stream about 100 yards wide, banked by the steep walls of a cañon, the slopes and summits of which are clothed with wood. Whatever changes the face of the land may show, the forest covers peak, hill, ridge, valley, plain,—everywhere it is continuous, never broken, except at such clearings as man has made. Mr. Stanley very graphically compares the country traversed by his expedition to the long glacis of a fort rising from the Congo to a height of 5000 to 6000 feet; down the slope flows the Aruwimi, one of whose feeders runs almost within sight of Albert Nyanza, to which there is a sudden drop of 2900 feet.

"The main Ituri, at the distance of 680 miles from its mouth, is 125 yards wide, 9 feet deep, and has a current of 3 knots. It appears to run parallel with the Nyanza. Near that group of cones and hills, affectionately named Mount Schweinfurth, Mount Junker, and Mount Speke, I would place its highest source. Draw three or four respectable streams draining into it from the crest of plateau overlooking the Albert Nyanza, and two or three respectable streams flowing into it from north-westerly; let the main stream flow south-west to near N. lat. 1°; give it a bow-like form N. lat. 1° to N. lat. 1° 50′; then let it flow with curves and bends down to N. lat. 1° 17′ near Yambuya, and you have a sketch of the course of the Aruwimi or Ituri from the highest source down to its mouth, and the length of this Congo tributary will be 800 miles."

Here, then, we have remarkable hydrographical conditions. Only a few minutes' walk separates the feeders of the Congo and the Nile in this particular region. On the other side, again, are found streams flowing into the south of Victoria Nyanza rising close to others which run into Lake Tanganyika, which again, through the Lukuga, is believed to be a feeder of the Congo. Still further south are found the main Congo stream and its feeders rising in such close proximity to the source of the Zambesi that it is difficult to discrimate between the one and the other. Mr. Stanley's own lake, the Muta Nzige, of which he heard again when in the neighbourhood, very probably belongs not to the Nile but the Congo. All this is full of interest, and geographers will look with impatience for the publication of Mr. Stanley's detailed narrative.

Another fact of great interest Mr. Stanley refers to—the existence of a snowy mountain which may rival Kilimanjaro (19,000 feet), in the neighbourhood of Mount Gambaragara, or Gordon Bennett, between Albert Nyanza and Muta Nzige. This may be Mount Gordon Bennett itself, but Mr. Stanley does not think so, and he is supported by the few data which he furnishes. It would be quite in accordance with what we find in other parts of the world that a group of high peaks should be found together.

One other point of geographical interest is Mr. Stanley's observation that the Albert Nyanza is rapidly decreasing in size. A century or perhaps more ago, the lake must have been twelve or fifteen miles longer, and considerably broader opposite Mbakovia, than it is now. With the wearing away of the reefs obstructing the Nile below Wadelai, the lake has rapidly receded, and is still doing so, to the astonishment of Emin Pasha, who first saw Lake Albert seven or eight years ago. It is to be hoped that Mr. Stanley will find time further to investigate this subject, as well as to explore the country between the Albert Nyanza and Muta Nzige, settle the position and outline of the latter, and ascertain precisely to what river system it belongs.

The abruptness with which the forest comes to an end and the rich grass lands begin, about eighty miles from Albert Nyanza, is another point deserving special attention, and can only be explained when we have accurate observations of the rainfall and other conditions that go to form climate.

Such are some of the more important geographical results of Mr. Stanley's expedition, so far as we can gather from his preliminary letters; others may be derived from the map which accompanies his papers. More will no doubt follow. It is to be hoped that the rumour of Emin's return is not true, or at least that if he is coming to Europe he has left his province in efficient hands. In the interests of science as well as of humanity, it is important that the province which Emin has held so long may not be allowed to relapse into barbarism.

J. S. K.

A NEW PERMIAN RHYNCHOCEPHALIAN REPTILE.[1]

AMONG the many publications which have recently startled the palæontological world, one of the most important is unquestionably Dr. Hermann Credner's description of *Palæohatteria*, a new Permian Rhynchocephalian from the Plauen beds near Dresden—beds which have supplied the same author with copious material of Stegocephalians, both in the perfect and larval stages, the subject of his well-known admirable monographs. Great interest attaches to the present discovery from a purely zoological point of view, owing to the close relationship of this, one of the earliest of Reptiles, to the existing New Zealand *Sphenodon* (or *Hatteria*), the anatomy of which was first made known some twenty years ago by Dr. Günther in his classical paper in the Philosophical Trans-

[1] H. Credner, "Die Stegocephalen und Saurier aus dem Rothliegenden des Plauenschen Grundes bei Dresden," vii. Theil. *Palæohatteria longicaudata* (*Zeitschr. Deutsch. Geol. Ges.*, 1888, pp. 487-557, Pl. xxiv.-xxvi.).

actions (vol. clvii., 1867). Since that time *Sphenodon* (of which very few specimens were then known, and which was even supposed to be nearly extinct) has been found in abundance on various small islands in the Bay of Plenty, and has come into the hands of many anatomists, to the great benefit of reptilian morphology. An investigation of the development of this type is, unfortunately, still a desideratum, which, when supplied, cannot fail to throw great light upon the phylogeny of the Reptilia.

On the ground of its osteological structure and of the absence of copulatory organs, *Sphenodon* was recognized by Dr. Günther as the type of a distinct order, the *Rhynchocephalia*, a view in which he has been followed by Prof. Cope, who even goes further, and, very correctly as we think, approximates them to the *Plesiosauria* and *Chelonia*. However, the authority which attaches to the views of Prof. Huxley, who demurred to the ordinal separation of the *Rhynchocephalia* from the *Lacertilia*, has deterred a great number of systematists from accepting the order, and among these we find Dr. Credner still terming *Hatteria* a Saurian. Now, if the Saurians are to include the Rhynchocephalians, it seems unnecessary to divide the Reptiles into orders at all; we may safely say that, as far as our present knowledge goes, the difference between the Rhynchocephalians and the Lacertilians is ten times greater than that between the former and the Plesiosaurians, or between Crocodilians and Dinosaurians, and many times more so than between *Lacertilia* and *Ophidia*. The two latter are accepted as orders by those who refuse that rank to the *Rhynchocephalia*, but they hardly deserve to be looked upon as more than sub-orders in a group to be termed, in virtue of the law of priority, the *Squamata*. The *Rhynchocephalia* must be regarded as the most generalized of all recent and, perhaps, of all known Reptiles; in many points they approach the Stegocephalous Batrachians, and it is possible that the common ancestors of the *Chelonia*, the *Plesiosauria*, and the *Lacertilia* would fall in this order.

The following is Dr. Credner's definition of the new genus *Palæohatteria*:—

Habitus, that of a long-tailed lizard, 16 to 18 inches long, with robust limbs.

Vertebral column consisting of about six cervical, twenty dorsal, three or four distinct sacral, and fifty to fifty-five caudal vertebræ. Vertebral centra, solid amphicœlous sheaths which constrict but do not interrupt the notochord. Neural arches united to the centra by suture. Dorsal vertebræ with long anterior, caudal vertebræ with long posterior articular processes; no transverse processes; spinous processes of dorsal vertebræ elevated, with rounded upper border, decreasing rapidly on the tail to small tubercles, more and more posterior in position, and finally entirely disappearing. Small wedge-shaped intercentra between all præ-caudal and the anterior caudal centra; from the sixth caudal vertebra they are modified into chevrons. All præ-sacral, sacral, and the seven anterior caudal vertebræ with ribs. Dorsal ribs long and curved; cervicals straight; last dorsals short and feebly curved; sacrals short and stout; caudals short, hooked. Proximal extremity of ribs expanded, not divided into capitulum and tuberculum.

Skull pointed and compressed; orbits large and circular, with sclerotic ring; nostrils small, anterior; latero-temporal fossæ comparatively small. Dentition acrodont, the teeth acute and conical, slightly curved backwards at the extremity; a thin coating of dentine, which on the inner side of the basal third shows slight grooves. Præ-maxillaries distinct, each with three or four slender somewhat more strongly-curved teeth. Maxillary extending high up, armed with sixteen to eighteen teeth, of which the sixth and seventh are enlarged. Nasals nearly as long as the frontals. A large lachrymal between præ-frontal and maxillary. Jugal bordering the orbit inferiorly, bifurcating posteriorly into an ascending and a horizontal branch; the former forms with the post-orbital and the post-frontal a vertical post-orbital bar, the latter a horizontal bar with the quadrate.[1] Squamosal curved, fan-shaped, in contact anteriorly with the post-orbital, posteriorly with the horizontal branch of the jugal and with the quadrate. Basisphenoid a trapezoid plate with short lateral processes, with two small perforations near its anterior extremity, which tapers to the pointed præ-sphenoid. Vomer with hatchet-shaped groups of small teeth. Palatines with a series of teeth, parallel to the maxillaries, on the outer border. Mandibular ramus slender, straight, without coronoid process, formed of articular, angular, supra-angular, dentary, and probably also opercular and splenial.

Pectoral arch consisting of a long styliform episternum [interclavicle], which expands anteriorly into a small rhombic plate; two elbow-bent clavicles, overlapping the inner side of the episternal expansion; two crescentic scapulæ, truncate at each end and strongly thickened on the posterior border; and two non-perforated roundish coracoids.

Pelvis consisting of three paired elements, viz. a short massive ilium, with crest-like upper expansion and two diverging lower processes; a triangular posteriorly produced ischium; and a transversely oval, plate-shaped pubis with obturator foramen.

Limbs strong and stout, the posterior a little longer than the anterior. Distal extremity of humerus much expanded, with ectepicondylar foramen. Carpus with eight or nine ossified elements; tarsus formed of calcaneum, astragalus, and five tarsalia; five metacarpals and five metatarsals; five digits to both limbs, the first with two, the second with three, the third with four, the fourth with five, and the fifth with three phalanges, of which the distal is a sharp curved claw.

Abdominal ribs probably present, and formed of numerous small filiform bones.

An *armour* of small oat-seed-shaped scales, forming posteriorly diverging series, restricted to the ventral region between both pairs of limbs.

Among the most salient features in the structure of the new Reptile, as compared with other Rhynchocephalians, are the pelvis and the tarsus. The crest-like expansion of the costal border of the ilium and the bifurcation of its acetabular extremity, are, to a certain extent, Crocodilian or Dinosaurian, whilst the pubis and ischium appear to us to bear the greatest resemblance to the same in Plesiosaurians. It is also in the latter group that we have to look for so primitive and Batrachian-like a tarsus; for the tarsus of *Palæohatteria* affords an exact repetition of that of the likewise Permo-Carboniferous Plesiosaurian *Stereosternum*, which, on the ground of its five distal tarsalia has been made the type of an order, *Proganosauria*, by Dr. Baur. The close similarity of the dentition of *Palæohatteria* and that of certain contemporary Stegocephalians, especially *Dendrerpeton* and *Hylonomus*, is highly suggestive of relationship, and we are not surprised to hear from Dr. Credner himself of his having at first felt uncertain as to the class to which the fossil should be referred. Although unquestionably related to *Sphenodon*, *Palæohatteria* has, we venture to think, yet hardly a claim to enter the *Hatteriidæ*, and it would have been better had the author established for it a new family. The archaic condition of the humerus with both ent- and ect-epicondylar foramens, the presence of uncinate processes to the ribs, the absence of a ventral armour, the presence of a coronoid process in the mandible, and the share taken by the maxillary in the formation of the border of the orbit, a character common to the Chelonians and Plesiosaurians and certain Lizards, but not found in the Stegocephalians, the Ichthyosaurians, the Crocodilians, nor, we believe, in the other Rhynchocephalians, are

[1] What Dr. Credner calls "quadrate" is in reality quadrate + quadrato-jugal.

sufficient grounds for regarding the *Hatteriidæ*, with the single genus *Sphenodon*, as a different family.

Dr. Credner's paper also contains, incidentally, information on *Proterosaurus*, the structure of which is still, in spite of Prof. Seeley's recent investigations, very imperfectly known. In an example preserved in Freiberg, the author has discovered the interclavicle and clavicles, the former element closely resembling the same in *Palæohatteria*, whilst the latter is distinguished by its plate-like proximal expansion, which bears special resemblance to the so-called lateral pectoral plates of certain Stegocephalians. It appears almost certain that *Proterosaurus* was a Rhynchocephalian, but in many respects more specialized than *Palæohatteria*, intercentra being present only between the anterior cervical vertebræ, and the tarsus containing only six elements—three in the proximal and three in the distal row. G. A. BOULENGER.

THE SPECTRUM OF THE RINGS OF SATURN.

AN interesting note on the spectrum of Saturn's rings was communicated to the Royal Society on February 7 by Mr. Norman Lockyer. It has long been known that the rings are considerably more luminous than the planet, and the photographs by the Brothers Henry show that this is truer for the blue light than the more visible rays. It is therefore possible that they shine partly by their own light, and since it is now universally acknowledged that they consist of small bodies in motion, their spectrum has an important bearing on the meteoric hypothesis. Mr. Lockyer suggested that the additional luminosity might be due to collisions, and in order to determine whether the collisions were of sufficient intensity to produce incandescent vapours or not, he asked one of his assistants, Mr. Porter, to obtain a photograph of the spectrum. This was done at the Astronomical Laboratory at South Kensington, with a spectroscope having two prisms of 60° attached to the eye-end of the 10-inch equatorial. The photograph was taken with an exposure of about two hours, and shows decided indications of bright lines. Mr. Lockyer says:—"It is altogether too early to announce this as an established fact, but I think it well to send this note, in order that other observers with more powerful optical appliances and a better climate than that of London may investigate the question."

It is therefore very desirable that further inquiry should be made, both by photographic and eye observations. The bright flutings of carbon at wave-lengths 517, 474, and 564 should receive particular attention, the flutings being easily obtained for comparison from the flame of a spirit-lamp or wax vesta. Brightnesses may possibly occur also in the positions of the magnesium flutings at λ 500 and 521, the lead fluting at λ 546, and the manganese fluting at λ 558, all of which may be conveniently obtained for comparison by volatilizing the chlorides of these substances in the flame of a spirit-lamp or Bunsen burner.

It may be expected that the brightenings will be very feeble, owing to the masking effects of the more abundant solar light, so that the photographic method will probably give the best results on account of its power of integration.

In the same note, Mr. Lockyer states that "other considerations point to the possibility that bright lines or bands may be found in the spectrum of Uranus." A. F.

ON THE SPEED OF THE ELECTRIC TRANSMISSION OF SIGNALS THROUGH SUBMARINE CABLES AND LAND WIRES.

ELECTRO-TELEGRAPHIC operations for the determination of differences of longitude are usually so arranged as to furnish determinations of the speed of transmission of the electric signals. Each of two stations which are telegraphically connected is provided with a clock, and usually with a chronograph also; thus the clock-times at either station may be registered at will on the chronographs at both stations. The difference between the times indicated by the two clocks at any moment is thus readily ascertained, and two values of it will be obtained, one with the current transmitted in one direction, the other with it transmitted in the opposite direction. The difference between these two values indicates the sum of the speeds in both directions; and half the difference is usually called the "retardation on the line," as it indicates the amount by which every signal, on arrival at its destination, is slow on the time of its inception.

This method of determining the velocity is very simple and very exact; it does not require a knowledge of the errors of the clocks, or even of their rates, for the rates cannot sensibly alter in the brief interval between the signals with reversed currents, which need never exceed a few minutes.

The operations of two officers of the Indian Survey, Lieut.-Colonel Campbell, R.E., and Major Heaviside, R.E., for determining the differences of longitude between Bombay, Suez, and Aden,[1] furnish measures of the speed through two submarine cables which happen to be practically identical, though one cable was 355 knots, or as much as one-fourth, longer than the other cable. I gave the figures to Mr. W. H. Preece, of the Postal Telegraph Department, and he has found that they are very closely accordant with the theoretical speeds, calculated with due recognition of the different electrical conditions of the two cables. This is shown in the following table, in which Mr. Preece also gives the corresponding values by calculation and observation for the French Atlantic cable:—

Cable.	Length (knots).	Resistance (R) per knot.	Capacity (K) per knot.	KR per knot.	$L^2 \times KR$ per knot.	Thomson's constant, $a = \cdot 02332 \times KR$.	Apparatus time const. $a \times 1\cdot 55$.	Observed speed.
						sec.	sec.	sec.
Suez-Aden ...	1464	10·26	·358	3·67	7865162	·1809	·280	·280
Aden-Bombay ...	1819	6·60	·361	2·38	7874851	·1811	·281	·284
French Atlantic..	2584	2·93	·43	1·26	8413090	·196	·303	·3

For the speed of electric transmission through land lines, German geodesists have constructed an empirical formula on the assumption that the speed $= xl + yl^2$, l being the length of the line, and x and y two constants to be determined by observation. It is shown in the *Astronomische-geodätische Arbeiten* for the years 1883-84 and 1885-86, that, expressing l in kilometres,

$$\text{the speed} = 0\cdot0000208\text{s.}\ l + 0\cdot0000000206\text{s.}\ l^2$$

on the evidence of seventeen longitudinal arcs; and that on employing this formula to calculate the corresponding speeds in six arcs subsequently measured, the values obtained were found to differ 38 per cent. on the average from the observed speeds, and were generally quicker. This formula, however, takes no account of any differences in the electrical conditions of the lines. It gives 0·206s. and 0·302s. as the speeds of transmission through land lines 2700 and 3360 kilometres long, the lengths of the cables Suez-Aden and Aden-Bombay. The formula, however, cannot be legitimately applied to such long lines, for the longest of the seventeen on which the speeds were determined by observation, that from Berlin to Paris, was only 1230 kilometres. J. T. WALKER.

13 Cromwell Road, London, April 3.

[1] See vol. ix. of the "Account of the Operations of the Great Trigonometrical Survey of India." (Dehra Dun, 1883.)

NOTES.

THE Bakerian Lecture will be delivered to-day before the Royal Society by Profs. Rücker, F.R.S., and Thorpe, F.R.S. The subject is the Magnetic Survey of the British Isles for the epoch January 1, 1886, on which these gentlemen have been engaged for five years. They have made observations at more than two hundred stations, and have thus completed the first survey of the United Kingdom in which all three elements—the declination, dip, and horizontal force—have been determined for all parts. In addition to the general survey by means of which the directions of the isogonals, isoclinals, and lines of equal horizontal force have been found, special surveys have been made of selected districts in order to investigate the magnitude, direction, and causes of local magnetic disturbance. The principles which are justified by these inquiries have been applied to the whole country, with results which are likely to prove of interest both to physicists and geologists. We hope to give an account of the lecture in an early number.

PROF. MENDELEEF, the celebrated Russian chemist, has accepted the invitation of the Council of the Chemical Society to deliver the Faraday Lecture; he will probably give his mature views on the Periodic Law of the Elements, with which his name is so indissolubly connected. The lecture will be delivered by permission of the Managers of the Royal Institution in their theatre, on the evening of June 4. The Fellows of the Society will entertain Prof. Mendeleef at a dinner at the Holborn Restaurant the next evening; and the President, Dr. W. J. Russell, F.R.S., will hold a reception at the Grosvenor Gallery on June 7.

M. CHEVREUL, the famous French chemist, died on the morning of April 9 at the age of 102. He was born at Angers in 1786. During his long life he held many official appointments, and by his work as a chemist he secured an eminent place among the men of science of the present century. He constantly kept in view the possible applications of science to industry. Some of his discoveries have exercised an important influence on the manufacture of silk, and his researches relating to "fatty bodies of animal origin" marked an era in the development of various industries dependent on organic chemistry. M. Chevreul was a man of active and cheerful temperament, and extreme old age did not prevent him from continuing the studies in which he had found a perennial source of interest.

THE death is announced of the Finnish botanist, Prof. Sextus Otto Lindberg; and of Dr. Hermann Theodor Geyler, Director of the Botanical Gardens at Frankfurt. Dr. Geyler was born at Schwarzbach, in Saxe-Weimar, on January 15, 1835.

IN the House of Commons, on Tuesday, in connection with the vote for expenses incurred in the erection and maintenance of the buildings of the Department of Science and Art, Mr. Acland called attention to the inadequacy of the buildings used by the Normal School of Science. Mr. Acland's appeal, which was in no way exaggerated, received the cordial support of Sir H. Roscoe, who spoke of the condition of the buildings as "really a disgrace." Hon. members, he said, were hoping before long to have a technical Bill; but what would be the good of it unless proper teachers were provided? And proper teachers it was impossible to obtain unless their schools were what they ought to be. In almost every centre of population in foreign countries these normal schools were to be found, but there was only one in England. This had been built for one purpose, and converted to quite different purposes for which it was unfitted. The honour of the country was at stake, and this state of things had been borne quite long enough. Mr. Plunket, in his reply, declined to give any definite pledge about the matter. He had visited the buildings several times, and as one of the results of the debate of last year, the First Lord of the Treasury, the Chancellor of the Exchequer, the Vice-President of the Council, himself, and others made a most careful visit to every part of the building. One of the conclusions arrtved at was, that before additional buildings were erected it would be a good thing to get rid of a good deal of the material filling up the galleries at the present time. A Committee, consisting, among others, of Sir H. Roscoe, Lord Rayleigh, Sir B. Samuelson, and Lord F. Hervey, had been appointed for the purpose of weeding out those galleries in the science collections alone. Until that Committee had reported, it was impossible to take any further steps or to come to any definite decision with reference to increased expenditure to extend the buildings which at present existed.

A DEPUTATION from the National Association for the Promotion of Technical Education waited on Sir William Hart Dyke on Monday afternoon in the Conference Room at the House of Commons. In answer to the deputation, which was introduced by Lord Hartington, as President of the Association, Sir William Hart Dyke said the Government had the cause of technical education very much at heart, and would do their utmost to pass a Bill dealing with the subject during the present session. They would take into careful consideration the recommendations of the Association. He promised, meanwhile, that he would lay on the table of the House of Commons a memorandum explaining some of the difficult points of the Code in special reference to the instructions to be given to inspectors in carrying out the new provisions of the Code. He also promised that the subjects in which instruction might be given in evening schools should be increased from two to four.

AT the thirtieth session of the Institution of Naval Architects, yesterday, an important paper on the designs for the new battle-ships was read by Mr. W. H. White, F.R.S., Assistant Controller of the Navy and Director of Naval Construction.

THE Zoological Museum at Leyden, one of the most considerable on the Continent, has narrowly escaped a terrible disaster. On Monday, the 1st of this month, a fire broke out, and all the resources of the officials and of the town were taxed to extinguish it. Indeed, it was not got under until a considerable portion of the collection of specimens of hollow-horned Ruminants had been destroyed. Had the accident, which arose from the defect of a flue, taken place at night instead of in the afternoon, when plenty of assistance was promptly at hand, it is believed that the whole Museum would have perished. The authorities of other Museums, especially those which contain many spirit preparations, should not neglect this warning.

WE have already mentioned that an international meeting of zoologists will be held in Paris in August. The President will be M. Milne-Edwards, and some important questions will be submitted for consideration. Among them will be the question of the unification of the language of zoology in classification and specific denotation. M. R. Blanchard has prepared an important report on the subject, which will be published shortly in the *Revue Scientifique*, and form the basis for the discussions at the Congress.

THE Physiological Congress which is to be held in Basle in September will be attended by many French physiologists, if all those who propose to go are able to carry out their intention.

THE King of Sweden has selected Herr Ehrenheim, ex-Minister of State, as President of the forthcoming Oriental Congress in Stockholm. It is announced that Prof. R. L.

Beasley will represent the University of Cambridge; Oxford has not yet chosen its representative. The Shah and several Indian princes will send representatives.

THE Central Society of Agriculture of France has conferred upon Prof. J. C. Ewart the title of honorary member in recognition of the services he has rendered to the fishery industry by his "many and eminent labours."

THE *Kew Bulletin* for April 1888 contained a list of new garden plants described to the end of the year 1887. The *Bulletin* for the present month consists of a list of those described and published during the year 1888. The list has been extended to include the descriptions of new plants (and name alterations) which have appeared in several horticultural periodicals, that were not included in the former list. The number of new garden plants annually described in various English and foreign periodicals renders it a matter of considerable difficulty to botanists and horticulturists to keep them in view. The publication of a complete annual list of new garden plants is, therefore, as the editor explains, indispensable to the maintenance of a correct nomenclature, especially in the smaller botanical establishments in correspondence with Kew, as these, for the most part, are only scantily provided with horticultural periodicals. The editor also points out that such a list will afford information respecting new plants under cultivation at Kew, many of which will be distributed in the regular course of exchange.

A SEVERE shock of earthquake was noticed over the whole of South-East Japan on February 18. At Yokohama and at Tokio many houses were damaged. The shock continued for 6m. 12s., and was felt at Sendai, a town 45 geographical miles to the north of Tokio.

ON March 20, about 10 p.m., a slight shock of earthquake was felt near Carlstad, in Sweden. It was followed by a more severe shock at 3 a.m.

SEVERAL meteors have been observed recently in Scandinavia. On the evening of March 14, a brilliant meteor was seen at Molde, in North-West Norway, bluish-white in colour, and going in an easterly direction; and on March 21, at about 10 p.m., another was seen at Sarpsborg, on the Christiania fjord. It radiated in the west, and went in a southerly direction, displaying, during its passage, rainbow colours, and leaving a reddish trail behind. What may have been the same meteor was seen off the coast of Gothenburg, at 10.22 p.m., a considerable distance further south. It was very brilliant, and bluish-green in colour, and its passage—in a direction south-west-north—occupied fifty seconds.

THE atomic weight of chromium has been redetermined by Mr. Rawson, of University College, Liverpool. Previous determinations, of which there have been many, have resulted in placing the value somewhere between 52·0 and 52·5. The method employed by Mr. Rawson appears to have been an exceptionally accurate one, there being no transference from one vessel to another, no filtrations and consequently no burning of filter papers. The plan of operations consisted in first reducing a known weight of pure ammonium dichromate with alcohol and hydrochloric acid to chromic chloride, and subsequent estimation of the oxide produced by direct precipitation with ammonia. The purest obtainable ammonium dichromate, $(NH_4)_2Cr_2O_7$, was repeatedly recrystallized, dried for a couple of days at 100° C., and finally for a fortnight in a desiccator. The water used in the estimations was trebly distilled, and, on evaporation of 100 cubic centimetres, no residue was obtained. The purest commercial hydrochloric acid was redistilled, and the distillate in like manner gave no residue on evaporation. Similarly, the ammonia solution and the absolute alcohol were redistilled, until absolutely free from impurities. The method of vibrations was employed in weighing, and the platinum dish used in the operations was counterpoised by a similar dish of nearly equal weight, the slight difference being made up by a piece of platinum-foil. The two dishes were always treated alike: when one was placed on the water-bath, the other was also placed on a water-bath, and for the same time; they were both ignited for the same length of time, and, after ignition, were simultaneously placed in desiccators. In this way the usual errors in weighing platinum after such treatment were eliminated. During the experiments, the dishes were protected by covers of platinum-foil, which were not, however, weighed with them. In the actual experiments, the finely ground ammonium dichromate was weighed in one of the dishes, 10 c.c. of water added, and when the salt had dissolved 10 c.c. of hydrochloric acid. In small quantities at a time, 10 c.c. of the alcohol were subsequently added, and the whole evaporated to complete dryness on the water-bath. After repetition of this treatment to insure complete reduction, the residue was dissolved in 10 c.c. of water and 2 c.c. of the ammonia added; after an interval another 10 c.c. of water and 3 c.c. of ammonia were added, and the whole evaporated again to complete dryness. The dish was then heated in an air-bath to 140° for five hours, and afterwards to redness for an hour in a muffle furnace. The residual oxide, after weighing till constant, was found to be perfectly pure, and of a fine green colour; on washing with water and evaporating the washings, no residue was obtained. In calculating the results, to which all the known corrections were applied, it was assumed that O = 15·96 and N = 14·02, both well-determined numbers. The mean of the values from six experiments, the maximum difference between which was only 0·120, gives for the atomic weight of chromium 52·061. Hence chromium appears likely to possess a whole-number atomic weight, and it cannot but be admitted as remarkable that so many of the later stœchiometrical investigations, conducted with all the modern experimental refinements, have yielded values approximating to true multiples of the atomic weight of hydrogen.

MR. W. E. BEALE writes to the *Times* from Folkington Manor, Polegate, Sussex, April 4:—"On this estate is to be seen a nest, which has evidently been built partly by a thrush and partly by a hedge-sparrow. The nest itself is of the ordinary size of the thrush's nest; but, instead of being lined with mud, it is lined with horsehair, wool, and moss. The birds seem to have been good friends during the laying of their eggs. On Monday last there were three sparrow's eggs in the nest, and five thrush's. But on visiting the nest to-day it was found that the sparrow's eggs had been destroyed. The birds appear to have quarrelled when it came to the question of which should sit on them, and the thrush asserted its rights, not, however, without a struggle on the part of the sparrow, one of the thrush's eggs being broken, one missing, and three being perfect."

ACCORDING to the *American Field*, wild boars have become very numerous in the deep recesses of the Shawangunk Mountains, that border Orange and Sullivan Counties, N.Y. They are the genuine Black Forest wild boars of Europe, the descendants of nine formidable and ferocious boars and sows which Mr. Otto Plock, of New York, imported some few years ago for the purpose of annihilating the snakes and vermin that infested his estate near the Shawangunk Mountains. After the boars had eaten up all the snakes and vermin in the inclosure, they longed for more, and dug under the wire fencing and escaped to the mountains, where they have since bred and multiplied. They are so ferocious that the most daring hunter is said to hesitate before attacking them. They have immense heads, huge tusks and shoulders, and lank hind-parts.

MR. T. WORKMAN writes to us from Belfast that, having fallen into a doze on the afternoon of Friday, March 29, he was awakened by the undoubted hum of a mosquito, and thought himself back in Singapore, where he was about fourteen months ago. His first impulse was to drive away the nuisance, but curiosity to know whether it really was what he thought made him forbear, and he was soon rewarded by its settling on his right eyebrow and inserting its stiletto, with the usual sharp result, both to him and to it. Mr. Workman incloses in his letter a sketch of the insect. A mosquito in March in the north-east of Ireland is certainly a rare phenomenon.

THE first part of the Transactions of the meeting held in August 1888, in Paris, for the study of tuberculosis in man and animals, has just been published by M. Masson. It is a volume of 500 pages, and contains much interesting matter.

MESSRS. MACMILLAN AND CO. have issued the second part of vol. ii. of the new and thoroughly revised edition of "A Treatise on Chemistry," by Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. In this volume, the authors treat of metals and their compounds.

A VALUABLE list of the Coleopterous fauna of the Liverpool district, by Mr. John W. Ellis, has been reprinted from the Proceedings of the Liverpool Biological Society. The list contains nearly 30 per cent. of the British beetles.

THE second part of Prof. E. Strasburger's "Histologische Beiträge" (Jena, G. Fischer) has been published. In this part, which is illustrated with four lithographic plates, the author deals with the growth of vegetable cellular membranes.

MESSRS. G. BELL AND SONS are about to publish "Names and Synonyms of British Plants," by the Rev. G. Egerton-Warburton. This is a complete alphabetical list of known British plants, giving, under each, references to its description in Sowerby's "English Botany" (Syme Boswell), "The London Catalogue of Plants," and the "Floras" of Babington, Bentham, and Hooker. The correct pronunciation of the names is indicated by accents. A list of the most usual synonyms is appended.

WE have received vol. ii., No. 2, of the Proceedings of the Tokio Physical Society. It is worthy of note that the report of the Society is printed in Japanese, in Roman letters, while the various papers are in English. Amongst the contributions in the present number are: effects of stress on magnetization of nickel, by H. Nagaoka; thermal conductivity of marble, by K. Yamagawa; an apparatus for purifying mercury, by H. Nagaoka.

THE next Congress and Exhibition of the Sanitary Institute will be held in Worcester at the end of September. Arrangements are in progress, and will be published shortly.

AT the Central Institution of the City and Guilds of London Institute, Mr. T. Bolas will deliver a course of six lectures on photography, on Wednesday evenings, at 7.30, beginning on May 8. Lectures I. and II. will deal with the use of artificial light in photography; lectures III. and IV. with photo-mechanical printing methods; and lectures V. and VI. with direct contact printing methods.

THE London Geological Field Class under the direction of Prof. H. G. Seeley, F.R.S., will begin the summer excursions this year on May 4, and will continue them on Saturday afternoons thereafter till the end of June. Intending students should apply at once for tickets to the Honorary Secretary, Mr. Walter Lewinton, Lundy House, Willoughby Road, Hampstead, N.W.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. Cox; a Sinaitic Ibex (*Capra sinaitica*) from Mount Sinai, presented by Sir James Anderson; four Black Swans (*Cygnus atratus*) from Australia, presented by Messrs. James and Alex. Brown; a Raven (*Corvus corax*), British, presented by Mr. G. F. Hastings; a Collared Fruit Bat (*Cynonycteris collaris*), a Side-striped Jackal (*Canis lateralis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LUMINOSITY OF VENUS.—Venus being now favourably situated, it is a convenient time for making observations with reference to the question of the cause of the recorded so-called phosphorescence. If there be any extensive phosphorescence, as first suggested by Sir William Herschel, or if there be an atmosphere occasionally illuminated by electrical discharges similar to those which produce auroræ in our own atmosphere, or even if there be a meteoritic bombardment, the light observed may possibly give indications of a spectrum of bright lines or bands.

THE SPECTRA OF R LEONIS AND R HYDRÆ.—A *Wolsingham Observatory Circular* (No. 23, April 2, 1889), by Mr. Espin, states that: "The spectra of R Leonis and R Hydræ contain bright (hydrogen?) lines, first seen on February 25. Observations confirmed, through the kindness of Mr. Common, by Mr. Taylor, at Ealing, who sees two in R Leonis and one in R Hydræ." The spectra of these two important variables have hitherto been simply described as being of Group II (Lockyer), indicating, according to Mr. Lockyer, carbon-fluting radiation and metallic-fluting absorption. Mr. Espin's observations are of very great interest in connection with the meteoric theory as to the cause of variability in this class of stars. It will be remembered that the variability is ascribed to the effects of a cometic swarm revolving round a central one, the maximum occurring at periastron passage, when the revolving swarm passes through the outliers of the central one. It was predicted that, under these conditions, bright lines would make their appearance, and the prediction has now been verified in the most complete manner. Both the stars observed by Mr. Espin were near their maxima, that of R Leonis occurring on March 23, and that of R Hydræ on February 17 (*Ann. du Bur. des Long.*, 1889). It may also be remembered that bright lines have been seen in R Cygni and *o* Ceti when near their maxima. The meteoric theory is therefore greatly strengthened by these observations. The importance of making further observations of these stars, with special reference to the disappearance of the bright lines, is obvious.

THE SUN-SPOT MINIMUM.—Prof. Tacchini has recently communicated to the *Lyncei* of Rome (vol. v. series 4*a*, March 3, 1889), a note by Prof. Riccò on the days on which the solar surface was entirely free from spots, during the years 1885-6-7-8. It appears from the tables given that in 1885 there were only six days on which no spots were visible, whilst there were fifty-one in 1886, ninety-eight in 1887, and 140 in 1888. The maximum number of blank days occurring in one month was in November 1886, there being no spots on twenty-six days of that month. There were twenty blank days in October 1886, eighteen in July, and sixteen in May of the same year. A second ta le is given, showing the total numbers of days on which no sp s were visible during the years 1872–88 inclusive, and also the greatest number of consecutive days on which there were no spots during the same years. From this it appears that the greatest number of blank days was 248 in 1878, the last minimum period, whilst in 1872, 1882, and 1884, spots were visible every day. It is suggested that the approaching minimum will occur in 1889–90. In 1879 there were thirty-nine consecutive days on which no spots were recorded, this being the maximum number in any one year; the greatest number since then was seventeen in 1888.

DISCOVERY OF A NEW COMET.—A faint comet was discovered by Mr. E. E. Barnard, Lick Observatory, on March 31. The position of the object was as follows:—

March 31, 17h. 19m. G.M.T., R.A. 5h. 20m. 50s.; N.P.D. 73° 53′ 0″.

It has since been observed at Copenhagen:—

April 4, 8h. 51m. G.M.T.; R.A = 5h. 17m. 56s.; N.P.D. = 74° 0′ 55″.

OBSERVATIONS OF VARIABLE STARS IN 1888.—Mr. Sawyer publishes the results of his observations of variable stars made in 1888, in *Gould's Astronomical Journal*, No. 190. Amongst the principal of these were U Orionis (Gore's variable), observed at maximum 1888 December 26; Mira Ceti at maximum 1887 November 10; W. Cygni at minimum 1889 January 1, since when it has brightened fast. ρ Persei was considered as having been at minimum, 1888 November 7; ε Aurigæ about 1889 January 15. R Scuti seems to have been just three weeks in advance of the ephemeris in NATURE; R Lyræ and U Monocerotis corresponded to the predicted times pretty closely. R Virginis also was estimated to be at maximum only one day later than given by the ephemeris; *g* Herculis was recorded as at maximum 1888 June 3 and September 11, and at minimum July 18.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *APRIL* 14–20.

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

At Greenwich on April 14

Sun rises, 5h. 7m.; souths, 12h. 0m. 11·5s.; sets, 18h. 53m.: right asc. on meridian, 1h. 31·6m.; decl. 9° 35′ N. Sidereal Time at Sunset, 8h. 25m.

Moon (Full on April 15, 22h.) rises, 17h. 3m.; souths, 23h. 20m.; sets, 5h. 21m.*: right asc. on meridian, 12h. 52·9m.; decl. 0° 14′ S.

Planet.	Rises. h. m.		Souths. h. m.		Sets. h. m.		Right asc. and declination on meridian. h. m.		° ′
Mercury..	4 58	...	11 20	...	17 42	...	0 51·6	...	3 31 N.
Venus.....	5 6	...	13 25	...	21 44	...	2 56·9	...	23 44 N.
Mars	5 40	...	13 6	...	20 32	...	2 37·8	...	15 31 N.
Jupiter....	1 9	...	5 5	...	9 1	...	18 35·2	...	22 55 S.
Saturn....	11 52	...	19 32	...	3 12*	...	9 5·0	...	17 55 N.
Uranus ...	18 14	...	23 41	...	5 8*	...	13 13·8	...	7 7 S.
Neptune..	6 39	...	14 24	...	22 9	...	3 55·4	...	18 43 N.

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

April.		h.		
14	...	14	...	Saturn stationary.
20	...	20	...	Jupiter in conjunction with and 0° 19′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.		Decl. ° ′				h. m.	
U Cephei ...	... 0 52·5	...	81 17 N.	...	Apr.	16,	3 14	*m*
Algol	... 3 1·0	...	40 32 N.	...	,,	17,	23 43	*m*
R Corvi ...	... 12 13·9	...	18 38 S.	...	,,	16,		*M*
Y Virginis ...	... 12 28·1	...	3 49 S.	...	,,	17,		*m*
δ Libræ ...	... 14 55·1	...	8 5 S.	...	,,	16,	1 8	*m*
U Coronæ ...	... 15 13·7	...	32 3 N.	...	,,	17,	23 55	*m*
S Coronæ ...	... 15 16·9	...	31 46 N.	...	,,	14,		*M*
U Ophiuchi...	... 17 10·9	...	1 20 N.	...	,,	15,	3 18	*m*
					,,	15,	23 26	*m*
β Lyræ... ...	... 18 46·0	...	33 14 N.	...	,,	15,	22 0	m_2
					,,	19,	3 30	*M*
R Lyræ ...	... 18 52·0	...	43 48 N.	...	,,	20,		*M*
χ Cygni ...	... 19 46·3	...	32 38 N.	...	,,	17,		*M*
S Sagittæ ...	... 19 51·0	...	16 20 N.	...	,,	17,	4 0	*m*
S Cygni ...	... 20 3·2	...	57 40 N.	...	,,	14,		*M*
X Cygni ...	... 20 39·0	...	35 11 N.	...	,,	15,	22 0	*m*
T Vulpeculæ	... 20 46·8	...	27 50 N.	...	,,	20,	9 0	*M*
δ Cephei ...	... 22 25·1	...	57 51 N.	...	,,	19,	1 0	*m*

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

Meteor-Showers.

	R.A. °		Decl. °		
Near ν Virginis	174	...	7 N.	...	Slow; bright.
,, β Serpentis	233	...	16 N.	...	Very swift.
,, π Herculis	256	...	37 N.	...	Swift.
The *Lyrids*	269	...	33 N.	...	April 19, 20. Swift.
	272	...	20 N.	...	Swift.
From Vulpeculæ	299	...	24 N.	...	April 19, 20. Swift.

GEOGRAPHICAL NOTES.

THE Founder's Medal of the Royal Geographical Society has been awarded to Mr. A. D. Carey, of the India Civil Service, for his remarkable journey in Central Asia, at his own risk and expense, during which he travelled over a distance of 4750 miles, through regions which have never before been visited by an Englishman, and very rarely by any European. The Patron's Medal has been awarded to Dr. G. Radde, Director of the Natural History Museum, Tiflis, for a life devoted to the promotion of scientific geography, as a traveller, observer, and author. The Murchison Grant has been given to Mr. F. S. Arnot, towards providing and conveying a suitable present to the Chief Chitambo, of Ilala, as a recompense for his services in connection with the removal of the body and personal property of Dr. Livingstone in 1872. Mr. Arnot also receives the Cuthbert Peek Grant, in recognition of the interest and value of his seven years' travels in Central Africa. The Back Premium has been awarded to Mr. F. C. Selous, in acknowledgment of the geographical work accomplished by him in his recent journey in Mashona Land and north of the Zambesi; and the Gill Memorial to Mr. M. J. Ogle, of the Indian Survey Department, in recognition of his excellent survey work in Eastern Assam, in Manipur, and in Northern and Western Burma. The three new honorary corresponding members are Captain Dutton, of the U.S. Survey; M. Maunoir, secretary of the Paris Geographical Society; and Dr. Ballivian, a Bolivian geographer. Sir Mountstuart Grant Duff will succeed General Richard Strachey as President.

ON Monday night Mr. Harold W. Topham read to the Royal Geographical Society an account of his visit last summer to the Glaciers of Alaska and Mount St. Elias. Speaking of Glacier Bay, near Sitka, Mr. Topham said that into it many large glaciers descend, only one of which, the Muir, has been explored. It is thirty miles long, and its breadth, where it runs out into the sea, is one mile. It is decreasing very rapidly, so rapidly, indeed, that the sailors assert that they can, year by year, distinguish the difference in its size. The height of the ice wall at the foot of the glacier, where it is washed by the sea, was 319 feet in 1886, whilst last year it was 266 feet, a decrease of 53 feet. A cairn which had been erected to ascertain the rate of motion of the glacier, was found almost overthrown into a crevasse. Mr. Topham speaks of the magnificence of the mountain range stretching from Cross Sound to Yakatat. The peaks reach up 16,000 feet, the whole of which height is at once presented to the view. Their bases are washed by the sea, into which their glaciers descend. Many of these glaciers are singularly free from moraine. They are exceedingly steep, and are broken up into innumerable ice falls. The St. Elias Alps, from Cross Sound to Fairweather, run close to the sea. They then curve inland, and sweep round Yakatat Bay at a distance of about thirty miles from the water. There are many fine peaks in the range, and the eye wanders on from summit to summit till it rests upon the finest of all, Mount St. Elias, at the far north-west of the range. Lieutenant Allen stated this peak to be 19,500 feet high. It is the highest mountain in North America. To the north and west of Yakatat Bay all is ice. It is a vast plain of ice, stretching back sixty miles or more, and running eighty miles along the coast. At a place fifty miles up the glacier from the bay, the party found they were only 650 feet above the sea. This gives a fall of only 13 feet to the mile. The rate of progress, therefore, of the ice, must be very small, and this is proved by the quantity of scrub and trees which grow upon the terminal moraine upon the top of the ice. The moraine is several miles broad, and is covered with brush of alder and willow and spruce. The party proceeded by boat from Yakatat to opposite Mount St. Elias. They proceed up the Yahtsétah River. Seven miles from the sea, the river issues from beneath the ice, and it brings with it such a quantity of dirt, that the water is of a greyish-white. The river, where it issues from the ice, is about 50 feet broad, but it divides and subdivides to such an extent that at its mouth it is about seven miles in width. The west bank is composed entirely of ice. Where the river issues from under the ice, the latter is 500 feet thick, and possesses a moraine several miles wide, the last mile of which, the one nearest the edge of the glacier, is covered with thick brush. Through this brush they had some difficulty in forcing their way to the open glacier beyond. The best way of describing the moraines upon the Malaspina Glacier is to liken the surface of the ice to a very choppy sea, on to which has rained innumerable stones and rocks. The depressions are often 100 feet deep. On this moraine were found shale and slate granite quartz, with sulphates and pyrites and copper. After several ineffectual attempts Mr. Topham and his companions decided to ascend St. Elias on the south-west side, west of the Chaix Hills. The party ultimately, from their camp 1500 feet high, reached the brink of the crater, 7600 feet above sea-level and 5000 above the Tyndall glacier; another six hours found them at a height of 11,461 feet. They were then on the northern and upper rim of the crater, and judged the summit to be another seven or eight thousand feet above. The crater is full of ice, and upon its precipitous cliffs are a number of overhanging glaciers, splashed, as it were, upon the rocks and unattached from the snow-fields above. This is characteristic of a number of the glaciers in the neighbourhood. There they are—right on the rocks, with yawning crevices upon them broken up and ready to topple over upon you. Perhaps in a few years they will have melted entirely away. Everything, Mr. Topham states, around St. Elias bears evidence to the conclusion that the long period of ice through which the land has been passing is now coming to an end; a conclusion which is certainly rash. Mr. Topham gave a detailed description of the panorama to be seen from the highest point reached. There is, he states, vegetation upon the south-east slopes of the hills to a height of 1500 feet above the glacier. The greatest height at which he found vegetation, exclusive of lichens, was 4500 feet above the sea, but the place was exposed to the full glare of the sun, and no other vegetation was found for an interval of 1500 feet below. A characteristic of the Alaskan glaciers is the curious way in which small isolated bits of moraine show up here and there above the ice. For example, you may walk down the centre of the Tyndall upon white ice without seeing more than a few stones to suggest the existence of a moraine, and suddenly you will come upon an island of *débris*, disconnected from any regular moraine. It springs from nowhere, is quite isolated, and appears to have no reason for being there.

BIOLOGICAL NOTES.

THE RATTLE OF THE RATTLESNAKE.—The habit of sloughing is common to all serpents: a short time before the removal of the old skin takes place, the new epiderm makes its appearance beneath the old. The mode of growth of the new and the removal of the old is the same in all snakes, with the exception that, in those with a rattle, that portion of the slough that covers the tip of the tail is retained to form one of the rings of the rattle. The attachment is simply mechanical; the rings are merely the sloughs off the end of the tail. The terminal bone of the tail is formed of vertebræ that have coalesced and changed in great measure their shape; in the different species the number of vertebræ included in this bone varies considerably, and sometimes it varies in individuals of the same species. With the purpose of indicating the manner of growth of the rattle, and as far as possible determining its origin, Mr. S. Garman has followed up its appearance in several species, full details of which, with figures, have been lately published. In the very young rattlesnake, while the vertebræ are still separate, there is no rattle, but about a week after birth a well-marked button is seen; with the first slough the first ring is set free, the button being pushed forward, and a third button is gradually perfected. In time the traces of the vertebræ in the terminal bone are almost obliterated; the bone becomes thickened, pushed forward at its edges, and otherwise enlarged. In a full-grown rattlesnake the hinder seven of the rings belong to the period of the snake's most rapid growth—they form the "tapering rattle" formerly used in classification of the species; while four of the rings and the button are formed while the gain in size was less rapid, and form the "parallelogrammic rattle" of the old classifiers. Many serpents besides those possessed of a "crepitaculum" are addicted to making a rattling noise by vibrations of the end of their tails. In illustration of the extent to which the tail has been modified in different cases, Mr. Garman figures the tails of several species, among others that of *Ancistrodon contortrix*, Lin., the copperhead of the United States. The tip of its tail is directed downwards as well as a little backwards; most often the button has one or two swellings in a degree resembling those on a ring of the rattle. A living specimen of this snake, kept for a year or more, would take to rattling on the floor whenever it was irritated; the sound was made by the terminal inch of the tail, this part being swung from side to side in the segment of a circle, so that the tip might strike downward. The result was a tolerable imitation of the sound made by a small rattlesnake.—(*Bulletin Museum Comp. Anatomy*, vol. xiii. No. 10, August 1888.)

A NEW SPECIES OF LAMINARIA.—The discovery in the Mediterranean Sea, midway between Marseilles and Algiers, of a Laminaria, not only new to the shores of Europe, but an addition to the group—one, too, neither small in size nor obscure in its characteristics—is a very interesting fact for botanists. *Laminaria rodriguezii* has been described by Dr. Ed. Bornet in a recent number of the Proceedings of the Botanical Society of France. It was taken by M. J. Rodriguez a few miles south of Port Mahon, on a rocky bottom, in a depth of from 125 to 150 metres. It was also taken on the east and north coasts of Minorca. It appeared to be abundant in the first-mentioned of these localities. The fronds grow to a height of 2 metres. In general aspect, consistence, and colour this new species somewhat resembles *L. saccharina*, but it cannot be for a moment confounded with this well-known form. It is attached to the stones upon which it grows by a series of little root-like processes, which emanate from stolons running over the surfaces of the stones. From these stolons the young fronds arise, and in specimens with adult fronds, a whole colony of small fronds will be found springing from the stolons. *Lam. bongardiana* and *L. longipes* of Kamchatka, *L. japonica* from Japan, and *L. sinclairi* from California, are the only known species, with simple fronds, which possess these rooting stolons, but none of these can be confounded with the present new form. Of the five species of Laminariaceæ which have been from time to time recorded as occurring in the Mediterranean, this is the only one that is without any doubt a native. *Phyllaria reniformis* may possibly be indigenous, but *Ph. purpurascens*, *Lam. saccharina*, and *Sac. bulbosa* are almost certainly waifs that have been only met with in the neighbourhood of ports. The *Lam. saccharina*, Ardissone, found growing at Syracuse, in Sicily, proves, however, to be Bornet's new species, which is the sole representative on the Atlantic sea-board of the Pacific Ocean forms above referred to. —(*Bull. de la Soc. Bot. de France*, tome xxxv. pl. 5.)

THE ENVELOPES IN NOSTOCACEÆ.—M. Maurice Gomont has printed a brief abstract of his researches on the investing envelopes of the filamentous Nostocs. The thallus in these consists of the simple row of cells, the trichome, and the protective envelope, more or less marked (the gaine); when the hormogones are dispersed, this latter disappears. In a 33 to a 50 per cent. solution of chromic acid, the gaine becomes swollen and dissolves, leaving only a tube-like pellicle; next the protoplasm of the trichome cells becomes greatly changed, leaving the cell-walls clearly defined. These consist of an external layer, seemingly intermediate between the membrane met with in the hyphæ of Fungi and the cuticle of the higher plants; it has a remarkable power of resisting the action of acids: in a 33 per cent. solution of chromic acid or in concentrated sulphuric acid, it remains unchanged for a space of twenty-four hours; it is insoluble in hydrochloric or acetic acids, or in caustic potash; it is dissolved in a 50 per cent. solution of chromic acid, but only after several hours; with aniline or fuchsine it assumes a brighter hue than ordinary cuticle. The interior layer gives the reactions of cellulose. The chemcal properties of the gaine prove it to be a true cuticle.—(*Journal de Botanique* for 1888.)

THE SCOTTISH METEOROLOGICAL SOCIETY.

AT the half-yearly meeting of the Society, held on Monday, April 1, it was stated in the Report of the Council that new stations had recently been added in the Newington District of Edinburgh, and in the Botanic Garden, these additions to the observing staff being regarded with much satisfaction, particularly in view of the facilities which a somewhat thickly planted series of stations in Midlothian offer, in the observation of the physical data required in investigating the various meteorological gradients, as proposed by the late Mr. T. Stevenson. Dr. Archibald Geikie, Prof. Crum Brown, and Prof. Bayley Balfour were elected Members of Council.

The inspection of the fishery barometers of the Meteorological Council at fifty-four of the fishing ports on the Scottish coasts has now been completed by Mr. Dickson, who gave much attention, by short lectures to the fishermen, conversations with them, and otherwise, to awaken an interest in weather forecasts and their intelligent interpretation. Though the giving of the lectures is practically limited to the Saturdays, when the fishermen are disengaged, yet opportunity was taken to deliver eleven lectures, which were attended by audiences varying from 40 to 250. The method of proceeding was to give, by the help of weather charts, a short explanation of the law of storms, and an account of the weather of the week immediately preceding the lecture. The fishermen were then invited to ask questions, and raise discussions on the subjects of lecture.

During the winter Prof. Balfour engaged Mr. Turnbull to give fourteen lectures to the *employées* of the Garden on meteorology, in which marked prominence was given to the practical side of the science, explaining and teaching them to handle each instrument—why it is placed in the position it occupies, and not elsewhere; and showing the methods of reducing the observations. The efficient training of a body of men from which the Council largely draws its observers is a matter of no small importance. A suitable site has been procured in Fort William for the proposed low-level observatory, and plans of the buildings prepared by their architect, Mr. Sydney Mitchell, and submitted to the Directors and the Meteorological Council, and approved of. The plans and specifications are at present in the hands of the contractors, and the building will forthwith be commenced.

Mr. Herbertson exhibited to the meeting an instrument, named the stephanome, designed by Prof. Tait, for use at the Ben Nevis Observatory for measuring the angular size of halos, fog-bows, glories, &c.; also a valuable collection of sixteen photographs taken at the Observatory, of which the following are of special interest: a cirrus cloud in the northern horizon, taken at midnight in June, when the clouds are seen to be brightly illuminated; St Elmo's Fire, at 11 p.m. on the top of the stove-pipe; and views of the Observatory after continued fog and strong wind, but no fall of snow, when everything is covered with long crystals of ice formed out of the fog.

Dr. Buchan read a paper on the distribution of storms round the Scottish coasts, based on the observations made at the lighthouses during the past seven years. The year is divided by the equinoxes into two strongly contrasted portions as regards storms of wind. The minimum occurs in July, and the maximum in January. Over the whole country there is an annual average of 431 hours of storm occurrence. Dividing Scotland into seven districts, the following is the order of occurrence: Firth of Clyde, 327 hours; Tweed to Aberdeen, 373 hours; Aberdeen to Caithness, 379 hours; Fort William to Islay, 408 hours; Cape Wrath to Mull, 435 hours; the Irish Sea, 508 hours; and Orkney and Shetland, 562 hours. From a report prepared by Mr. Omond it appears that, on an average of the past five years, the wind at the Ben Nevis Observatory has risen to or exceeded the rate of 45 miles an hour, 849 hours per annum.

Mr. H. N. Dickson read a paper on "The Weather Lore of Scottish Fishermen." The fishermen had a very complete and generally accurate knowledge of weather phenomena as far as it was purely a matter of observation. In the course of his inquiries he had got a great deal of miscellaneous information from them on prognostications. The prognostications which received the greatest acceptance among the fishermen were those of halo, coronæ, and mock sunrises. It is a belief current from Aberdeen to Wick that, if a sun-dog preceded the sun, it was a sign of good weather, but if it followed the sun it was a sign of bad weather. Another very general belief in prognostications was the existence of spiders' webs amongst the cordage of ships and in sails. That was a very general belief all along the coast. There was another prognostication which was currently believed in by the fishermen, taken from the occurrence of broken rainbows, which are called "packmen," from the fact that the packmen sold pieces of coloured ribbon. As regards the cirrus cloud, in Shetland and Orkney and on certain parts of the west coast, but not on the east coast, there was an almost universal belief in "weather-heads." If these "weather-heads" ran in the direction of north-east to south-west, it was a sign of good weather, but if it ran south-east to north-west, it was an unfavourable sign. If the aurora rises in the north, and does not come past the zenith, it is a sign of good weather; but should the streamer extend beyond, a gale of south wind is expected. The only other point with regard to the aurora was that in Shetland it was supposed to be near a very severe gale if the aurora emitted a sound resembling the shaking of a blanket. Another prognostication, very interesting in its way, and which all fishermen had seen, is the "false dawn." The "false dawn" was when the dawn seemed to break, and then disappeared. There was some question as to whether it was a prognostication. At St. Andrews they were almost unanimous in believing it as a prognostication, and in other places he got individuals who believed it was a sign of good or bad weather. It was interesting in this way that he had never heard of the "false dawn" as a prognostication before, and he made some investigations as to whether it was common in other parts of the world, and he found it was also current among the Negroes of South America. In Shetland there was a class of prognostications which did not appear anywhere else. It was a sign of a coming gale if the surface of the water became stiff and bubbles remained in the wake of a boat, and if the wake of a boat remained visible for an unusually long time. Another prognostication was known as "cheepers." A sound was heard as if a lot of little birds were floating above the boat, and gave a sort of cheeping sound. That was also called "foul air" by another class of fishermen. In the Outer Hebrides the state of the air was almost the only thing the men paid attention to. It was current all down the west coast that a heavy surf was the sign of a gale approaching, but on the east coast one did not hear much of the heavy surf. He had found among the fishermen much less superstition than they usually got credit for, especially at the largest stations. In the smaller stations, where the boats were very small, there was still a good deal of superstition. In the larger stations, where the boats were large and the men went far out to sea, there was a great deal of faith in weather prognostications and a strong desire for instruction.

Mr. H. N. Dickson also added a note on the temperature of the water round the east coast of Scotland. The curve of the daily variation of temperature in the North Sea was as nearly as possible symmetrical above and below the mean. That was the case where there was reason to believe the water was almost stationary. In observations taken in the North Atlantic and on the west coast of Scotland in warm currents of water, as long as the curve was below the mean, it was almost quite straight, and when above the mean the maximum was intensified and sharpened. In observations taken in the cold Polar current off the Island of Jan Mayen the opposite was the case, the curve being deep below the mean and flat above it.

Mr. Philip Sewell gave a few notes of a voyage he made to Siberia last summer. From the temperature observations and other information submitted, he considered trading to the mouths of the Obi and Yenissei to be practicable in ordinary summers.

TWO-NOSED CATENARIES.[1]

THE curve to be given to an ideal linear chain or rib under uniform-vertical-load area between itself and a horizontal straight line is well known to be a Transformed Catenary, having its ordinates in a constant ratio to the corresponding ordinates of a Common Catenary inverted, with the horizontal straight line as directrix (Rankine, "Civil Engineering"; Church, "Mechanics of Materials," &c.).

Thus, the equation of the Common Catenary being—

$$\frac{y}{m} = \cosh\frac{x}{m},$$

using the notation of the hyperbolic functions, then the equation of the Transformed Catenary will be—

$$\frac{y}{m} = r\cosh\frac{x}{m},$$

r being a fraction, greater or less than unity.

The authors of this paper appear to have been the first to notice the elegant mathematical fact that, for values of r numerically less than $\frac{1}{3}\sqrt{3} = 0{\cdot}577$, the Transformed Catenary possesses two points, equidistant from the vertex, at which the curvature is a maximum; so that in the practical design of masonry arches, which are almost always made circular, a better

[1] "Two-Nosed Catenaries and their Application to the Design of Segmental Arches." By T. Alexander, C.E., Professor of Engineering, Trinity College, Dublin, and A. W. Thomson, B.Sc., A.M.I.C.E., Lecturer in the Glasgow and West of Scotland Technical College. (From the Transactions of the Royal Irish Academy, vol. xxix. Part 3, 1888.)

approximation to the true theoretical shape of the arch is attained either by taking the "three-point circle," passing through the vertex A and the two points of equal curvature B_2 and B_2', or by taking the "described circle," touching at B_1 and B_1', or by taking the "inscribed circle," touching at A and again internally at B_3 and B_3' beyond the points of maximum curvature B_1 and B_1', instead of taking, as customary, the circle of curvature at the vertex; and the authors show that if an elliptical arch is described, the proper approximation to its shape is obtained from an orthogonal projection of one of these circles.

The points B_1 and B_1' are called the *noses* of the transformed catenary, and give the name to the paper.

The transformed catenary, which may be taken as the line of thrust, is shown to lie below the "described circle," and above the "three-point circle," so that by taking these or similar circles for the boundaries of the ring of the arch, the proper stability of the arch is secured.

The mathematical treatment of the Catenary given by the authors would gain considerably in elegance by the employment of the hyperbolic functions, now no longer to be disregarded; thus, instead of writing—

$$y = r\frac{m}{2}\left(e^{\frac{x}{m}} + e^{-\frac{x}{m}}\right)$$

$$\tan\theta = \frac{dy}{dx} = \frac{r}{2}\left(e^{\frac{x}{m}} - e^{-\frac{x}{m}}\right),$$

the notation—

$$\frac{y}{m} = r\cosh\frac{x}{m},\ \tan\theta = r\sinh\frac{x}{m},$$

should be employed; and for purposes of numerical calculation of these hyperbolic functions, it is only necessary to notice that if $\tan\theta = \sinh u$, $\sec\theta = \cosh u$, then $u = \text{hyp.}\log(\sec\theta + \tan\theta)$; so that the table of u, already calculated by Euler, used in conjunction with the tables of the ordinary circular functions, will give us the numerical values of the hyperbolic fnnctions; for large values of u, when θ denotes an angle being nearly a right angle, the approximate equation—

$$\log\cosh u = \log\sinh u = u\log e - \log 2$$

being sufficient.

Tables of numerical results are given at the end of the paper, with practical illustrations, for the benefit of architects and engineers, and supplementary tables are added for the immediate designing of brick, sandstone, and granite arches, with circular soffits; so that these investigations should prove decidedly useful to those engaged in the design of similar structures.

A. G. G.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xi. No. 3 (Baltimore, April 1889.)—Were it not for the size of the pages, this number might be taken to be a number of the *Mathematische Annalen*, seeing that out of its ninety-eight pages sixty-eight are written in German. The first memoir, by Oskar Bolza (pp. 195–214), is entitled "On the Construction of Intransitive Groups," and touches on points discussed by Jordan ("Traité des Substitutions"), Capelli ("Sopra l'Isomorfismo dei Gruppi di Sostituzioni"), Netto ("Substitutionentheorie"), Cayley ("Theory of Groups"), and Dyck ("Gruppentheoretische Studien"). This is followed by a short note by Karl Heun (pp. 215–20), on "Die herstellung einer linearen Differentialgleichung aus einem gegebenen Element der Integralfunction." Next we have an important memoir by Koenigsberger (pp. 221–82), "Ueber die Reduction von Integralen transcendenter Functionen." The closing note, by Dr. Franklin (pp. 283–92), "On the Double Periodicity of the Elliptic Functions," *inter alia*, proves a theorem of a bicircular quartic, enunciated by Clifford (see Crofton, L.M.Soc. Proc., vol. ii), and also results due to Siebeck and Greenhill, but all are established here from a different point of view.

Rivista Scientifico-Industriale, February 15.—Researches on the thermo-electric conductivity of magnetized iron (concluded), by Prof. Ercole Fossati. From these experiments the author concludes generally that the electric conductivity of iron either suffers no change under transverse magnetization or undergoes some increase; this increase, however, is much less than the diminished conductivity of iron magnetized in the longitudinal direction. This inference agrees perfectly with the deductions he had already arrived at experimenting with iron conductors of varying dimensions.—Some experiments with a new battery, by Prof. Augusto Righi. Excellent results have been obtained from the battery here described, which consists of 108 condensers disposed in six groups of eighteen each, one above the other, in order to obtain high potentials. The outer armatures communicate with the conductors of a Holtz machine, the central with the ground, and a capacitity is thus obtained equal to that of $\frac{18}{6} = 3$ jars, united in a single battery with armatures communicating directly with the two conductors of the machine. The capacity of the whole system is thus 18,810 electrostatic units, or about $\frac{1}{48}$ microfarad.

Rendiconti del Reale Istituto Lombardo, February 28.—Notice of the late Prof. Giuseppe Meneghini, by Prof. T. Taramelli. In this biographic memoir a summary account is given of the services rendered to geological studies by the eminent naturalist, who was born in Padua in 1811, and died in January of the present year. Meneghini is best known as joint translator, with Savi, of Murchison's work on the Alps, Apennines, and Carpathians, and by his systematic monograph on the fossils of the Upper Lias in Lombardy and Central Italy. His last publication was a paper on the Cambrian trilobites of the Iglesiente district, and his name will always be associated rather with the palæontological than the stratigraphic or petrographic side of geology.—Meteorological observations made at the Royal Brera Observatory, Milan, during the month of February.

THE last issue of the *Memoirs of the St. Petersburg Society of Naturalists* (vol. xix., Botany) contains, besides several very interesting short papers in the Proceedings, a new contribution to the flora of Novgorod, by A. Antonoff, which raises the number of species of flowering plants discovered in the Government of Novgorod to 700; a note on the comparative anatomy of the tissues in the leaves of *Salicineæ* as a basis for classification, by V. Dobrovlanski; and a suggestive description of the flora of the Shenkursk and Kholmogory districts of Archangelsk, by N. Kuznetsoff. Owing to the extension of a subsoil of limestone, which is much warmed by the sun during the summer, the flora of the region contains a number of species belonging to a more congenial climate, while several species characteristic of those latitudes are wanting. On the other hand, owing to its proximity to the Urals, and the existence on the west of such a barrier as Lake Onega, the flora contains a considerable number of Siberian species, while many West European species do not appear. M. Kuznetsoff's remarks on the extension of the *Abies sibirica*, which is slowly advancing towards the West, and the lime-tree, which seems to be, on the contrary, disappearing, are very interesting. Both the *Ulmus campestris* and the *U. effusa* were found as far north as the sixty-third degree of latitude. The presence of the *Lymnanthemum nymphoides*, which is found in Lithuania and South-Eastern Russia, but not in Central Russia, save Kursk, is especially remarkable, and M. Kuznetsoff explains the extension of this aquatic plant over Archangelsk by its having spread along the canal which connects the Volga with the Dvina. No fewer than twelve other South Russian plants, which must have migrated along the same canal, are named by the author. As to the *Mulgedium tataricum*, C. A. Mey., which is characteristic of the salt steppes of Astrakhan, it has been found on a shoal of the Dvina, under 64° N. lat. The paper is accompanied by a map, showing the western limits of extension of the *Abies sibirica*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 14.—"On the Organization of the Fossil Plants of the Coal-Measures. Part xvi." By W. C. Williamson, LL.D., F.R.S., Professor of Botany in the Owens College, Manchester.

In this memoir the author first calls attention to detached observations, made in his earlier memoirs, relating to the manner in which a medullary axis is developed in the interior of each of the primary vascular bundles of the Carboniferous Lycopodiaceæ. He then traces the changes undergone during the development of a small branch-bundle in *Lepidodendron Harcourtii*.

This is followed by a description of a small new species of Lepidodendron.

In a second new species, named *Lepidodendron intermedium*, an apparently early form of exogenous zone is shown to exist. When describing, in his previous memoir, Part xi. (see Plate 49, Fig. 11), the stem now designated *Lepidodendron fuliginosum*, he showed that, in it, we have an example of the most rudimentary and least perfectly developed form of an exogenous xylem yet seen amongst these Carboniferous Cryptogams. In this example, but a few radiating laminæ of vascular tissues make their appearance in the innermost cortex. In the plant now described, though these few laminæ are represented by a continuous cylindrical zone of tracheids, and though the laminæ are arranged in radial order, they are still embedded in a mass of cellular tissue, much in excess of what constitutes the medullary rays in the higher types of Lepidodendroid organization.

A fourth new species of Lepidodendron is described, under the name *L. Spenceri*, in young states of which no medulla is visible, but, in its place, a number of vertically elongated cells and imperfectly lignified scalariform tracheids are seen, inclosed within an outer series of perfectly lignified tracheids.

A fifth new species, *Lepidodendron parvulum*, is also described; after which the author points out the differences between the mode of development of the cellular medulla of these exogenous Cryptogams, and that of the representative organ among the Dicotyledonous Exogens. Amongst the ordinary Exogens, the growing tip of a stem or branch is a mere aggregation of cells, which mass is soon separated into two zones by the development within it of a ring of vascular bundles. The cells inclosed within this ring become the medulla, and those external to it constitute the cortex. Such a pith subsequently undergoes but a very limited enlargement. In most cases a time arrives when it grows less with age, and ultimately disappears; but in the Lepidodendra, though the tip of each growing stem was, in the first instance, also a cellular mass, an axial solid bundle of vessels was developed in the centre of the new growth almost at its very commencement. But it was only after this growth had made some progress, and the twig had become clothed externally with numerous leaves, that the first traces of a medulla began to appear in the centre of the bundle. It is thus clear that the medulla of these Carboniferous Lycopods is not genetically homologous with that of an ordinary exogenous flowering plant.

The axial vascular medullary bundle expanded into a hollow cylinder under the internal pressure of the growing medulla, which latter not only attained to considerable dimensions, but was a persistent organ. The ring inclosing the medulla supplied all the vascular bundles going to leaves and in part to branches. The author demonstrates that the branches are supplied with such bundles in two ways; when the growing stem divides dichotomously, which it does as amongst living Lycopods, the medullary vascular cylinder splits into two equal halves. But, besides this mode, the author shows that very frequently comparatively small segments are cut completely out of the vascular cylinder, in which a gap is thus left where the bark and the medulla meet. The angular segment thus detached develops into a solid cylindrical bundle, in which, in time, a medulla forms as before. The author is inclined to believe that all these latter forms of bundles only supply short abortive lateral branches, which most probably supported Lepidostrobous fruits.

March 21.—"On the Velocity of Transmission through Sea-water of Disturbances of Large Amplitude caused by Explosions." By Richard Threlfall, M.A., Professor of Physics, and John Frederick Adair, M.A., Demonstrator of Physics, University of Sydney. Communicated by Prof. J. J. Thomson, F.R.S.

This paper contains an account of a large number of experiments made with the object of determining the velocity of waves of compression caused by explosions under water.

The method adopted depended on the use of a certain "gauge" devised for the occasion, whereby the arrival of the disturbance at a given point was transmitted to a chronograph.

The disturbances themselves were caused by submarine explosions of dynamite and gun-cotton in quantities varying from nine ounces to four pounds.

The distance over which the velocity was measured was about 200 yards.

The water was that of the Pacific Ocean in the harbour of Port Jackson, New South Wales.

The chronograph was of the falling pendulum description, and fired the charge automatically.

The absolute time was obtained by comparing the chronograph tuning-fork with an astronomical clock.

The distance was obtained in terms of the standard yard of New South Wales by means of trigonometrical survey. The chief results for the range quoted are as follows:—

Class.	Description of explosive.	Number of experiments (each experiment involving two explosions and time measurements).	Velocity found in metres per second.	Temperature C.	Velocity of sound calculated in metres per second.	Excess of velocity as compared with velocity of sound.
						per cent.
A	9 oz. dry gun-cutton	11	1732 ± 22	17°·8	1523	13·75
B	10 oz. No. 1 dynamite	24	1775 ± 27	14·5	1508	17·7
C	18 oz. dry gun-cotton	5	1942 ± 8	18·3	1525	27·3
D	64 oz. dry gun-cotton	3	2013 ± 35	19·0	1528	31·7

The chief portion of the paper is occupied in the description of the details of the precautions taken to make the measurements as accurate as possible. This involves some chronographic improvements. An explanation of the large observed velocity is attempted.

"On an Effect of Light upon Magnetism." By Shelford Bidwell, M.A., F.R.S.

Several experimenters in the early part of the present century tried to magnetize iron and steel by the action of light,[1] but I do not know of any recent attempts in this direction, and of late years the thing has been generally regarded as impossible. Under ordinary circumstances there can be little doubt that this is the case, but, if a certain condition is fulfilled, we might, I think, expect to find some evidence of the action of radiation upon the magnetism of iron.

The condition is that the susceptibility of the bar AB to be operated upon shall be greater (or less) for a magnetic force in the direction AB than for an equal one in the direction BA. This paper contains a short preliminary account of a series of experiments which have been undertaken with iron bars having this property. Much yet remains to be done, which will require a considerable amount of time, and for which special apparatus must be constructed. In the meantime, the results already obtained appear to possess sufficient interest to justify their publication.

The method of preparing the bars is as follows. A piece of soft iron rod, which may conveniently be 10 or 12 cm. long and from 0·5 to 1 cm. in diameter, is raised to a bright yellow heat and slowly cooled. When cold, it is placed inside a solenoid, through which is passed a battery current of sufficient strength to produce a field of about 350 or 400 C.G.S. units. The iron when removed from the coil is found to be permanently magnetized, and its north pole is marked for the sake of distinction with red sealing-wax varnish. The bar is then supported horizontally and in an east and west direction behind a small reflecting magnetometer, and over it is slipped a coil, which is shunted with a rheostat, the resistance of which can be gradually increased from 0 to 26 ohms. The coil can be connected by a key with a single battery cell, which is so arranged as to produce a demagnetizing force inside the coil. The resistance of the rheostat is slowly raised, so that more and more current passes through the coil, the battery key being alternately lifted and depressed until the magnetometer indicates that the iron bar as a whole is perfectly demagnetized. The strength of the demagnetizing force required varies according to circumstances: it is generally about one-thirtieth or one-twenty-fifth of the original magnetizing force.

After this treatment the iron rod does not differ, so far as ordinary tests will show, from one which has never been submitted to magnetic influences. Nevertheless, as is well known, it possesses certain properties which distinguish it from a piece of really virgin iron. In the first place, the magnetization induced by a force acting in such a direction as to make the

[1] Chrystal, "Encyclopædia Britannica," vol. xv. p. 274, mentions the following names: Morichini, Mrs. Somerville, Christie, Riess, and Moser.

marked end a north pole is greater than that caused by an equal force in an opposite direction. Again, if such a bar be held horizontally east and west (to avoid terrestrial influences), and tapped with a mallet, the marked end at once becomes a north pole. A similar effect follows if the rod be warmed in the flame of a spirit-lamp. Lastly, if it be placed inside a coil and subjected to the action of a series of rather feeble magnetic forces, of equal strength but alternating in direction, the marked end will generally become a north pole, even though the last of the alternate forces may have tended to induce the opposite polarity.

A rod treated as above described appears to be remarkably sensitive to the action of light. When such a rod is placed behind the magnetometer, and illuminated by an oxyhydrogen lamp about 70 cm. distant, there occurs an immediate deflection of from 10 to 200 scale-divisions,[1] the magnitude of the effect varying in different specimens of iron. As the action of the light is continued, the deflection slowly increases. When the light is shut off, the magnetometer instantly goes back over a range equal to that of the first sudden deflection, then continues to move slowly in the backward direction towards zero.

The first quick movement I believe may be due to the direct action of radiation, and the subsequent slow movement to the gradually rising temperature of the bar. With a thick rod (1 cm. in diameter) the slow movement is barely perceptible, extending over only one or two scale-divisions in the course of a minute, the spot of light becoming almost stationary after the first sudden jump. With a thin rod the sudden effect is generally smaller, while the slow after-effect is greater, and may continue until the spot of light passes off the scale.

As a general rule the magnetic effect is such as to render the marked end of the rod a north pole: occasionally, however, it becomes a south pole, but in such cases I have always found that the polarity is comparatively feeble. It may even happen[2] that the marked end becomes north when certain portions of the rod are illuminated, and south when the light acts upon other portions. This is probably due to irregular annealing and a consequent local reversal of the direction of maximum susceptibility: it indicates that the light effect is local, and is confined to the illuminated surface. In one remarkable specimen, which happens not to have been annealed at all, the sudden effect and the slow effect are in opposite directions. When the light is turned upon this rod, there is at first a sudden deflection of twenty magnetometer-scale-divisions to the left, the spot afterwards moving slowly and steadily towards the right. When the light is shut off there occurs at once a jump of twenty divisions further towards the right before the spot begins to move back in the zero direction.

Some attempts have been made to repeat the experiments with light polarized by means of a Nicol's prism; but, either because the largest prism at my disposal was too small (its aperture being barely 2 cm.), or because too much of the radiant energy was absorbed by the spar, I failed to get any magnetic effects whatever with the prism in either position.

[Prof. Silvanus Thompson has quite recently been kind enough to lend me a very large and excellent Nicol's prism. From a few experiments already made with this instrument it appears that the action of the light is quite independent of the plane of polarization.]

There can be no doubt whatever of the reality of the effects here described: they are perfectly distinct, and are at any time reproducible with certainty. The only question is how much of them is primarily caused by the action of light, and how much by mere incidental change of temperature. But, taking all the circumstances into consideration, I think the evidence is in favour of the conclusion that the *instantaneous* magnetic change, which occurs when a prepared iron bar is illuminated, is purely and directly an effect of radiation.

Physical Society, March 23.—Prof. Reinold, President, in the chair.—Prof. J. V. Jones read notes on the use of Lissajous's figures to determine a rate of rotation, and of a Morse receiver to measure the periodic time of a reed or tuning-fork. In determining resistance absolutely by the B.A. or by Lorenz's method, it is important to know the speed of rotation at the instant when the deflection of the galvanometer needle is observed. To determine this, an arm carrying a mirror is caused to oscillate by a pin placed eccentrically in the end of the spindle, and a Lissajous's figure is obtained by using another mirror mounted on a vibrating reed driven electrically. Equality of period is obtained when the resulting elliptical figure is permanent, and the frequency of the reed is determined subsequently. In making the experiments it is found convenient to control the speed of the disk by braking it either with the finger or a piece of wood. The reed consists of a rectangular steel rod, 100 centimetres long, and section 1·51 × 0·60 centimetres, and the length of the vibrating segment can be altered by sliding it through a clamp. To permit of this change without altering the electrical contacts, the latter are formed by two independent springs, one of which is always in contact with the rod. For determining the frequency of the reed a second pair of contacts are operated by the vibrator and the currents recorded by a Morse receiver, whilst simultaneously the paper receives marks from a pen controlled by a standard clock. The limit of accuracy of this part of the experiment is found to be $\frac{1}{10}$ per cent., due to changes in the reed's frequency. This is a serious defect, and the author of the paper asked for advice as to the precautions necessary to obtain reeds of constant pitch. Prof. Ayrton, whilst recognizing the extreme importance of determining speed accurately, suggested that the inconstancy of the reed may be due to the impulse being given at the end instead of the middle of its swing, and recalled an experiment, shown before the Society by Prof. Perry and himself, in which the pitch of an electrically driven fork was varied greatly by altering the adjustment of the contact screw. Referring to Dr. Thompson's modification, where two tuning-forks drive each other, it was pointed out that the method requires the synchronism of the two forks to be very exact. Mr. Blaikley inquired whether any doors were opened or closed during the experiments, as the pitch of a reed is affected by the size of its resonance chamber. He also stated that the pitch of reeds driven pneumatically could be maintained constant to 1 part in 10,000, and mentioned that two forks nearly in unison influence each other's period when near together. Referring to the two forks mentioned by Prof. Ayrton, Prof. S. P. Thompson said it was advantageous to mount such forks on sounding boxes, for when placed at a suitable distance apart they then exert considerable mutual control. The sketch put on the board by Prof. Jones led Dr. Thompson to suppose that a perfect method of driving forks had been devised, for two springs were shown touching opposite sides of the bar, and such an arrangement might be used to complete the circuit, only when the reed is in the middle position. He also believed that forks give greater constancy than single reeds, and mentioned some recent improvements, in which one prong of an electrically driven fork is made of phosphor bronze. Mr. T. H. Blakesley, reasoning from ideas suggested by Mr. Stroh's experiments on vibrating membranes, concluded that the periods of forks, placed at $\frac{1}{4}$ wave-length apart, would not influence each other. In reply to a question from Mr. F. J. Smith, Prof. Jones thought there could be no "creeping" of the reed through the clamp. He also stated that he had been led to use a reed from the results obtained in Delaney's system of telegraphy, and the fact that Lord Rayleigh considered electrically driven forks satisfactory.—Dr. Hofford read extracts from the following papers:—On the Clark cell as a source of standard currents, by Prof. R. Threlfall and Mr. A. Pollock. The authors find, contrary to ordinary ideas, that Clark cells can be used to send currents of considerable magnitude without the E.M.F. being appreciably changed, and have constructed cells which give 0·001 amperes steadily for half an hour. This result has been obtained by increasing the size of the cell so that each electrode is about 5 square inches in area, and the internal resistance is about 6 ohms. For the ordinary small test-tube cell, the resistance of which may be about 1500 ohms, the current ought not to exceed 0·00001. On closing the circuit the P.D. (potential difference) drops almost instantaneously to its steady value, and when the circuit is opened rises equally rapidly to very nearly the original E.M.F. The cells completely recover in time. If the current sent be too large, the P.D. falls for a time, and afterwards rises and tends towards a fixed value. In this respect Clark's cells are greatly superior to large Daniell's, sending currents through the same resistance. The paper contains several tables and curves, as well as valuable results respecting the close agreement between the E.M.F.'s of a great number of different cells.—On the application of Clark's cell to the construction of a standard galvanometer, by Prof. R. Threlfall. A large cell, as above mentioned, together with a known platinoid resistance, are used to standardize a reflecting galvanometer, constructed with a single

[1] The magnetometer mirror was 1 metre distant from the scale, and each division = 0·64 mm. ($\frac{1}{40}$ of an inch).

[2] This has been observed in two specimens.

movable coil, sliding in guides so as to vary the constant in known proportions. Two controlling magnets are carried on opposite sides of a sleeve sliding on a central tube, inclosing the long fibre, and a small hollow copper cylinder in oil acts as damper. The tangent law was found by calculation to be practically correct up to 15°, and the scale is curved so as to read tangents on a scale of equal divisions. To give this result the approximate polar equation to the curve is shown to be $r = f(1 + 0{\cdot}207\theta^2 + 0{\cdot}0269\theta^4)$. In standardizing the instrument a known current is sent through it from the Clark cell, and the controlling magnets adjusted till the spot comes to a fiducial mark on the scale. By varying the position of the coil, currents ranging from 0·001 to 0·4 ampere, can be measured. —On the measurement of high specific resistances, by Prof. Threlfall. The chief points dealt with are, the means for producing thin plates of material of known dimensions, the form and methods of magnetizing the needles, and the arrangement of suspension found necessary when great sensibility is required. For producing the plates, two plane platinized brass slabs are used, and kept at a known distance apart by micrometer screws, whilst the material is melted between them. The screws are then withdrawn, and the resistance determined by comparison with a megohm, using different E.M.F.'s in the two cases so as to obtain about equal deflections. As regards the galvanometer, after many unsatisfactory attempts to use one made according to the Messrs. Gray's pattern, the coils of that instrument were mounted in the ordinary way, and used with an astatic combination of magnetized steel disks. Extreme care was taken to obtain disks exactly similar, and a pair of electro-magnets were made to magnetize them *in situ*, so as to obtain great astaticism. For suspending the magnets, quartz fibres were found greatly superior to silk, the zero of the instrument being very indefinite, even with a silk fibre 30 inches long. Considerable difficulty was experienced in attaching the mirror to the needle on account of the distortion produced by ordinary cements; slow drying white paint was ultimately used and found satisfactory.—On the measurement of the resistance of imperfectly purified sulphur, by Prof. Threlfall and Mr. A. Pollock. The apparatus used is described in the previous paper, the galvanometer of 16,000 ohms being arranged to give one division for 2×10^{-12} amperes. A mean of the results obtained gives about 11×10^{13} ohms per cubic centimetre as the specific resistance. In performing the experiments many precautions were required to prevent air currents and magnetic disturbances, and paraffin keys were found to give much better insulation than ebonite ones. In conclusion, the authors enumerate the chief points to which attention should be paid in designing and using very sensitive galvanometers. They consider it desirable to use quartz fibres at least 6 feet long, to provide very fine adjustment for the controlling magnets, whose supports should be independent of the suspension arrangement, and believe that the whole should be placed in a thick soft iron cylinder. Mr. Boys, speaking of attaching mirrors to wires, said he found a very small speck of shellac varnish to be very satisfactory. As regards quartz fibres, Prof. Threlfall's method of producing them differed materially from his, and the fibres were much thicker. He considered it quite unnecessary to use fibres anything like 6 feet long, and thought 15 inches quite sufficient where the weight to be supported was not large. Prof. Ayrton regarded the results obtained from Clark's cells to be of extreme scientific and commercial importance, for they showed that a very convenient standard of E.M.F. could also be used as a standard for current. Prof. Thompson, after commenting on the convenience of good E.M.F. standards, expressed a hope that Prof. Threlfall would be able to suggest a convenient method for producing a standard ampere.

Royal Meteorological Society, March 20.—Dr. W. Marcet, F.R.S., President, in the chair.—Dr. Marcet delivered an address on "The Sun: its Heat and Light," in which he said that the source or origin of all meteorological phenomena is the sun, which sends or radiates its heat to the earth through the molecular vibration of the invisible matter connecting earth with space. If there were no air and moisture we should feel the sun's heat to a much greater extent. After the sun's rays have reached the earth, a portion of the heat they bring with them is absorbed by the earth and terrestrial objects, another is converted into motion, and a third is reflected into space. After describing the various actinometers and other instruments used for determining the amount of solar radiation, Dr. Marcet showed that the temperature of the solar rays falls rapidly when tested at increasing altitudes in a balloon. He then gave an account of some observations made by Mr. Glaisher in the celebrated balloon ascent which he and Mr. Coxwell made at Wolverhampton on September 5, 1862, when they reached a height of about seven miles above the earth's surface. Regarding the transformation of solar heat into motion, a very interesting illustration is afforded by the radiometer, in which the direct influence of the sun's rays causes a light vane to rotate; while another illustration of the mechanical effects of heat upon fluids is their conversion into what is known as the spheroidal condition. In connection with this Dr. Marcet explained how by wetting his hand he could pass it through molten lead without injury. He also related the case of Henry Hall, one of the keepers of the Eddystone Lighthouse, who, on the occasion of the fire which destroyed the lighthouse on December 4, 1755, accidentally swallowed some molten lead, but did not die till several days afterwards, when a piece of lead was taken out of his stomach. Dr. Marcet then briefly drew attention to the sun's light, stating that the passage of the sun's light through our atmosphere alters it in kind to a great and remarkable extent. Light can be decomposed into its elementary colours. In connection with this branch of the subject Dr. Marcet performed a number of experiments, including, among others, that of passing a ray of light through a glass freed from dust, when the ray disappears within the vessel, but reappears on the other side, showing that the power to form light was there, though not the material for this power to act upon. Dr. Marcet concluded his very interesting address by describing the various forms of sunshine recorders.—The meeting was then adjourned in order to afford the Fellows and their friends an opportunity of inspecting the Exhibition of Instruments opened on the previous evening. A full account of this Exhibition has already been given on p. 523.

Geological Society, March 20.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—Supplementary note to a paper on the rocks of the Atlantic coast of Canada, by Sir J. W. Dawson, F.R.S.—The occurrence of colloid silica in the Lower Chalk of Berkshire and Wiltshire, by Mr. W. Hill and Mr. A. J. Jukes-Browne.—Note on the pelvis of *Ornithopsis*, by Prof. H. G. Seeley, F.R.S. The remains preserved in Mr. Leed's collection at Eyebury, and described by Mr. Hulke, are the largest and most perfect pelvic bones of a Saurischian known in this country. An examination showed that the bones of the right and left sides were united in the median line almost throughout their length by a median suture, and that they formed a saddle-shaped surface internally from front to back. After giving a detailed description of the pubis and ischium, the author stated that he was not aware that this type of pelvis had been previously observed. He noted that the antero-posterior concavity between the anterior symphysis of the pubic bones and the posterior symphysis of the ischia was a well-marked characteristic of Saurischian reptiles, but that it remained to be determined to what extent the median union of the pubic bones was developed in the group. It was impossible to judge of the form of the ilium from the imperfect fragment preserved, but it did not make any recognizable approximation to the bone in those American genera which offered the closest resemblance of form to the pubis and ischium. There were several minor differences of proportion between the bones from the Oxford Clay and those from the Wealden of the Isle of Wight, and the former differed in ways pointed out from *Morosaurus*, *Diplodocus*, and *Brontosaurus*, though there were resemblances.

Zoological Society, March 19.—Prof. Flower, F.R.S., President, in the chair.—The Secretary read a list of the fishes collected at Constantinople and sent to the Society by Dr. E. D. Dickson. The species were sixty-six in number, and had been determined by Mr. G. A. Boulenger.—Mr. Tegetmeier exhibited a female Gold Pheasant in male plumage, and a curiously distorted pair of horns of the Ibex of Cashmir.—The Rev. A. H. Cooke read a paper on the position of the land-shells of Australia and the adjacent islands, commonly referred to the genus *Physa*, which it was shown (mainly from an examination of the *radula*) were really more nearly allied to the genus *Limnæa*. Mr. Cooke proposed to refer these species to the genus *Bulinus*, established by Adanson in 1757.—Mr. G. A. Boulenger read notes on some specimens of Lizards belonging to the Zoological Museum of Halle, which had been sent to him for examination. To these notes were appended revised descriptions of two Lizards from the Argentine Republic, *Gymnodactylus horridus* and *Urostrophus scapulatus*.—A communication was read from Prof. W. N. Parker, containing an account of the occasional persistence ot the left posterior cardinal vein in the Frog. This condition, abnormal in the Frog, was shown to be essentially normal in *Protopterus*.—A communication was read from Mr. J. Douglas Ogilby, containing notes on some fishes new to the Australian fauna.—Mr. Oldfield Thomas read a paper giving the description of a new Bornean Monkey belonging to the genus *Semnopithecus*, obtained by Mr. Charles Hose on the north-west coast of Borneo. The author proposed to name it *Semnopithecus hosei*, after its discoverer.

April 2.—Prof. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1889, and called attention to a specimen of the Manatee (*Manatus australis*), purchased March 2, being the second example of this Sirenian obtained alive by the Society; to an Oriental Phalanger (*Phalanger orientalis*, var. *breviceps*), presented by Mr. C. M. Woodford, of Sydney; and to a specimen of Owen's Apteryx (*Apteryx oweni*), presented by Captain C. A. Findlay.—Mr. Smith-Woodward exhibited and made remarks on a maxilla of the early Mesozoic Ganoid *Saurichthys*, from the Rhætic formation of Aust Cliff, near Bristol.—A communication was read from Mr. W. K. Parker, on the osteology of *Steatornis caripensis*. The conclusion arrived at as regards the affinities of this isolated form of birds was that *Steatornis* is a waif of an ancient avifauna, of which all the near allies are extinct, and that *Podargus* of Australia is its nearest surviving relative.—Mr. Oldfield Thomas read some preliminary notes on the characters and synonymy of the different species of Otter. The author gave a revised synonymy of the four species of *Lutra* recognized as belonging to the Palæarctic and Indian Regions, and of the two found in the Æthiopian Region. The American Otters, for want of a larger series of specimens, could not at present be satisfactorily worked out.—Mr. E. T. Newton read a paper, entitled "A Contribution to the History of Eocene Siluroid Fishes." Mr. Newton observed that spines of Siluroid fishes from the Bracklesham Beds were described by Dixon in his "Fossils of Sussex" (1850), and referred to the genus *Silurus*. Mr. A. Smith-Woodward had recently shown good reason for referring these specimens, and certain cephalic plates from the same horizon, to the tropical genus *Arius*. The greater part of a skull, from the Eocene Beds of Barton, in the Museum of the Geological Survey, confirmed the latter generic reference. Its close resemblance to a skull of *Arius gagorides* in the British Museum left no room for questioning their generic relationship, while at the same time the fossil differed from any known species of *Arius*. The fortunate discovery of one of the otoliths within the fossil skull, and its resemblance in important points to that of *A. gagorides*, still further confirmed this determination. Some other otoliths from Barton, and one from Madagascar, were also referred to the genus *Arius*.—Mr. A. Smith-Woodward read a note on *Bucklandium diluvii*, a fossil from the London Clay of Sheppey, noticed by König, and hitherto not satisfactorily determined. It was shown that this fossil was a portion of the skull of a Siluroid Fish allied to the existing genus *Auchenoglanis*.—A communication was read from Mr. H. W. Bates, F.R.S., containing descriptions of new species of the Coleopterous family Carabidæ, collected by Mr. J. H. Leech in Kashmir and Baltistan.—A second communication from Mr. Bates gave descriptions of some new species of the Coleopterous families Cicindelidæ and Carabidæ, taken by Mr. Pratt at Chang Yang, near Ichang, in China.

PARIS.

Academy of Sciences, April 1.—M. Des Cloizeaux, President, in the chair.—On regulating the velocity of a dynamo-electric machine serving as a receiver in the transmission of force by electricity, by M. Marcel Deprez. The case is first considered of the magnetic field and of the electromotive force of each machine, which are shown to be functions of the intensity of the general current only when the inducting electros are disposed in a simple series in the principal circuit. Cases are then discussed in which the receiver has a constant magnetic field, and in which the field of the generator is constant.—On the biorthogonal reduction of a lineo-linear form to its canonical form, by Prof. Sylvester. Taking F as a lineo-linear function of two series of letters—

$$x_1, x_2, \ldots, x_n; \xi_1, \xi_2, \ldots, \xi_n;$$

then F will contain n^2 terms. By subjecting the letters x and ξ respectively to two independent orthogonal substitutions, arbitrary quantities are introduced into the transformed form $n^2 - n$, so that by giving them suitable values we should be able to get rid of this number of terms while retaining the n pairs alone, whose arguments will be, for instance,

$$x_1\xi_1, x_2\xi_2, \ldots x_n\xi_n.$$

Prof. Sylvester here calls the multiples of these arguments the *canonical multiplicators*; he gives the rule for determining them, and at the same time for finding the two simultaneous orthogonal substitutions which lead to the canonical form.—On the progress of the Suez Canal, and its state in the year 1888, by M. de Lesseps. Of the works undertaken to widen the Canal from 22 to 65, 75, and in some places even 80 metres, some have already been completed, and for a distance of about 15 kilometres from Port Said vessels have now ample space for passing each other. The depth will be increased to 8·50, and ultimately to 9 metres, and navigation by night is facilitated by luminous buoys and tow-paths, the light being obtained by means of compressed gas. All the sidings have been widened to 100 metres between Suez and Port Said, thus allowing six large vessels to be shunted at the same time in all of them. Ships using the electric light are now able to traverse the Canal in about twenty hours, the time hitherto required being from thirty-five to forty hours. In 1888 the Canal was traversed by 3440 vessels of 6,640,832 tons (2625 of 5,223,254 tons, British), yielding to the Company 65,102,000 francs in tolls, &c.—On an aperiodic balance with direct readings of the last fractional weights, by M. P. Curie. The instrument here described, and illustrated with a vertical section and a general view, has been constructed for the purpose of increasing the rapidity and accuracy of weighing operations in scientific and industrial laboratories.—On transformation and equilibrium in thermodynamics, by M. P. Duhem. It is pointed out that the "new function" spoken of by M. Gouy in a recent communication (*Comptes rendus*, cviii. p. 507), had already been anticipated by Mr. J. W. Gibbs, in 1873, whose views were later explained by M. Duhem in his work on the thermo-dynamic potential.—On the difference of potential at contact of a metal and of a salt of the same metal, by M. H. Pellat. The author's researches lead to a general law thus expressed: The difference of normal potential between a metal and the solution of a salt of the same metal is nil. It also follows that the difference of potential of two salts of the same acid and of different metal at contact, increased by the difference of potential of these metals placed in contact, is proportional to the quantity of heat liberated by the substitution of one of the metals for the other in the salt of the acid in question.—On telephonography, by M. E. Mercadier. The problem of telephonography—that is, the transmission of sound to distances by telegraph lines, for instance—is here studied in connection with the recent improvements of the phonograph by its inventor, Mr. Edison, and by Mr. S. Tainter (graphophone). M. Mercadier's process, which shows good results even with inferior instruments, appears to be much simpler than that by which Mr. Edison has lately succeeded in communicating along the wires between New York and Philadelphia, using for the purpose his new improved phonograph.—Papers were contributed by M. F. Beaulard, on the double elliptical refraction of quartz; by M. Woukoloff, on the law of the solubility of gases; by M. René Drouin, on succinamic nitrile; by M. Albert Colson, on the artificial and natural alkaloids; by MM. P. Langlois and Ch. Richet, on the strength of the respiratory function as affected by anæsthetics; by M. Abel Dutartre, on the action of the poison of the land salamander (*Salamandra maculosa*); and by M. Haug, on the Lias formations in the sub-Alpine ranges between Digne and Gap.

BERLIN.

Meteorological Society, March 12.—Prof. von Bezold, President, in the chair.—Dr. Wagner spoke on the connection between cosmic and meteorological phenomena. After a short review of the earlier attempts to connect meteorological phenomena with the rotation of the sun or with the phases of the moon, he passed on to a consideration of Prof. von Bezold's recently published work, in which it is shown that the storms in Bavaria and Würtemberg have a distinctly recurrent periodicity of 26 days, corresponding to the period (25·84 days) of the sun's rotation. In opposition to this, Köppen had found from his own calculations, based on more extensive data, that the storms are recurrent with a periodicity of 29 and not 26 days, thus corresponding to the synodical period of the moon. The speaker had himself investigated the periodicity of storms, not only in Bavaria and Würtemberg, but also in Baden, keeping the observations of lightning separate from those of mere rain-storms: this seemed to be necessary, not only inasmuch as von Bezold did not take any account of lightning, but also because the occurrence of lightning at the time of new moon, or during the last quarter of the moon, might give rise to apparent maxima resulting from purely optical causes. He found that the storms possess a periodicity of 29 days, which include three maxima, the chief of these being in the last half-quarter, the next at new moon, and the least at full moon. No physical explanation, or even any idea of any connection between the storms and the phases of the moon, can at present be given.—Dr. Assmann gave an account of a phenomenon which had been observed on the trees in the Thiergarten as a result of the recent heavy snow-fall. The masses of snow which were piled up high on the branches of the trees had slipped down round their sides and hung down like curtains; they possessed a not inconsiderable consistency and glacier-like structure. The superficial thawing which occurred daily about midday had contributed largely to bring about the modification which the snow had undergone.

Physiological Society, March 15.—Prof. du Bois-Reymond, President, in the chair.—Dr. Benda spoke on multinuclear mammalian spermatozoa, and refuted a number of objections which had been raised to his views on spermatogenesis.—Prof. Gad gave an account of experiments which Dr. Piotrowski had made under his direction, on the difference between the conducting power of nerves and their irritability. It was known that under certain conditions, as, for instance, when a nerve is dying or is surrounded by an atmosphere of carbonic acid gas, its power of conducting impulses shows no change, while at the same time the irritability of that part which is surrounded by the gas has disappeared. After confirming the above by renewed experiments, Dr. Piotrowski found that when he surrounded a small stretch of the sciatic nerve with alcohol vapour he obtained a result exactly the reverse to that observed with carbonic acid gas: the nerve was irritable, but could no longer convey impulses coming from its central end. Irritability and conducting power were tested, not only by muscular contractions, but also by the negative variation at the peripheral end of the nerve. Three distinct causes might be assumed for the difference between irritability and conducting power which had been experimentally proved as above. In the first place, irritability and conducting power might be two totally distinct properties of a nerve. But this view must be dismissed, inasmuch as the only possible way of conceiving the propagation of an impulse is to suppose that the impulse is transmitted from one transverse section of the nerve to another, so that the stimulation of one section acts as a stimulus to the rest. In the second place, it might be supposed that the electrical resistance of the nerve-sheath and medullary-sheath had been increased, so that the stimulus, which was applied from the exterior, could not overcome this increased resistance, while at the same time the conducting power of the axis-cylinder remained unchanged. But this view is untenable in face of the fact that alcohol vapour increases the irritability of a nerve but lessens its conducting power. And it is still further opposed by an experiment on the olfactory nerve of the pike. This nerve possesses scarcely any sheath, or at most an extremely thin one, and still it behaved exactly as does a sciatic nerve when surrounded by carbonic acid gas. Finally, mechanical stimuli were just as efficient as electrical, and in this case the resistance of the sheath does not affect the question. A third possible explanation was that nerves possess not only a longitudinal, but also a transverse irritability, and that the latter is diminished by the CO_2, and increased by the alcohol vapour. This last explanation was also rendered probable by an experiment in which the heightened irritability under exposure to alcohol vapour was still further increased when the current used for stimulation was led through the nerve at right angles to its length by means of wide electrodes instead of by means of the wire electrodes usually employed, in which latter case a small longitudinal stretch of the nerve is included between the points of the electrodes. The speaker therefore regards it as proved that the irritability of a nerve can be diminished by the action of CO_2 without its conducting power being simultaneously affected. Further, that by means of alcohol vapour the irritability may be increased, while the conducting power is at the same time considerably diminished, and that nerves possess a distinct transverse irritability. The speaker also regarded it as extremely probable that the effect of CO_2 and alcohol vapour is different upon the transverse and longitudinal conducting powers of a nerve.

VIENNA.

Imperial Academy of Sciences, February 7.—The Secretary read a letter by Dr. Ludolf Griesebach on his travels in Turkistan, describing the geology of the environs of Ghazni.—The following papers were read:—On the retinal image of the insect's eye, by Prof. S. Exner.—On the orbit of Winnecke's comet in the years 1858–86, by E. von Haerdtl.—On the relation of atmospheric pressure to electricity (sealed), by T. Altschul.

February 17.—The following papers were read:—On some derivatives of cyanamide, by A. Smolka and A. Friedrich.—On morphine, by Zd. H. Skraup and Dr. Wiegmann.—On the definitive determination of the plane of polarization, by the late L. Kudelka.—On an anomaly of Mendeleeff's periodic system (sealed), by B. Brauner.—On marine Hydrachnida, with some remarks on Midea (Bruz), by R. von Schaub.—On the passage of electricity through bad conductors, by H. Koller.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Egeson's Weather System of Sunspot Causality: Charles Egeson (Sydney, Turner and Henderson).—The Chemistry of Photography: R. Meldola (Macmillan).—First and Fundamental Truths: J. McCosh (Macmillan).—British Dogs, No. 30: H. Dalziel (U. Gill).—The Dentists' Register, 1889 (Spottiswoode).—The Medical Register, 1889 (Spottiswoode).—A Treatise on Manures: A. B. Griffiths (Whittaker).—Argentine Ornithology, vol. ii.: P. L. Sclater and W. H. Hudson (Porter).—Encyclopædia Britannica, ninth edition, index (Edinburgh, Black).—By Leafy Ways: F. A. Knight (Stock).—An Elementary Text-book of Applied Mechanics: D. A. Low (Blackie).—Journal of the Scottish Meteorological Society, third series, No. 5 (Blackwood).—Deutsche Ueberseeische Meteorologische Beobachtungen, Gesammelt und Herausgegeben von der Deutschen Seewarte, Heft 2 (Berlin).—Journal of the Chemical Society, April (Gurney and Jackson).—Geological Magazine, April (Trübner).—Mind, April (Williams and Norgate).—Himmel und Erde, April (Berlin).

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