THURSDAY, JULY 11, 1901.

ROTHSCHILD'S NOVITATES ZOOLOGICAE.

Novitates Zoologicae. A Journal of Zoology in connection with the Tring Museum. Edited by the Hon. Walter Rothschild, Ernst Hartert and Dr. K. Jordan.

IT has long been the custom of some of the principal museums of natural history in all parts of the world to maintain a periodical devoted, more or less exclusively, to the publication of the discoveries made by the members of their staffs and based on the collections placed under their care. The long series of *Annales du Musée* and *Archives du Musée* issued by the naturalists of the great French museum in the Jardin des Plantes are well known to all workers in biology. The National Museum of Holland issues its *Notes from the Leyden Museum* with great regularity, and of not less importance to zoological science are the *Annals* of the Museo Civico of Genoa. On the other side of the Atlantic, we find the *Bulletin* of the American Museum of Natural History at New York, and the similar publication of the National Museum of the U.S. at Washington, both mainly devoted to the work performed by the naturalists of those institutions, and in South America the Museums of Parà and S. Paulo issue corresponding publications. One advantage of this plan is that it helps to make the existence of the museum and its working staff more generally known, and another that it supplies a convenient medium for the exchange of publications with other similar institutions.

Shortly after Mr. Walter Rothschild had founded the Zoological Museum at Tring, in order to house his large collections, and to render them more accessible for scientific research, he wisely determined to establish an illustrated periodical for the publication of the results of his own work and that of his fellow-labourers in the new institution.

Novitates Zoologicae is the appropriate title of this "organ," and quite deserves its well-chosen name. Beginning in 1894, it has now completed its seventh annual volume; and the eighth (for 1901) is in full swing. But before we speak of the contents of this work, a few words may be said about the building in which Mr. Rothschild's treasures are housed, and which stands in a quiet corner of the little town of Tring on the borders of Tring Park. Lord Rothschild's son has been from early youth a devoted student of natural history of all kinds, and has well employed his almost unrivalled opportunities for hunting up new and rare specimens in every quarter of the globe. Active agents under his directions have explored the mountains of New Guinea, the little-known islands of the Northern Pacific, and the forests of South America with great success, and have reaped a large harvest of zoological specimens which have accumulated under his care. After the collections thus made had outgrown the accommodation that could be given to them in a private establishment, Mr. Rothschild determined to establish a building for their special reception. This was accomplished about 1891, when a museum, plain in structure, but admirably adapted to its object, arose, under Mr. Rothschild's directions, at the corner of Tring Park, and has since that period become famous amongst naturalists as the "Zoological Museum, Tring."

The Tring Museum consists of two departments—the public galleries and the working laboratories. The galleries contain a fine series of mounted specimens illustrative of all the leading orders of animals and admirably mounted and arranged for the edification of the general public, who are admitted to inspect Mr. Rothschild's treasures four days in the week. Mammals, birds, reptiles, fishes, insects, shells, corals, sponges and other marine animals crowd the shelves, and amongst them are many specimens of special interest on account of their rarity or remarkable forms. The mammals and birds of the British islands are specially attended to, and a cabinet of glazed drawers, accessible to every visitor, contains a nearly complete series of British butterflies and moths, which renders the identification of these insects easy to the inquirer. Amongst the rarities in the order of mammals is a stuffed specimen of the extinct quagga (*Equus quagga*), one out of the four or five still known to exist in European museums. Another nearly extinct mammal well represented at Tring is the white or square-mouthed rhinoceros of South Africa (*Rhinoceros simus*). Two of the few remaining examples of this huge animal were shot in Mashonaland by Mr. R. T. Coryndon in 1892. One of these is now in the British Museum, while the other was secured by Mr. Rothschild. The specimen in the Tring Museum, which has been splendidly mounted by Messrs. Rowland Ward and Co., stands more than 6 feet at the withers, and is upwards of 12 feet in length. It is the original of the excellent figure of this species given in the Zoological Society's *Proceedings* for 1894. In the bird-series, humming-birds, parrots, game-birds, apteryxes and cassowaries are some of Tring's strongest points, whilst the set of bones of the extinct *Æpyornis* of Madagascar is unrivalled, and will strike everyone with admiration.

Such are some of the more striking objects in the public galleries of the Tring Museum, but still more important are those stowed away in the laboratories where Mr. Rothschild's naturalists, Mr. Ernst Hartert and Dr. Jordan, will be found hard at work. Mr. Hartert devotes his time mainly to birds of all classes, of which there is a splendid series at Tring. Dr. Jordan bestows his attention on the invertebrates, and especially on the lepidopterous insects, or moths and butterflies, in many branches of which the Tring collection is almost unrivalled. Both these naturalists, as well as Mr. Rothschild himself, publish most of their contributions to science in *Novitates Zoologicae*, of which we have given the title at the head of this article, although contributions are likewise made to the *Novitates* by many other specialists, to whom specimens are sent from the Tring Museum for examination and description. Seven bulky volumes of this excellent periodical have now appeared, and the eighth is in rapid progress. They are, we need hardly say, printed in excellent type and on good paper. They are also accompanied by numerous beautiful plates drawn by the best zoological artists of the day for the illustration of the special novelties described in the text.

Commencing with the first volume, which appeared in 1894, we find articles on mammals, birds, reptiles and insects of the orders Lepidoptera and Coleoptera. Fifteen coloured plates illustrate this volume, amongst which we may call special attention to that of a new lemur from Madagascar, *Propithecus majori*, drawn by Keulemans.

The second volume (1895) is nearly of the same character, and contains, amongst other rarities, a figure of the very remarkable duck *Salvadorina waigiouensis*, lately discovered in the little-known island of Waigion, the last place, perhaps, in which one would have thought of looking for a merganser. In this volume also will be found a description of some very interesting remains of the extinct gigantic bird of Madagascar (*Æpyornis*) prepared by Mr. C. W. Andrews, of the British Museum; also a beautiful figure (by Keulemans) of a new and most magnificent bird of paradise, *Astrapia splendidissima*, based on a specimen in the Tring Museum which is said to have come from the foot of the Charles Lewis mountains in Dutch New Guinea.

We need not recapitulate the contents of the following five volumes, which, however, are all of great zoological interest. But we may allude to some of the most extraordinary novelties illustrated, amongst which are (in vol. iii.) a very remarkable new Picarian bird from Madagascar, *Uratelornis chimaera*. In vol. iv. will be found figured another new and extraordinary bird of paradise, described by Mr. Rothschild as *Loboparadisea sericea*.

In vol. v. are pictures of two beautiful new tanagers, discovered by Mr. Rothschild's collector, Rosenberg, in North-western Ecuador.

In vol. vi. is given a figure of a new and gigantic tree-kangaroo (*Dendrolagus maximus*) lately discovered in Dutch New Guinea. This volume likewise contains an elaborate essay by Mr. Rothschild on the kiwis or apteryxes of New Zealand, with a chapter on their anatomy by Mr. F. E. Beddard, F.R.S., illustrated by numerous plates.

In vol. vii. (1900) will be found the conclusion of an important monograph on the butterflies of the genus *Charaxes* and the allied forms, prepared by Mr. Rothschild in conjunction with Dr. Jordan, and accompanied by numerous illustrations, which was commenced in vol. v. It will be evident, therefore, we think, that, as already stated, Mr. Rothschild has selected a most appropriate title for the organ of the Tring Museum, and has been very successful in his search for the subjects to which its pages are devoted.

THE METRIC SYSTEM.

Le Système Métrique. By G. Bigourdan. Pp. vi+458. (Paris: Gauthier-Villars, 1901.) Price fr. 10.

M. G. BIGOURDAN, of the Astronomical Observatory of Paris, has published a work with the object, apparently, of showing how leading a part France has taken in the introduction and propagation of the international metric system of weights and measures. The book, however, tells one nothing new, for cannot all it tells be found as to early history in "Base du Système Métrique" (1806, 1821); as to subsequent development in the works of Barny, Saigey, Tarbé, Leoni-Levi, the second report of the Standards Commission (1869), &c.; and as to latest scientific data in the *Proc. Verb. et Trav. et Mem. du Bureau International des poids et mesures* (Gauthier-Villars, 1875–1900)? Many of these publications are, however, difficult to obtain, and hence M. Bigourdan has met a want by putting together under one cover all available information with reference to the origin, construction and verification of metric standards.

In these days of advertisement some readers fight shy of log-rolling works, of the dishing-up of old books under new titles, of the re-editing of other men's labours, and perhaps of the literature of metric propaganda there has been enough. In the present work, however, the temptation to advertise appears to have been avoided, and the compiler has simply given, in a careful, concise and exhaustive manner, the results of the labours of the eminent chemists, physicists and mathematicians—as Arago, Benoit, Berthollet, Bertrand, Borda, Broch, Cornu, Delambre, Deville (H.), Faye, Fizeau, Foerster, Lagrange, Lalande, Laplace, Lavoisier, Stas, Tresca, &c.—who have made the metric system the only international system for all purposes.

The book contains thirty-three chapters, the first of which deals with the weights and measures in use in France previous to the revolutionary period, and to the hypotheses of Bailly and Paucton with reference to uniformity. Then follow chapters referring to the proposition of Talleyrand to the General Assembly of France in 1789; to the decrees of that Assembly in 1790 establishing a new and uniform system of measurement; and to the establishment (under the Metric Convention of 1875) of the Comité International des poids et mesures. This Comité was thus one outcome of the original proposition of 1789—a remarkable outcome generally, seeing that it changed the weights and measures of nearly the whole of Europe, and swept away native and arbitrary metrological systems which had been handed down from primitive times; systems embarrassing to scientific progress, hurtful to commerce and a tax on intelligence.

M. Bigourdan (p. 14) seems to say that in 1790 some communication was made by France to England as to the adoption of a new international base of measurement. No such communication was, however, made either through the Foreign Office or officially to the Royal Society; nor was England then invited to take part in the establishment of the metric system.

An interesting account is given by the author of the founding of the Bureau International (Pavillon de Breteuil, Sèvres, près Paris); of the construction of the new international standard of the metre, and of the kilogramme; made of platinum (90 per cent.) and iridium (10 per cent.); and which were in 1889 deposited at the International Bureau, where they are still kept. An account is also given of the verification of the étalons-nationaux, or copies of the étalons-internationaux, which have now been distributed to the high contracting states who have joined the Convention of 1875. The national standard metre and kilogramme, which were issued by the Comité to Great Britain, are referred to in the Metric Act of 1897.

With reference to the determination of the length of a linear measure, as the metre, by spectroscopic reference to rays of light, Prof. Michelson and Dr. Benoit obtained remarkable results in 1892–3.

Reference is also made by M. Bigourdan to the researches of Drs. Chappuis and Guillaume as to the mass of 1000 cubic centimetres of water at 4°. They find that a cubic decimetre of water weighs 999·936 grammes (p. 413) or 1 kg.–64 mg. Prof. D. Mendeléeff has, however, stated the mass of a cubic decimetre of water at 4° as 999·847 grammes (*Proc. Roy. Soc.*, 1896, p. 155).

The book contains seven interesting portraits of Talleyrand, Delambre and others; also an alphabetical list of more than 400 authors and persons who have taken part in the introduction and verification of metric standards, and a useful chronological table of French laws and ordinances (1557–1896).

We no longer now regard the metre as the length of 1/10,000,000th part of the quadrant of the meridian, or the kilogramme as the precise weight of a cubic decimetre of distilled water. Such derivations and definitions have proved a failure, and very much of the information set out by the author with reference thereto, although of historic interest, might well be condensed in the next edition of the book.

PROF. MAX MÜLLER'S LAST ESSAYS.

Last Essays. By the Right Hon. Prof. F. Max Müller. 1st series. Pp. vii + 360. (London: Longmans and Co., 1901.) Price 5*s*.

THE seventeenth volume of the late Prof. Max Müller's "Collected Works" contains a series of essays on language, folklore and other subjects which were selected for publication by the venerable scholar about the time that his illness assumed its last acute form; but, alas! he never lived to expand and annotate, according to his wont, such as had already appeared in print before. The greater number of them treat, as we should expect, of the subjects of which he had made a close and lifelong study, and these bear in every paragraph evidences of the clear thought and brilliant exposition which all Prof. Max Müller's readers were accustomed to expect from that expert philologist. In two of them, "My Predecessors" and "How to Work," we get a few glimpses of the man as well as of the scholar, and they cannot fail to interest all those who wonder from time to time how one man, with so many varied interests and occupations, could manage to do so much good work in a single lifetime. In "How to Work" we see the leading ideas which he kept ever before him whilst carrying on his labours of copying manuscripts, editing texts and the like, and when we read the advice which he gave to the students of Manchester College in 1896 we are able to note that we are reading the words of a man who practised what he preached. He said, "Put your whole heart, or your whole love, into your work," and "half-hearted work is really worse than no work"; it is a pity that, like the verses from the Koran which are writ large and hung up on the walls of the mosques where all men may see and read them, these excellent words cannot be copied in large letters and set before the eyes of our boys and girls in schools and colleges. Of equal value is his counsel to them to make indexes to the books that they read, and he pointed his moral admirably when he told them how he worked with slips when making his *index verborum* to his great edition of the "Rig-Veda." But then Prof. Max Müller belonged to a school which produced such scholars as Fleischer, Lepsius, Bühler, Rödiger and Hoffmann, and we cannot help doubting if their modern representatives have the inclination or can find the time to make tens of thousands of index slips. The social life of Universities, even in Germany, makes it more and more difficult for a man to devote years, or months, to tasks of this kind, and a professor finds that lectures, committee meetings, &c., use up, and alas! sometimes waste, a great deal of his time.

The essay on "Coincidences" will be read by every one who is interested in the study of comparative religion with the deepest interest, for in it is demonstrated with considerable clearness and with incontrovertible proofs, if we accept the facts set out by Prof. Max Müller, that Christianity owes much to Buddhism. The Roman Catholic missionaries Huc and Gabet, while travelling in Thibet in 1845, discovered to their horror that the Buddhist priesthood possessed the crosier, the mitre, the dalmatic, the cope, the service with two choirs, the psalmody, exorcism and prayer-beads, and that the celibacy of the priesthood, spiritual retreats, worship of saints, fastings, processions, litanies, holy water, &c., were as much the characteristics of the Buddhist as of the Roman Catholic religion. After thinking the matter over for some time the Christian missionaries made up their minds that these resemblances were the work of the Devil, who wished to lead astray any missionary who ventured to travel in Thibet, and now we know that an actual historical communication existed between Roman Catholic and Buddhist priests. It has recently been proved that the Buddhist Canon was collected at the Council held B.C. 259. at Patna by Asoka, and that the Pâli Canon of Buddhism was written down in the first century before our era, and that the Sanskrit Canon was written down in the first century after. Thus it seems clear that if any borrowing at all took place between the two religions, the Christian borrowed from the Buddhist, and not the Buddhist from the Christian. This need cause no surprise, for, apart from the well-known historical connection which existed between the Buddhists and Nestorians in the seventh, eighth and ninth centuries, there was undoubtedly frequent communication between India and Persia and Asia Minor from the time of Alexander the Great. The Buddhist religion was, like the Christian, a missionary religion, and in proof of this Prof. Max Müller has adduced some very interesting facts.

There are many other essays in the volume to which we should, if space permitted, like to call attention, and among them are those on "The Savage" and "Literature before Letters." The former was first printed in 1885 in the *Nineteenth Century*, and we cannot help thinking that had its learned author lived to see it reprinted he would have modified several sections of it; the latter is full of interest, as much for the subject of which it treats as for the indications it gives of Prof. Max Müller's extraordinary power of memory. Finally, Oxford men will read with pleasure the appreciation of the late Dean Liddell which is found on p. 314 *ff.*; and historians of modern Europe will find much information on the famous Schleswig-Holstein Question in the last essay in the volume. It is almost superfluous to add that the style in which the essays are written is clear and fluent, and we are sure that even the scientific opponents of the great Sanskrit scholar will be glad to possess in a collected and handy form some of the last writings of a man who has scored his mark broadly and deeply upon the edifice of Indian philology.

HETEROCYCLIC ORGANIC COMPOUNDS.

Die Heterocyklischen Verbindungen der Organischen Chemie. By Edgar Wedekind. Pp. iv + 458. (Leipzig: Veit and Co., 1901.) Price 12 marks.

THE author of the book before us states in his preface that his object is to extend those chapters of the elementary treatises on organic chemistry which deal with heterocyclic derivatives, to supply a text-book of the subject for the use of advanced students and the technical chemist, and thus to render unnecessary the possession of exhaustive and expensive text-books.

But, with the best will in the world, we regretfully come to the conclusion that the work is of very slight practical value; heterocyclic derivatives are frequently derived from straight chain compounds possessing complex molecules, and the chemist will find himself compelled to refer to one of those works Dr. Wedekind would avoid the use of in order to elucidate the synthesis of the heterocyclic ring.

One example of this difficulty, which may, indeed, be met with on almost every page of the book, will suffice; speaking of the methods of formation of osotriazoles, we find given as the second method: "intermolecular separation of the elements of water from the hydrazo-oximes of 1 : 2-diketones

$$\begin{array}{l} R.C{=}N.NHC_6H_5 \\ \quad | \\ R.C{=}N.OH \end{array} \quad \rightarrow \quad \begin{array}{l} R.C{=}N \diagdown \\ \quad | \qquad\quad > NC_6H_5." \\ R.C{=}N \diagup \end{array}$$

Now unless the student or technical chemist had made a special study of the hydrazo-oximes he would possess the vaguest idea of their method of formation, and would have to refer to a text-book. A well-known and inexpensive work of this nature ("Organische Chemie," Richter, ninth edition), under the heading α-hydrazo-oximes, describes, not only the formation of these bodies, but also, on the same page, their intramolecular condensation to the heterocyclic ring.

Dr. Wedekind has adopted an empirical classification which brings substances of most dissimilar constitution under the same heading; for example, in the group—Hetero-rings containing five members:

I. Oxygen as member of the ring.

(1) Single rings with one oxygen,

we find the following bodies, which possess slight genetic connection: furfuran, tetramethylene oxide, γ-lactones, and anhydrides of the acids of the succinic series (it is true the author announces his intention of passing over reduced and easily resolvable rings, such as anhydrides and lactones, but to be consistent, should not a reduced ring, such as piperidine, be also ruled out of court?)

Nor does Dr. Wedekind's system even possess the merit of originality; this system first appeared in the seventh (German) edition of Richter's "Organic Chemistry," and has been adhered to in subsequent editions; it was adopted by Brühl from Anschütz and Schroeter (editor and sectional editor of the above work) in his continuation of the German translation of Roscoe and Schorlemmer's "Organic Chemistry" (vols. vi. and vii.).

The genetic or rational system of nomenclature was adopted by Krafft in 1893, and is to be found, further freed from empiricism, in the last instalment of Meyer and Jacobson's "Organic Chemistry" (the group of the polynucleic benzene derivatives, 1901).

A due sense of the proportionate importance of certain classes of bodies is frequently absent; thus the very important purine group is dismissed in a few pages as an appendix to the benzopyramidine group, purines being considered as glyoxalinepyramidines.

For the rest, the book, which contains an enormous amount of information, seems carefully compiled, up-to-date and accurate; we prefer to find the references at the foot of the page instead of being collected at the end of the first and of the second part; out of 1475 references there are fifteen to English publications, which, considering the amount of work which has been done in this country on heterocyclic rings, seems scarcely a fair proportion.

In view of the facts that the ninth edition of V. von Richter's "Organic Chemistry" (Anschütz-Schroeter) has appeared, and that Messrs. Veit and Co. promise the rapid completion of Meyer and Jacobson's admirable handbook, we can only repeat that such books as the one which forms the subject of this notice are completely superfluous.

W. T. L.

OUR BOOK SHELF.

The Induction Motor. A Short Treatise on its Theory and Design, with numerous Experimental Data and Diagrams. By B. A. Behrend. Pp. 105. (New York: *The Electrical World and Engineer*, 1901.

Mr. Behrend, in the preface to his book, rather offers an apology for adding one more to the already overwhelming number of books dealing with electricity and its applications. In some cases an apology of this kind is, unfortunately, justified; but in this instance, in view of the very great importance of the subject from the electrical engineer's point of view and the increasing introduction of polyphase electrical installations, a work on the above subject, written by a writer who, from his continental experience, should know what he is talking about, is to be welcomed. The author's point of view is made clear by a quotation from Prof. J. J. Thomson, printed on the title-page: "The absence of analytical difficulties allows attention to be more easily concentrated on the physical aspects of the question . . . than if he merely regarded electrical phenomena through a cloud of analytical symbols"; and on a first glance at the book, which consists of only 105 pages, one had hoped for a concise and easily comprehensible statement of the subject. This cannot, however, be said to be the case. The book could be very conveniently entitled "A notebook for the designer of induction motors," and to an electrical engineer well versed in polyphase work it would be, without doubt, very useful. The reader who does not possess these qualifications will not find it of much value. The author admits this, in that he adds an appendix containing an extract from Gisbert Kapp's "Electric Transmission of Energy," dealing with the elementary theory of the induction motor, and says that after reading this the reader will be better able to understand his own diagrams and deductions. We think, however, that the author would have done well had he made his reasoning a little more clear and detailed. The method adopted is the graphical method, a diagram being given for each machine, &c., considered. The diagrams are given without, in some cases, any of the reasoning which leads up to them. This to the engineer who thoroughly understands the subject does not matter, and to such we would recommend the book. Besides dealing with the general calculations concerned with single and polyphase motors, one chapter is devoted to the special design of a three-phase motor of 200 h.p.; and two chapters, the first and the last, deal with the theory of the alternating current transformer. In appendix ii. a graphical method is given for integrating some of the equations given in the body of the book. We think it is possible for this so-called "non-mathematical" treatment to be carried a little too far. The electrical engineer who does not wish to be severely handicapped in his profession must be able to work out an integration without having recourse to a roundabout method to avoid it, which is most likely only applicable to the particular case under consideration.

Bulletin of the Philosophical Society of Washington. Vol. xiii. 1895–1899. Pp. xxvi + 507. (Washington, D.C.: Judd and Detweiler, 1900.)

THE subjects of papers included in this volume are:—Central American rainfall, a transcontinental series of gravity measurements, cloud classifications, steel cylinders for gun construction, the latitude-variation tide, Alaska, graphic reduction of star places, chemistry in the United States, the transcontinental arc, a century of geography, the comparison of line and end standards, recent progress in geodesy, secular change in the direction of the terrestrial magnetic field at the earth's surface, and the function of criticism in the advancement of science. In addition, there are a number of obituary notices of members of the Society.

Several of the subjects of the papers have already been referred to in these columns, and as the papers go back to March 1895, it is a little late to describe them in any detail. The volume is of particular interest to students of geodesy and physical geography, the papers on the measurement of arcs for the determination of the size and shape of the earth, and on gravity observations, being full of information. The results of a series of gravity measurements, made by Mr. G. R. Putnam, lead to the conclusion that "general continental elevations are compensated by a deficiency of density in the matter below sea-level, but that local topographical irregularities, whether elevations or depressions, are not compensated for, but are maintained by the partial rigidity of the earth's crust." Gravity measurements made on the summit of Pike's Peak and at Colorado Springs, near the base, give the value 5·63 for the mean density of the earth. A discussion of Mr. Putnam's gravity observations leads Dr. C. K. Gilbert to agree that they "appear far more harmonious when the method of reduction postulates isostacy than when it postulates high rigidity."

At the close of a paper on the transcontinental arc measured by the U.S. Coast and Geodetic Survey, Mr. E. D. Preston refers to the accuracy of the observations, and remarks: "The quality of the triangulation is best shown by a comparison of bases. The Fire Island one, nearly 9 miles long, was determined in five different ways through 1800 miles of triangulation, and the extreme range of the results is only two-tenths of a metre. The value from Kent Island base, 5 miles long and 263 miles away, only differed from that given by the Atlanta base, nearly 6 miles long and 868 miles away, by one centimetre."

The paper on the secular change in the direction of the terrestrial magnetic field at the earth's surface, by Mr. G. W. Littlehales, contains a number of valuable plates showing curves of the secular motion of the magnetic needle for twenty-nine different places.

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.*]

On the Theory of Temporary Stars.

IN a note read before the Royal Astronomical Society on May 10, Father Sidgreaves offers a suggestion regarding the displacement of the dark bands in the spectrum of Nova Persei which seems to obviate the serious difficulty felt by astrophysicists in the explanation of the shift of the lines on Doppler's principle.

The ingenious idea set forth in this note—emanating, apparently, from so high an authority as Lord Kelvin—certainly goes far to explain the singular fact that the displacement of these dark bands in the Novæ should *always* be towards the more refrangible side. But Father Sidgreaves remarks that the suggestion does not "help us over the second difficulty: the great breadth of the bright lines, some of which seemed to have lost nothing in width up to the last days of April." The following remarks may perhaps contribute towards an explanation of this second phenomenon, and may thus form a theory supplementary to that proposed in Father Sidgreaves' note.

First of all, it ought to be remarked that the structure of the bright bands, when seen with high dispersion, is extremely complicated. In Nova Aurigæ, as well as in the present new star, the bands were observed to consist of several bright maxima separated by darker interstices. Sir Norman Lockyer, in his communication to the Royal Society on March 28, presented some exceedingly interesting diagrams, exhibiting the intensity curves of the bright hydrogen bands in Nova Persei. Sir Norman shows that these bands consisted of at least three, and in the case of $H\beta$ of even four, maxima. The very same structure appears in the chief nebula band at $\lambda = 501$, as is

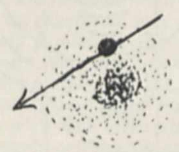

FIG. 1

shown by the measurements made with the Cooke spectroscope of this Observatory, an account of which will shortly be published.

In the note referred to, Sir Norman Lockyer has already suggested that we have here "indications of possible rotations or spiral movements of two distinct sets of particles, travelling with velocities of 500 and 100 miles per second." It appears, therefore, that the extreme width of the bright bands is not caused by a continuous broadening of the line—such as, for instance, increased pressure would produce—but by the juxtaposition of several lines belonging to the same substance, but of somewhat different wave-lengths owing to motions in the line of sight. An explanation of the width of the bright bands is thus equivalent to giving a sufficient reason for the production of displacements such as would conduce to the peculiar grouping of the maxima in the bright lines of the spectrum of new stars.

Father Sidgreaves starts from the assumption of "a collision between two stars." We shall here proceed from the hypothesis propounded by Prof. Seeliger, of Munich, that the Nova is due to the phenomenon of a dark body impinging upon and penetrating into a mass of nebular material.

Now it seems extremely unlikely that the density of the matter composing the nebula should be the same throughout. There will in all probability be a condensation of this matter round the centre, or centres, of gravity of the mass, so that the density must be assumed to decrease outwards from this centre. I consider an assumption of this kind to be warranted, if not demanded, by our modern views regarding the evolutions of stellar systems. But if a body flying through space should approach such a mass, the probability is very small that its line of motion would pass directly through the centre of gravity. Hence we are fairly warranted in assuming that the path of the body through the nebula will lie somewhere between its centre and its boundary (Fig. 1).

In such a case the friction on the surface of the body, caused by its motion through the resisting medium must be greater on the side next the centre of the nebula than on the side next its boundary. This difference of resistance must obviously result in imparting to the impinging body a rotatory movement.

Of course a tremendous translatory velocity would be required to produce any sensible motion of rotation in the impinging body itself. But by following Prof. Seeliger's reasoning it becomes easy to understand how even a comparatively small translatory motion suffices to originate enormous gyratory movements in the strata of the atmosphere surrounding the body. Obviously, the immediate consequence of a collision between body and nebula will be a superficial heating of the former and the resulting formation of an incandescent atmosphere around it. Now Prof. Seeliger has pointed out that the attraction of the body on the nebular mass through which it travels must greatly enhance the relative velocity of those particles which pass near the surface. In his opinion, "no extravagant assumption is required to obtain very great velocities for these particles, velocities such as have been proved to exist in the case of Nova Aurigæ." Hence, even when the initial translatory motion is small, the attractive force of the body would cause enormous differences of velocity between the impinging particles of the cosmical cloud and the atmosphere of the intruding body. And

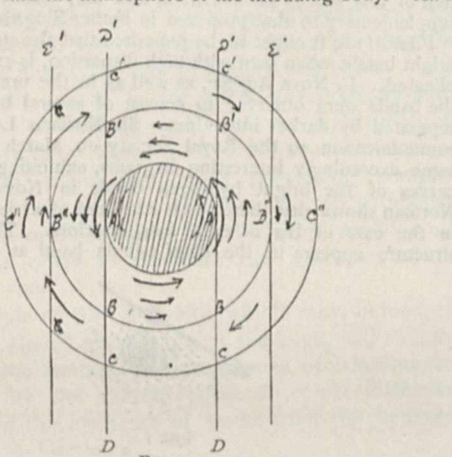

FIG. 2.

it is easy to perceive that, in case of a preponderance of impacts on one side over those on others, there must result a gyratory movement of the atmosphere, the velocity of which will, in course of time, become much of the same order as that of the impinging nebular matter.

The assumption of a cosmical cloud, the density of which increases towards the centre of gravity, leads, therefore, to the necessary conclusion that the incandescent gaseous matter near the body must assume a vorticose motion of probably very high velocity. This motion has its maximum near the surface of the body, whence it will grow less with increasing distance from the centre.

According to the fundamental laws of gyration the rotatory motion must vanish at a certain distance, beyond which it will assume the opposite direction. Let Fig. 2 represent a section through the centre of the vortex in a plane perpendicular to its axis of rotation. Let AA be the surface of the body, BB the locus of the stationary sphere separating the two oppositely-gyrating systems, CC the outermost boundary of the whole system of gyration. Then we have between A and B a rotatory motion of high velocity in *one* direction, decreasing in amount from A towards B, and a rotatory motion in the opposite direction between B and C of less average velocity than the former. The space from A to C is filled with incandescent nebulous matter, the maximum incandescence being at A, whence it decreases towards C. The space beyond C, on the other hand, is filled with nebulous matter of low temperature and no rotatory motion.

The whole vortex travels, of course, along with the central body in a certain direction. This obviously imparts to the light emitted by *every* particle of the whole system exactly the *same* displacement, and hence the motion of translation may be left out of consideration in questions dealing with *relative* velocities.

The assumption made so far, that the rotation of the particles takes place in circles concentric with the circumference of the body, must, however, be modified. The fan-like action of the body's atmosphere will draw in towards the poles of rotation quantities of nebulous matter which, yielding to centrifugal force, will flow towards the equator, and be thence projected outwards again.

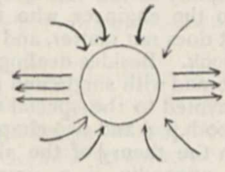

FIG. 3.

The nature of this action may best be seen by considering a section of the system in a plane passing through the centre of the vortex and in the direction of the axis of rotation. The figure so obtained (Fig. 3) is precisely the same as that arrived at by Dr. Siemens in his ingenious theory of the conservation of solar energy. (NATURE, March 9, 1882.) In fact, the conditions postulated by Dr. Siemens in his theory—viz., that the sun is surrounded by matter in a rarefied form, filling interplanetary and even interstellar space—are precisely the conditions under which the phenomenon of a new star is here supposed to occur.

We have, then, to expect an indraught of cool nebulous matter at the poles of the intruding body, and an outflow in all directions of hot nebulous matter at its equator.

In spite of the apparent complexity of the different motions involved in the gyration here described, it is comparatively easy to indicate the influence they must have on the appearance of the lines of a substance present in the nebular matter. Let us first consider the influence of the *tangential* components of the gyratory motion.

Reverting to Fig. 2, and assuming AD to be the direction of the line of sight, it is clear that in the space AADD we have to deal with an incandescent nucleus AA whose light is intercepted by incandescent matter at a lower temperature between A and C, and by dark nebulous matter of still lower temperature between C and D. The resultant effect would be exactly that which Sir William Abney has described in *M. N.* xxxvii. p. 278. The displacements of the line in opposite directions from the normal caused by the approach and recession of the limbs of the rotating body and its atmosphere would broaden the absorption band, which would therefore appear dark in the centre and would gradually shade off towards the edges. The intensity curve of

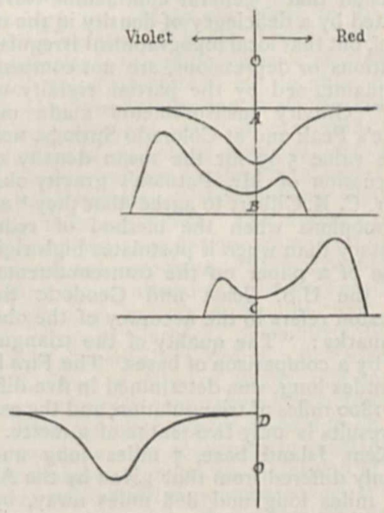

FIG. 4.

the band produced by this part of the gaseous envelope, still provided there be no *radial* motion of matter in the vortex, would thus be similar to that exhibited in curve A in Fig. 4.

Taking next the segment BAB'B" on the left hand side of the figure, we have a motion of the incandescent nebulous matter *towards* us. We must therefore expect a bright line displaced towards the violet. The maximum intensity of this line will be near the edge farthest from the normal position, and it will gradually dim off in brightness as the normal wave-length is approached. This dimming off, which is chiefly the consequence of decreasing incandescence with decreasing rotatory motion, is enhanced by the absorbing action of the cool substance in the outer rings of the vortex. For this matter, having no motion with a direction *towards* us, can absorb only those wave-lengths which coincide with its own, viz. those emanating from the incandescent matter at and near the arc BB″B′, while it leaves the light of higher wave-lengths emanating from A unaffected.

If we now consider the conditions prevailing in the annular section BCC″C′B′, we see at once that the motion of the particles is here in the opposite direction, viz. away from the earth. The light emanating from these particles will, therefore, be displaced towards the red, and consequently a bright line must appear on the less refrangible side. But the velocity of motion in the line of sight in this annular section is smaller than at A, and the incandescence of the particles much inferior; hence the maximum intensity of this new line will not be so far from the normal wave-length, and the line will also be fainter than that on the violet side described before. Taking into consideration these circumstances, we may then assume that the intensity curve resulting from the whole radiation in the segment C′C″CA on the left hand side of Fig. 2 is approximately represented by the curve B in Fig. 4. The radiation of the corresponding segment on the right hand side of Fig. 2 must obviously be the image of B in the normal OO′, and is thus represented by C of Fig. 4.

As all the light emanating from the star must be supposed to pass through the slit of the spectroscope, the line seen in the spectrum will be the resultant of all the component curves. Clearly the character of this compound line remains unaltered, whatever position the line of sight may have with reference to the motion of the star or to the axis of gyration, except the one case when the line of sight is parallel to this axis. Obviously the band would then be reduced to a single line at normal wave-length. The probability of such an occurrence is, however, excessively small. Hence the theory here advanced would lead us to accept the peculiar character of the bright lines exhibited in the curves B and C of Fig. 4 as *a feature characteristic of the whole class of temporary stars.*

So far we have traced the structure of the line emitted by a substance of the nebulous matter on the assumption of circular rotatory movements. We have still, however, to take into account the influence of the flow of this matter to and from the centre of the vortex, as indicated in Fig. 3.

The cool matter flowing in at the poles of the vortex must be supposed to be in a non-luminous condition. It can neither radiate nor absorb selectively in the way as Kirchhoff's law would require, and hence it has no effect on the structure and position of the bright and dark bands. The hot and incandescent matter flowing out at the equator, however, has an important influence in this respect. Reverting to Fig. 2, it may be readily seen that the radial component of the motion of the gaseous particles within the space A A D D included between the two tangents to the surface of the body is directed *towards* the sun. Consequently the absorption bands caused by these particles must all appear displaced towards the violet. Thus, instead of curve A in Fig. 4, which represents the intensity of these bands when there is no radial motion, we obtain curve D of the same figure as the actual representation of the intensity of these bands in the spectrum. The striking difference between A and D is therefore the considerable displacement towards the more refrangible side of the absorption band in D. No matter what direction the line of sight has with regard to the motion of body or nebula, or whether we consider a section through the vortex at right or oblique angle to the axis of gyration, in all cases, except the one mentioned above, *the displacement of the absorption bands must be towards the more refrangible side.* The effect of the radial components of the gyratory motion on the position of the bright bands is easily seen from a consideration of the conditions prevailing in the segments C C″ C′ A in Fig. 2. Apparently there are as many motions towards as there are away from the sun. Hence the effect will consist in a general broadening of the four maxima represented in B and C of Fig. 4, without, however, affecting their position relatively to the normal wave-length.

The combination of B, C and D in Fig. 4 will therefore approximately represent the complete intensity-curve of a line emitted by a substance in the gaseous envelope of the Nova. The combination of B and C alone represents the structure of the bright bands; it agrees perfectly with the drawing given by Sir Norman Lockyer for the case of $H\beta$. Often enough the two inner maxima may overlap each other and thus produce the impression of a single strong maximum at normal wave-length. This would explain the curves with only three maxima exhibited in the diagrams of Sir Norman's paper.

There can be no doubt that the absorption band in D will partly interfere with the maximum of the emission band on the violet side. As a rule the former may be assumed to be the more refrangible, since its displacement must be enhanced by the expansion of body and vortex as a consequence of increased production of heat. In the case of Nova Persei, the difference in the displacement owing to this latter effect must have been very considerable; the two bands were here placed beside each other with comparatively little encroachment of the one upon the other. The conditions in Nova Aurigæ appear to have been somewhat different. Here the displacements of the emission and absorption bands seem to have been fairly equal, the latter obliterating the former almost completely. I consider the bright lines noticed in almost all the absorption-bands of this Nova to be the remnants of the more refrangible maxima of the bright bands.

In any case the effect of a partial encroachment of the absorption band upon the emission band must be a displacement of the centre of the bright band towards the red. We therefore derive two most important results from the theoretical considerations here given:—

(1) *In all the temporary stars the absorption bands must be displaced towards the more refrangible side.*

(2) *In all the temporary stars the centres of the emission bands must show displacements towards the less refrangible side.*

These conclusions are in entire accordance with the facts. As already mentioned, an exception may happen when the line of sight is approximately parallel to the axis of gyration. In this case both the emission and absorption lines would appear in their normal positions, since all the vortex-motions are then more or less perpendicular to the line of vision. Hence the two lines would overlap each other almost completely, and the result would be a purely continuous spectrum with little or no traces of selective absorption or emission. Such an exceptional case many perhaps have presented itself to our eyes in Nova Andromedæ.

The new star in Perseus, thanks to its discovery by Dr. Anderson almost immediately after its appearance in the heavens, offered to astronomical science the unique opportunity of recording the initial stages of its development. None of the theories hitherto propounded have so far succeeded in accounting for the spectral changes so markedly exhibited in the star's light during the first days of its existence as a radiating celestial body. But just these quite unexpected and at first sight perplexing changes find a marvellously simple explanation by the modification of Prof. Seeliger's nebular theory here offered. The first effect of the collision between the dark body and a cosmical cloud must be an enormous heating of the body's surface and the generation of an incandescent atmosphere around it. The depth of this "cloak" of incandescent matter will at first be small, so that the star at that time presents the aspect of a luminous nucleus surrounded by a comparatively shallow atmosphere of incandescent gases. The spectrum yielded by such a star must be continuous, showing dark lines generated by the absorbing faculty of the glowing gases between the nucleus and space. At the moment of the outburst these dark lines will be exceedingly faint, and they will show only such a displacement as is necessary from the amount and direction of the translatory motion of the body. As time passes, however, and the gyration of the atmosphere becomes stronger, the outward flow of the hot particles must rapidly increase, and thus, in accordance with the developments given above, the dark lines, while becoming broader and more distinct, must gradually shift towards the more refrangible side. This increase in the displacement of the dark bands during the first days has been actually observed by Prof. Vogel and many other spectroscopists. To yield a *bright* line spectrum the incandescent atmosphere must have attained a considerable depth, otherwise the bright lines emanating from particles in the space CC″C′A would make no marked impression on the vividly luminous continuous background. Hence we conclude that the bright bands can only appear with sufficient distinctness when the gyratory motion has attained considerable velocity. This is exactly the sequence of the phenomena observed immediately after the outburst.

In the beginning the attracted nebular particles will impinge directly on the surface of the dark body, and hence the heat developed will mainly serve to raise the temperature of this surface. But after gyration has set in, the direct contact between the outside nebula and the body's surface is greatly lessened by the interference of the vortex. The attracted particles will then impinge upon the vortex-rings by which many of them are deflected into circular orbits and thus prevented from colliding with the surface. It is therefore conceivable that the incandescence of the nucleus, after having attained a maximum very soon after the collision, decreases again when the vortex motion gains in power. After a time, the incandescence of the nucleus will be chiefly maintained by the friction between the vortex and the surface. The star's radiation must therefore ultimately attain a lower limit where it becomes stationary so long as the vortex motion is constant. This state appears to have been reached by Nova Persei towards the middle of March.

The variability of the star is a natural consequence of this theory. We have only to suppose that the dark body, when entering the cosmical cloud, had no sensible rotation of its own. In this case the impacts would be more frequent, and consequently the incandescence more vivid, on one part of its surface than on others. Now, when the gyratory motion has become considerable, the friction between vortex and body must gradually impart a slow rotatory movement to the latter. Thus, by rotation, the patch of greater luminosity would at times be revealed to us, while at other times it would become invisible.

In conclusion I shall mention a fact revealed by the observations which speaks greatly in favour of the theoretical views set forth in this paper. Whenever the continuous spectrum of the Nova became feeble, the green band at $\lambda = 501$ was seen to gain considerably in breadth and brightness. Now a reduction of the intensity of the continuous background must obviously be accompanied by a decrease in the intensity of the absorption bands. If the nucleus were to lose its radiating power altogether, these bands would naturally become emission bands. In such a case the bright bands of the spectrum would therefore appear much broader and more intense. Hence any reduction in the general emissive power of the nucleus must tend to increase the width and brightness of the spectral lines.

That the spectrum gradually changes from the chromospheric to the nebular type is exactly what must be expected from the foregoing considerations. I need scarcely say that the theory is sufficiently flexible to adapt itself to any kind of hypothesis which may be made with regard to the physical constitution of the nebular matter. Considering the enormous forces which must have been developed in the impacts, I incline to the opinion that, besides a gaseous fluid, we are probably here in presence of cosmical matter of a meteoritic constituency such as Sir Norman Lockyer assumes in his well-known theory.

I am fully aware that the explanations I have been able to give in this communication can only be a first approach to the comprehension of a phenomenon which is necessarily one of extreme complexity. Considering, however, that the theory here advanced is based upon assumptions which seem to me perfectly warranted and highly probable, and that the prominent facts brought out by the spectroscope are satisfactorily explained by it, I venture to submit it even in this preliminary state to the criticism of astronomers. It is certainly the first time that the ingenious theory of Dr. Siemens has been called upon to explain a phenomenon in the remote recesses of the universe, and I am confident there must be many admirers of this eminent man of science who would wish to find his excellent theory applicable to the extraordinary case of stellar evolution before us.[1]

My best thanks are due to Mr. G. Clark, of this Observatory, for several suggestions which proved to be most valuable for the above investigation.

J. HALM.

Royal Observatory, Edinburgh, June.

[1] It is worthy of remark that a terrestrial cyclone, if the velocities therein exhibited were vastly greater than they actually are, and if its centre were occupied by a radiating nucleus so hot as to make the gyrating gases incandescent, would present to an outside observer exactly the same structure in the bands of its spectrum as is exhibited in the case of Nova Persei.

Vitality of Seeds.

THE resistance of the dormant protoplasm of seeds to low temperatures has lately received much attention. C. de Candolle, Pictet, Brown and Escombe and Sir W. T. Thiselton-Dyer have in succession extended our knowledge of the resistance of seeds towards extremely low temperatures. The last-mentioned experimenter has shown that very various seeds do not lose their germinating power after being exposed to the temperature of liquid hydrogen.

The upper limit of temperature which seeds can resist does not seem to have been carefully ascertained. It is probable that it would vary with different seeds and for the same seed when containing different percentages of water. For it is known that the coagulating point of proteid depends, within certain limits, on the amount of water present in it. Thus Lewith (*Arch. für exp. Pathol. u. Pharmak.* 1890) showed that proteid containing 25 per cent. of water coagulates at 74°–80° C., containing 18 per cent. at 80°–90° C., and with 6 per cent. only at 145° C. It follows that if it is the coagulation by heat of the proteids of the seed which prevents the embryo returning from its state of suspended animation into active vitality, the resistance of the seed will depend on its state of desiccation.

With this idea I have been making a few preliminary experiments on desiccated seeds, and I find that in every case they can resist surprisingly high temperatures. At first I thought it necessary to desiccate the seeds over sulphuric acid for a fortnight or longer before raising their temperature considerably. I now find it as effective, and more convenient, to dry the seeds on an oven for a day at 65°–75° C., and then for a day at 90° C. After this they may be raised to successively higher temperatures without harming them till their upper limit is passed. All the seeds I have tested can resist a temperature of at least 100° C. The following are the species I experimented with:—*Avena sativa*, *Lolium perenne*, *Lactuca sativa*, *Helianthus argophyllus*, *Mimulus moschatus*, *Medicago sativa*, *Brassica Rapa*, *Eschscholtzia californica*, *Papaver somniferum*, *P. nudicaule*, *Meconopsis cambrica*, *Schizopetalon Walkeri*.

Of these Medicago has proved the most resistant. After an exposure of one hour to 110° C. and then of one hour to 121° C., 10 per cent. germinated.

The effect of exposure to the high temperature is, however, noticeable in all cases by the marked retardation of germination and by the extremely slow growth afterwards. The young plants, too, seem weakly, and there is a distinct loss of sensibility to the geotropic stimulus in their radicles. Whether they would ultimately become normal I cannot say, as the conditions under which they were germinated were not suitable for further development.

For most of the other seeds the upper limit seems to be considerably lower. It lies about 110° C. Perhaps, however, by more careful desiccation even these less resistant ones may be brought into a condition to stand exposure to higher temperatures. The following table will convey some idea of these preliminary experiments, showing the upper limit and the retarding effect of exposure to high temperatures for each species.

The Roman numerals indicate the number of days between moistening and germination as indicated by the protrusion of the radicle.

Temperatures	15°	97°	100°	105°	107°	108°	110°	112°	114°
Avena sativa	iii	vi	v	iv	—	—	xi	—	—
Lolium perenne	v	iv	iv	v	xii	—	xii	—	—
Lactuca sativa	ii	ii	ii	ii	vi	—	viii	xii	xviii
Helianthus argophyllus ...	iv	iii	iii	iv	xi	—	xi	—	—
Brassica Rapa	ii	ii	—	iii	vi	vi	viii	—	—
Eschscholtzia californica...	ii	iii	ii	ii	ii	—	vii	—	—
Mimulus moschatus ..	—	vii	ix	xviii	—	—	—	—	—

From this table the increase in the time needed for germination is apparent. All the samples of seeds were sown on moist sand simultaneously, and maintained under conditions of temperature and moisture as similar as possible.

For the other seeds not mentioned in this table the time needed for germination was not recorded, and only the maximum temperature resisted was observed. These maxima were as follows: *Schizopetalon Walkeri*, 105°; *Papaver somniferum*, 100°; *P. nudicaule*, 100°; *Meconopsis cambrica*, 100°; *Medicago sativa*, 121°.

This great resistance of dried seeds to comparatively high temperatures naturally calls to mind Prof. Giglioli's most remarkable experiments with regard to the actions of poisons, both gaseous and liquid, on seeds. An account of them was given in NATURE, 1882, p. 328, and 1895, p. 544. He found that dried seeds of *Medicago sativa*, although exposed to the prolonged action of gases such as oxygen, chlorine, nitric oxide, &c., and of poisonous fluids, *e.g.* alcohol, corrosive alcohol, &c., retained their power of germination. In some of his experiments the time of immersion of the seeds in the poison was so prolonged (many years) that the supposition of the non-penetration appeared precluded. I have repeated Giglioli's experiments with several species, and found, as he did, that some seeds can withstand the action of poisons while others cannot Seeds of *Medicago sativa* were exposed from 10-30 days to the action of methylated spirit, spirit saturated with mercuric chloride and with picric acid without their powers of germination being noticeably affected. Similarly, seeds of *Papaver Rhoeas*, *P. somniferum* and *Schizopetalon Walkeri* resisted the action of spirit, but were apparently killed by corrosive alcohol. *Papaver Rhoeas* germinated after two days' immersion in chloroform and two days in spirit. On the other hand, seeds of *Nicotiana Tabacum*, *Linaria reticulata*, *Gypsophila paniculata* and *Calandrina umbellatum* did not germinate after immersion in spirit.

The following experiment shows, I think, that this astonishing resistance to poisons is not due to the quiescent state or stability of the protoplasm of the seed, but to the imperviousness of the seed-coat. A large number of seeds of *Medicago sativa* were taken, and half of them were punctured with the prick of a needle. All were then desiccated, and after desiccation immersed some in spirit, some in spirit and mercuric chloride and some in spirit and picric acid. It was then found that the intact seeds germinated in large quantities even after immersion in the poisonous fluids, while the punctured seeds germinated in no case after immersion. In a control experiment it was found that the punctured seeds both before and after desiccation germinated freely. It would appear, then, that when the penetration of the poison was secured the effect was to destroy the vitality of the seed. HENRY H. DIXON.

Botanical Laboratory, Trinity College, Dublin.

An Instance of Adaptation among the Deer.

MY friend Major C. S. Cumberland has just brought from Manipur the head and hind-foot of a deer, the latter of which affords an interesting instance of adaptation to environment. The deer in question is the Manipuri representative of the thamin (*Cervus eldi*) of Burma, an animal inhabiting open tree jungle. The Manipur valley is, however, a huge swamp, and the thamin of that locality have developed a peculiar modification in the foot which enables them to walk with ease in such ground. In the Burmese thamin the under surface of the hind pasterns is covered with hair in the ordinary manner, and the animal walks entirely on the main hoofs, keeping the pasterns much elevated. In the Manipuri thamin, on the other hand, the under surface of the pasterns is covered with a hard, horny, bare skin, which immediately above each hoof has almost the consistency of horn, and is practically continuous with the hoof itself. Moreover, so far as can be determined from comparison with a mounted specimen of the Burmese form, the pasterns are very considerably longer than in the latter. In walking, according to the account given by Major Cumberland, the foot is much bent, so that the animal walks on nearly the whole of the under surface of the pasterns, and thus gains a firm support on the yielding morass.

Assuming this feature to be constant (as Major Cumberland believes to be the case), the Manipuri thamin appears entitled to rank as a distinct local form, for which the name *C. eldi cornipes* will be appropriate, Major Cumberland's specimens standing as the type.

But, quite apart from this minor point, the specimens are of especial interest as showing a previously unknown mode by which ruminants may adapt themselves to a life in swamps. In the well-known instance of the sitatunga antelope of Africa a sufficiently large surface of support is afforded by a lengthening of the hoofs; in the present case the hoofs remain of the normal length, and support is obtained by the animal walking on the under surface of the pasterns, which is specially hardened. It is, in fact, an incipient instance of the reversion of a digitigrade animal to the plantigrade progression of its swamp-dwelling ancestors. R. LYDEKKER.

Snow Conditions in the Antarctic.

THE meteorologist of my expedition has unfortunately given a somewhat incorrect idea about the snow conditions at Cape Adare. He reports, namely, that there is a very small snow fall at the sea-level. This is, in my opinion, not the case. But his mistake is excusable and easily explicable; of course, being a young Tasmanian and not previously having seen ice and snow, a devotee to his instrument, took down in his note book the evidence of a usual snow gauge. Snow seldom or never fell in the Antarctic except during heavy gales, and it must be clear to anybody familiar with snow that a snow gauge of the ordinary type is worse than useless during heavy gales. Although Cape Adare itself and the peninsula on which we lived were almost free of snow in the open, we had more than ten feet of snow to the leeward of our hut at Camp Ridley, and undoubtedly there would have been still more had the huts been higher. This indicates, of course, that much snow fell, but it was blown away as well from the promontory at Cape Adare as from the unfortunate snow gauge. In my opinion a very heavy snow fall takes place within the Antarctic circle. And I believe that the strong gales within the Antarctic circle generally are local and that these snow bared dark promontories are the very homes of the Antarctic gales, while those places where no dark land is to be seen probably are unmolested by great atmospheric disturbances and are therefore covered in heavy snow. From time to time in the pack ice I have passed through distances where the ice was covered in several yards of loose snow. This I noticed as well on my first voyage in 1894 as during my last expedition. I will therefore use the opportunity to warn the coming expeditions from not providing against the difficulties which a very heavy snow fall incurs for sledge parties within the Antarctic circle. C. E. BORCHGREVINK.

(Commander British Antarctic Expedition, 1898-1900).

Douglas Lodge, Bromley, Kent, July 6.

PHOTOGRAPHIC AND PHOTOMETRIC SURVEYS OF THE STARS.[1]

EVERYONE will naturally wish to offer words of hearty congratulation to Sir David Gill and his able coadjutor, Prof. Kapteyn, on the completion of the Cape Durchmusterung, of which the third and last volume has recently appeared. Some twenty years since, when the capacity of celestial photography was practically an unknown factor, Sir David Gill proposed to himself to complete a survey of the southern hemisphere by means of photographic star maps. The original conception was a tolerably modest one. Sir David Gill's idea was simply to prepare from these maps a working catalogue of stars to facilitate the meridian zone observations, after the programme of the Astronomische Gesellschaft, but "to avoid the repetition of such an arduous undertaking as Argelander's Durchmusterung as a preliminary step." How the original plan was extended and grew, till the results fill three bulky volumes, exceeding Argelander's work both in number of stars and in accuracy of observation, he has himself told in the introduction to the first part, to which we have already referred (NATURE, vol. lvii. p. 513). Very rapidly has the work gone on once all preliminary difficulties were removed, and now the astronomers of the Cape and of Groningen see their work completed on a uniform plan within a moderate space of time, with an accuracy which approaches that attaching to the older so-called "Precision Catalogues," together with the means existing for the determination in special instances of star places with even greater accuracy. For though we have spoken of the completion of the work,

[1] "The Cape Photographic Durchmusterung for the Equinox 1875." By David Gill, C.B., LL.D., F.R.S., &c., His Majesty's Astronomer at the Cape, and J. C. Kapteyn, Sc.D., &c., Professor of Astronomy at Groningen. Part iii. Zones $-53°$ to $-89°$. Pp. 88+671. (Edinburgh: Neill and Co., 1900.)

"A Photometric Durchmusterung, including all Stars of the Magnitude 7·5 and brighter North of Declination $-40°$, obtained with the Meridian Photometer during the Years 1895-98." By Edward C. Pickering, Director of the Harvard College Observatory. Pp. 330. (Cambridge, U.S.A., 1901.)

this is to be understood in a limited sense. The discussion of the catalogue is about to begin. Such discussion will include the examination and detection of errors in the "Precision Catalogues," the search for, and discovery of, stars with large and unsuspected proper motions, and the formation of a catalogue of variable stars for the southern hemisphere. Further, the course of the work has disclosed the existence of a possible systematic difference of colour in stars, depending on the galactic latitude, and intimately connected with this inquiry is the investigation of the systematic corrections which should be applied to the magnitudes derived from the Cape plates to ensure one uniform system, photographically considered, or to connect the photographic and optical magnitudes. A revision conducted on such ample lines is a task of only less magnitude than that of the construction of the catalogue itself, while the importance and interest are even greater. That the same competent hands will carry such a discussion to a final issue will be the hope and the expectation of all astronomers.

The introduction supplied by Prof. Kapteyn to the third volume cannot possess the novelty and the interest which naturally attaches to that accompanying the first volume of the annals. In that it was necessary to detail his scheme of measuring the plates and effecting the reduction ; he also sketched the results at which he had arrived by comparison with the work made on the meridian by other astronomers, pursuing similar but less extensive methods. The subsequent volumes have had to record the mechanical accumulation of the places and magnitudes of stars observed by the same method, till we have piled up for us the enormous total of 454,384 stars, catalogued within an area of 13,911 square degrees, embraced in the district between the South Pole and the parallel of 19° south declination. The greater richness of the southern skies is shown by the fact that this number is only slightly less than that contained in the joint Durchmusterung of Argelander and Schonfeld, extending from the North Pole to 23° south declination. Further, this richness has increased as the observations have been carried polewards, the maximum being reached in the zone 48°–58° S. decl. In the first section, comprising the zone 18°–37° S. decl., the average number of stars to a square degree was 25·43 (NATURE, *loc. cit.*) ; for the whole the average number is 32·66, or more than double that of the Northern Bonn Durchmusterung. But in a discussion involving relative density of aggregation the vexed question of the maintenance of a uniform standard of magnitude throughout the whole survey enters with perplexing uncertainty. On this point Prof. Kapteyn entertains views into which we do not care to enter too minutely, for we are yet awaiting his complete answer to sundry criticisms which have been advanced. We are certainly inclined to follow him in his assertion that if two or three tenths of a magnitude be deducted from the estimates we shall obtain the limit of photographic magnitude to which the stars of the catalogue are certainly practically complete, and that consequently we may assume the whole catalogue to embrace all stars down to 9·2 mag.

There is, however, the other and more thorny question, which touches on the relative chemical activity of stars in different parts of the sky, which it is not so easy to answer. Prof. Kapteyn puts the question thus. To what limit of magnitude would the plates be found complete were the magnitudes of the Cape Durchmusterung reduced to a homogeneous set of photographic magnitudes for the whole sky ? The answer which he offers is that the Durchmusterung will be found practically complete in or near the Milky Way, to stars which in the scales of Schonfeld, of Gould and of Thome are of the magnitude 9·5, and for the rest of the sky to stars actinically equivalent to these. The vagueness of this reply is due to the peculiar feature that Prof. Kapteyn's discussions have disclosed, and whose complete explanation is not yet forthcoming. The measurement of a great number of plates has satisfactorily shown that the law expressing the growth of star density depending on proximity to the Milky Way differs essentially from that exhibited in the optical observations of Schonfeld and Gould. For this fact two explanations, equally plausible, can be offered. Prof. Kapteyn's contention is that there is a real difference in the colours of the stars as the Milky Way is approached, and that the increase of blueness leads to increasing discrepancies in the differences between photographic and visual magnitude, amounting roughly to 0·01 mag. for each degree of galactic latitude. On the other hand, the ground for the observed inequality may be due to systematic errors in assigning the optical magnitudes to stars under the different condition in the method of selection of the stars, when they pass slowly in the sparser regions of the sky, and when the richer regions are being observed. The tendency might very well be, from the greater time at the disposal of the observer in the first case, to observe fainter stars than when he finds his field crowded with passing objects. Of course, both views were fully admitted by Prof. Kapteyn, but he considered he had sufficient evidence to establish his case, and though he acknowledges the force of the arguments which have been brought against him, he is still inclined to maintain his view. The fuller discussion is one of those points which have been left for future investigation so as not to delay the completion of the main work, but if the Groningen astronomer can obtain support for his theory it may have an important bearing on our views concerning the cosmical arrangement of the stars.

The accuracy of the stars' coordinates remains practically the same as in the earlier volumes, and from a comparison with Gould's meridian places may be given as follows :—

Declination.	Prob. Error in Right Ascension.	Prob. Error in Declination.
$-38°$ to $-58°$	$\pm 0^s{\cdot}288$	$\pm 0'{\cdot}0444$
$-58°$ to $-86°$	$\pm (0^s{\cdot}157 + 0^s{\cdot}0764 \sec \delta)$	$\pm 0'{\cdot}0559$

But the method of measurement of stars on the polar plate affords a better means of determining the degree of accuracy attainable on these plates, and of the possible service they are likely to render in settling questions of identity or of proper motion. On this plate the rectangular coordinates have been measured with the Repsold apparatus acquired by the astronomical laboratory at Groningen, and the measures reduced by comparison with all the stars (save one) common to the plate and to Gould. Making due allowance for proper motion and error of observation in the Cordoba places, the probable errors of the Cape positions are found to be in R.A. $\pm 0''{\cdot}53$ (arc of great circle) ; in decl. $\pm 0''{\cdot}76$.

Considering the shortness of the focal length (54 inches) such a result is extremely gratifying, and it seems likely, as anticipated by the authors, that many questions connected with the proper motion of the southern stars can be at once set at rest by an appeal to the original plates. Some such work seems to have been already begun, judging by the tables added to the volume, in which are shown instances of stars missing on the plates and yet given elsewhere, and of stars found on the plates not recorded in known catalogues. Such work requires infinite patience and care, and we can only once more congratulate the joint authors on the success that has attended their unwearied efforts to secure uniformity and accuracy.

The second work under notice also exhibits the results of continued labour pursued with persistence and success. Photometry has so long been a feature in the researches at Harvard College Observatory, and so many successive volumes have detailed the method of observing, that on the present occasion the Director contents himself with a very short preface, but which gives evidence of the same untiring energy which marked the earlier volumes. For example, we are told that between 1891 and 1898 no less than 473,216 photometric settings were made with the meridian photometer, nearly all by the Director himself. The object of this heavy undertaking was to determine the magnitude of all stars brighter than 7·5 situated north of $-40°$ declination. In the early days of magnitude work the Director did not propose to pass the limit of $-30°$. This restriction was perhaps necessary on account of the smaller photometer employed, but to overstep it may also indicate that the Director feels himself now competent to cope with the difficult questions arising from the extinction of light in our atmosphere. For, although the Durchmusterung does not aim at completeness beyond $-40°$, a good many stars, reaching to even within one degree of the Harvard horizon, have been included. Such measures are necessarily frequently discordant among themselves and do not agree with the estimates made in the southern hemisphere, but the discussion of all the discordant residuals, from whatever source arising, is deferred till the appearance of another volume. A difference of 0·65 mag. from the mean has been selected as marking the limit of discordant measures.

It will be noticed that this photometric survey covers no inconsiderable portion of the area that has been examined by Kapteyn. The whole of the first volume of the Cape Durchmusterung, $-18°$ to $-37°$, is included, and should therefore furnish at once enlarged material for the examination of the systematic differences between photographic and visual magnitudes. Further, the meridian Pickering photometer is at present at the Arequipa Observatory, having been dismounted in September 1898, and the energetic Prof. Bailey is presumably using the same instrument at the southern station. Care has been taken to interchange the observers at Harvard so as to supply the means of reducing the observations on a uniform system, and thus continuing the Harvard survey to the Southern Pole. We may therefore look forward to the rapid acquisition of further data which will not only afford better values for the constants of reduction of the Cape plates, but exhibit in an unmistakable manner, though it may not solve, the perplexing difficulties to which we have alluded. Certainly, if energetic prosecution of the observations is of avail, the matter could not be in better hands than those of the Directors of Harvard and the Cape Observatories. W. E. P.

THE TREATMENT OF DISEASE BY LIGHT.

PHOTOTHERAPY, or the treatment of disease by light, has now, thanks to Prof. Finsen of Copenhagen, a recognised place in the domain of therapeutics. Finsen's first paper on the subject was published in 1893. In it he showed that the chemical or ultra-violet rays of the spectrum have a definite effect upon the course of small-pox, and he proposed that patients suffering from this disease should be kept in rooms from which the chemical rays of light were excluded by means of red curtains or red glass, in the same way that a photographer excludes these rays from his plates and paper. In an ordinary case of small-pox treated under the usual conditions, the eruption passes from the vesicular to the suppurative or pus-forming stage, and this condition is most marked upon the face and hands, the parts most exposed to light. It is in consequence of the destruction of the skin attendant upon the suppuration that the face and hands are so commonly the seat of hideous scars. Finsen's suggestion has been carried out with considerable success. In nearly every case in which the patient was kept in red light from the onset of the disease, there has been found to be a marked change in the course of the eruption. The suppuration and its attendant secondary fever have been almost, if not entirely, abolished, and as a result the patients recover with little, if any, scarring.

Finsen's next researches were made upon the action of light as an irritant, and they are of extreme interest to the biologist. It will suffice here to say that he found that the animal organism, especially in creatures which prefer to dwell in the dark, is markedly irritated by the chemical rays, while the other parts of the spectrum are non-irritant. From this he was led to investigate the effects of light upon bacteria. Here the field had already been occupied by Downes and Blunt, who, in 1878, in a paper read before the Royal Society, showed that the chemical rays are bactericidal. Duclaux, Arloing and others have worked upon the same lines and confirmed their results. It therefore seemed probable that superficial diseases of the skin caused by bacteria could be cured by the application of light. Of these, one of the most important and most intractable is lupus. Finsen, however, argued that the intensity of ordinary sunlight is obviously insufficient to kill the microbes as they lie in the skin, for lupus is particularly a disease of the face, which is more exposed to the sun than any other part. He therefore tried the effect of concentrating the light by means of lenses, cutting out the red and ultra-red rays by a blue medium. He found that cultures of micro-organisms *in vitro* were much more powerfully influenced by the concentrated rays. The sun's rays concentrated by the apparatus to be presently described were fifteen times stronger than ordinary sunlight. Powerful electric arc lights were also tried, and with a lamp of from 35 to 50 ampères the effect was similar to that of the sun, or even greater.

The next point to be determined was the penetrative power of light. For this purpose small sealed tubes containing silver salts were placed under the skin of animals and exposed to the concentrated light, and the silver was found to be blackened.

The effect of the blood circulating in the tissues was next demonstrated by a very ingenious experiment. A piece of photographic paper was placed behind the ear, and the outside of the lobule was exposed to the light. In about five minutes the paper was blackened. The experiment was then tried with the ear compressed between two pieces of glass so that it was rendered bloodless. The photographic paper was blackened by the light in twenty seconds. The absence of the red colouring matter of the blood allowed the chemical rays to penetrate with great ease.

The apparatus devised by Finsen for the treatment of lupus by the sun's rays (Fig. 1) consists of a large hollow planoconvex lens, filled with an ammoniacal solution of sulphate of copper and mounted upon a fork-like metal stand, so arranged that the lens can be moved about a horizontal and also round a vertical axis, and lowered and raised at will. The filtered sun's rays are focussed upon the area of skin to be treated, and at this spot is placed the compression apparatus. This is a very flat cylinder made of two plates of rock crystal fixed in a metal ring. Through the compression apparatus passes a current of cold water, so that the instrument is used to render the part to be treated bloodless and also to cool it. The pressure apparatus is held on the skin by a nurse throughout the whole sitting, which lasts one hour or a little more. The spot treated at each sitting is about the size of a sixpence.

The electric light apparatus (Fig. 2) is much larger and more complicated. Attached to a strong metal ring round a large arc lamp, of 30,000 to 35,000 candle-power, are four long cylinders like telescopes. Each telescope consists of two parts. The upper part, closed at each end by rock crystal lenses, makes the divergent rays of the arc light parallel, and the lower piece brings the rays thus rendered parallel, to a focus on the skin of the patient. The lower part of the apparatus is filled with distilled water and is surrounded with a jacket through which cold water circulates. The compression apparatus used

FIG. 1.—The treatment by sun-light.

for the sun treatment is placed, as before, at the focus of the light to render the skin bloodless and to keep it cool. The length of the sitting is one hour. There is no blue solution in the electric light apparatus as now made, as it has been found in practice that the tube of distilled water and the circulating water in the pressure glass are sufficient to absorb the comparatively small amount of heat-rays given off by the arc light. Rock crystal lenses are used because ordinary crown glass prevents a great part of the chemical rays from passing through.

As a result of an hour's application of the light the skin may be a little red, but there is no proper reaction for from six to twelve hours, when there is definite redness and swelling and sometimes slight blistering. In from three to seven days all trace of reaction has usually disappeared, and the skin, though still hyperæmic, can be treated again if necessary. The process is repeated over the whole of the diseased area and especially at its margins, the most active parts, until every sign of lupus tissue has disappeared. If the disease is extensive, the treatment lasts many months. It must be noted that in many of the bad cases not only is the skin affected, but also the mucous membranes lining the mouth and nose, and these parts can very rarely be influenced by the light.

In Copenhagen there is a Light Institute under the direction of Prof. Finsen, and a very large number of patients, more than 500, have passed through the institution. It was in Copenhagen that the Queen saw the treatment, and Her Majesty was so impressed with the good results attained there that she graciously presented a set of the apparatus to the London Hospital a little more than a year ago. The demands upon that institution became so great that a second and a third lamp had to be put up, and even with these it is impossible to cope with the influx of patients from all parts of the British Isles, and even from such distant colonies as Newfoundland and New Zealand.

The drawbacks to the treatment are, first, the length of time which a severe case takes, and, secondly, the cost. Not only is there the cost of the electric light and the necessary maintenance, but every patient has to be attended by a nurse. At the London Hospital it has been found that it costs about 400*l*. or more a year to run one lamp, so that the light department there necessitates an expenditure of 1200*l*. a year. It is, therefore, gratifying to find that Mr. Alfred Harmsworth has come forward and endowed one lamp by a munificent gift of 10,000*l*.

It must be noted also that public spirit in Manchester and Liverpool will shortly provide for the installation of the light treatment in these cities.

The results in cases of ordinary lupus are excellent, provided that the patients can remain continuously under treatment for a sufficient length of time. The average of a large number of cases is three months. Certain other diseases, lupus erythematosus, rodent ulcer and alopecia areata, are influenced favourably by the light treatment. In the first mentioned disease the results are not nearly so striking as in the common form of lupus, but about one-third of the cases do well.

The light treatment has been too recently tried in London for any definite statement to be made as to the permanence of the results. In Copenhagen it has been in use for five years, and some of the earliest cases are quite free from recurrence to date.

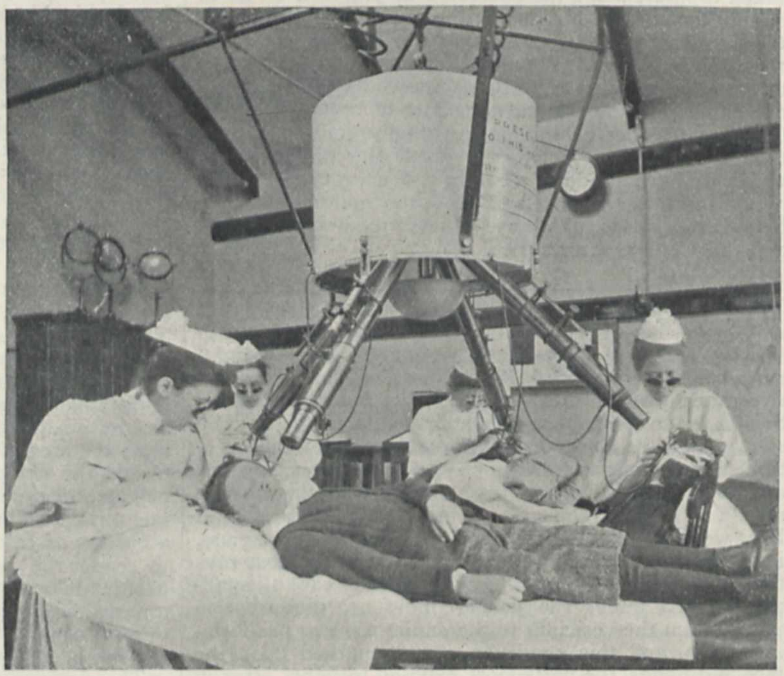

FIG. 2.—Treatment by electric light at the London Hospital.

The important advantages of this method of treatment over every other which has been used for lupus are that there is no destruction of tissue, there is no operation, and therefore no anæsthesia, for the treatment is painless, and, last but not least, in a disease which attacks the face the cosmetic results are wonderful. The skin of the areas treated is soft, supple and pale, and in some cases so nearly resembles the healthy skin that it requires careful observation to detect the difference. As we have already mentioned, the drawbacks are the time and the expense, and the impossibility of treating the mucous surfaces. If a cheaper method of application, with shorter exposures and the possibility of treating a larger area at one sitting, is introduced, there is no doubt that the light treatment will be used in every hospital where a suitable electrical installation is obtainable.

NOTES.

WE deeply regret to record that Prof. P. G. Tait, late professor of natural philosophy in Edinburgh University, died on Thursday last, July 4, at seventy years of age.

A STATUE of Chevreul is to be unveiled to-day at the Paris Museum of Natural History.

THE death is announced of Prof. T. H. Safford, professor of astronomy in Williams College, Williamstown, Mass., U.S.A. Prof. Safford was born in 1836 and was renowned for his mathematical attainments as well as for his work in preparing catalogues of stars.

THE death of Sir Cuthbert Peek, at the early age of forty-six, will be regretted in scientific circles, for he was a liberal patron of scientific work as well as an active worker. He was interested in many branches of science, being a Fellow of the Royal Astronomical, Geographical, Meteorological and other Societies, and of the Anthropological Institute. He also served on the councils of several scientific societies. He maintained a well-equipped observatory at Rousdon, near Lyme Regis, Devon, and the meteorological and astronomical observations made there have frequently been referred to in these columns. Science can ill afford to lose one who was in such complete sympathy with its interests.

TIDINGS have been received of the death of Dr. Joseph Le Conte, professor of geology and natural history in the University of California. He was born in Georgia on February 26, 1823, and was a son of Dr. Lewis Le Conte, the botanist. Having studied for the medical profession, and taken the degree of M D. at New York in 1845, he settled at Macon as a physician. Science, and particularly geology, however, attracted much of his attention. In 1856 he was appointed professor of chemistry and geology in South Carolina College, and he resigned this post in 1869 for the professorship at San Francisco. He was the author of a useful work on the "Elements of Geology" (1878), of which a revised edition was issued in 1889, and he gave special attention to the study of volcanic and also of glacial phenomena.

THE International Association for the Advancement of Science, Arts and Education will hold its second international meeting at Glasgow in the University and in the International Exhibition from July 29 to September 27.

THE *Times* correspondent at St. Petersburg states that the Imperial Geographical Society is sending an expedition to the Pamir under the leadership of Dr. Fedshenko with the object of making geological, botanical and zoological researches.

THE Institution of Mining and Metallurgy announce the intention to award two premiums of twenty-five guineas each for the best papers on the comparative merits of circular and rectangular shafts respectively, for mines of great depth. An annual prize of ten guineas will also be awarded for the best paper upon any subject connected with the treatment of ore. Particulars can be obtained from the secretary of the Institution, Broad-street House, London, E.C.

A CORRESPONDENT sends us the following translation of an article which appeared in the *Neue Freie Presse* of Vienna, and was translated in the Copenhagen Journal *Dannebrog* on June 28, upon the removal of Tycho Brahe's remains from his tomb. This is the first report we have seen of the event :—" On the occasion of the 300th anniversary of Tycho Brahe's death the Prague Town Council decided to gather together the remains of the celebrated astronomer, which were in the Teyn Church, and bury them anew. Under the guidance of Mr. Herlein this operation was commenced yesterday. After having lifted the stone block on the monument, which is situated near the first column in the nave and which bears a full-length effigy of the great astronomer, a semi-collapsed arch was found, and on removing the stones two mouldering coffins were seen. On the following day a committee met to determine whether these bodies were those of Tycho Brahe and his wife. Two workmen with candles descended into the vault and removed the débris which covered the coffins, the wood of which was quite rotten and fell to pieces at every rough touch. About 10 a.m. the lid of the first coffin was free to be removed. It was a surprising sight that met the eye ; the body in the coffin was a wonderful likeness of the effigy on the monument. The head was slightly turned to one side, the bones of the face and the peaked Spanish beard being well preserved. The head was covered with a skull cap, and the neck was surrounded by a Spanish ruff which, like the remainder of the clothing, had suffered little during the 300 years since Tycho Brahe was laid in his last resting place. The feet were shod in long cavalry boots reaching up over the knee. That the body was Tycho Brahe's was also seen from the absence of the nose ; Tycho lost this organ in a duel and wore a silver one in its place. Amongst the rubbish was found a silver wreath and spray of flowers. The construction of the grave was rather remarkable, the stones being laid loosely over one another. This is all the more astonishing seeing Tycho Brahe was buried with great pomp and honours, but it is supposed that the vault broke down during the restoration of the church in 1721."

DR. C. D. WALCOTT, director of the U.S. Geological Survey, contributes to *Science* of June 29 a long article on the relations of the national Government to higher education and research. The U.S. Congress has generously aided technical and higher education by grants of land to States and territories for educational purposes. This policy was inaugurated in 1787, when a contract was entered into between the Ohio Company and the Board of Treasury of the United States, whereby lot 16 in every township was given for the maintenance of public schools and not more than two complete townships were given perpetually for the purpose of a university, the land to be applied to the purpose by the legislature of the State. The most important act, after that of 1787, was that of 1862, granting land for the endowment of colleges for teaching agriculture and the mechanical arts. The total grants of land amount to about 20,000 square miles, about 4000 square miles of which are for the establishment of higher institutions of learning, and 16,000 square miles are in aid of "colleges for the benefit of agriculture and the mechanical arts." In addition, Congress now grants annually to each of the forty-five States the sum of 5000*l.*, which is expended under the direction of State boards. The policy of the U.S. Government has thus been to relegate the direct control of education to the States, aiding them in this work by grants of land, and in the case of technical education by grants of money also. The Government has carried on original research for its own purposes in the district of Columbia, through grants of money to its various scientific and technical bureaus. Of the total sum granted to these departments during the fiscal year 1901, more than 400,000*l*. or about 25 per cent. of the grant is available for scientific and research work and for higher education. The city of Washington possesses vast resources for work of this kind, and Congress has lately enacted that all the collections and museums in the city shall be available for higher education and research. The Washington Memorial Institution, which will begin work in three or four months, under the direction of Dr. Gilman, will suggest lines of investigation and coordinate the work that is being done by Government officials and private students.

As already announced, the British Congress on Tuberculosis will be opened at St. James's Hall on July 22. The Duke of Cambridge will inaugurate the congress on behalf of the King, who is patron. The work of the congress will be divided among four sections, viz.: (1) State and municipal—president, Sir Herbert Maxwell, F.R.S.; (2) medical, including climatology and sanitaria—president, Sir R. Douglas Powell; (3) pathology, including bacteriology—president, Prof. Sims Woodhead; (4) veterinary (tuberculosis in animals)—president, Sir George Brown. On Tuesday, July 23, the sections will begin their work, and at the second general meeting on the afternoon of this day Prof. R. Koch, of Berlin, will give an address. The chair will be taken by Lord Lister. On July 24, there will be, in the morning, a joint meeting of the medicine and pathology sections for a discussion on tuberculin. Prof. Brouardel, of Paris, will address the third general meeting in the afternoon. At this meeting Mr. Henry Chaplin, M.P., will be the chairman. The fourth general meeting, to be held on Thursday, July 25, will be addressed by Prof. McFadyean, of the Royal Veterinary College, and Lord Spencer will preside. The following are among the officers of the congress:—President of organising council, the Earl of Derby; chairman of organising council, Sir William Broadbent, F.R.S.; chairman of general purposes committee, Prof. Clifford Allbutt, F.R.S.; chairman of reception committee, Sir James Crichton-Browne, F.R.S.; hon. secretary-general, Mr. Malcolm Morris; hon. assistant secretary, Sir Arthur Trendell.

WE have received from the Deutsche Seewarte part x. of their colonial observations. This number contains a very valuable series of meteorological observations made in German East Africa, collected and discussed by Dr. Hans Maurer. Regular observations were begun there in 1891, but were not continuous owing to some unfortunate mishaps to the observers and to the difficulty of controlling the work at such a distance. Dr. Maurer was therefore dispatched by the German Government in 1895 to establish and superintend a network of stations, with the result that a very valuable series of hourly observations, from November 1895 to March 1899, have been obtained at several stations, and have been carefully collated and published in part i. of the work, including the harmonic constituents of the daily barometric oscillation for the monthly means. The second part of the present volume also contains some observations made before 1895 but not yet published, and a list of the works which contain observations previously published. The work is a most useful contribution to the climate of German East Africa.

IT has often been said that the study of electrochemistry is very much neglected in this country, and, indeed, until quite recently there was not, we think, to be found in any of our technical colleges a laboratory purposely designed for electrochemical and electrometallurgical work. Now, however, Owens College, Manchester, possesses in its new Physical Institute a laboratory thoroughly equipped for these purposes. Two rooms have been set apart for electrochemical work, the rooms chosen being in close proximity to the dynamo-room, from which currents up to 1000 amperes are obtainable. In addition to the ordinary equipment of a chemical laboratory leads have been run round the benches, so that every student has ready to his hand a supply of current at 2, 4, 6, 8 or 10 volts pressure. The apparatus requiring heavy currents, such as furnaces or large electrolytic tanks, is arranged on a bench at the end of the room at which the main leads from the dynamo-room enter. Bare copper wires are used for the conductors, the film of oxide and sulphide which forms on them protecting them sufficiently from too rapid corrosion. Now that Owens College has set so good an example, it is to be hoped that it will not be long before the otner technical colleges recognise the need of efficient means of training students in this very important subject. Considering that a supply of cheap electric power is scarce, England may not be perhaps the most suitable country for electrochemical industries, but its backwardness in their development is undoubtedly aggravated by the lack of opportunity for young engineers to study the principles of electrochemistry and electrometallurgy.

NEWCASTLE-ON-TYNE may be congratulated on being the first place in the United Kingdom to see the inauguration of the practice of supplying electricity "in bulk." The large power station of the Newcastle-on-Tyne Electric Supply Co. was formally opened by Lord Kelvin on the 18th of last month, and the credit for the successful starting of the system must be shared jointly by this company and the Walker and Wallsend Union Gas Co. This latter company are taking a large supply from the Newcastle company and distributing it throughout the area under their control, which includes a number of big engineering and other works which require a supply of electricity for motive power or lighting. Many of these works make use of so much power that it has been found necessary to erect a separate substation in each case, power being supplied at high pressure to the substation and thence, after the pressure has been reduced, being distributed throughout the works. Supply is obtainable on either the continuous-current or three-phase systems. For the purpose of supplying the three-phase current, there are to be at the Neptune Bank station four 700 kw. sets generating at 5500 volts, and a 1500 kw. Parsons turbo-alternator. The continuous current is supplied by four 100 kw. dynamos generating at 240 volts; there is also a 150 kw. motor generator taking three-phase current at 5500 volts and generating continuous current at 240 volts, but designed so that it can be used in the opposite direction—that is to say, being driven by the continuous current and generating three-phase currents. A site has been obtained for the erection of another generating station in which to put up new machinery when the present station becomes fully loaded.

WE have received from the Meteorological Reporter to the Government of India a report on cloud observations and measurements in the plains of the North-Western Provinces of India during the period December 1898 to March 1900 (Indian Meteorological *Memoirs*, vol. xi. part iii.). The observations were taken and discussed under the superintendence of Mr. E. H. Hill; they include both the heights and movements measured by means of two photogrammeters and a Fineman's nephoscope. In the fifteen months under review about 900 pairs of plates were exposed, and from these nearly 1000 calculations of heights of clouds have been made. The measurements have been arranged according to two seasons—June to October (the wet season, including the monsoon months) and November to May (the dry season). In the wet season the mean height of the cirrus was 35,000 feet, and the mean velocity 17·4 miles per hour; in the dry season 41,963 feet, and the mean velocity varied from 79 to 89 miles per hour. The mean height of the cumulus in the wet season was 5450 feet, and in the dry season (January and February only) 4100 feet, the velocities being respectively 13·7 and 10·2 miles per hour. The maximum velocity of the cirrus was estimated at 282 miles per hour both in February and March.

AN interesting letter by L. Schäfli on approximate integration is reproduced by Herr J. H. Graf in the *Berner Mittheilungen* for 1899, recently sent to us. The letter was written to a friend in explanation of certain difficulties he had experienced in reading Raabe's books on the calculus, and it probably dates from about 1840. It appears to throw some new light on the history of Bernouilli's numbers and functions, besides affording evidence of Schäfli's great power as a mathematician.

IN the *Journal de Physique* for May, M. Bernard Brunhes writes on the entropy of a gaseous mixture in combustion. It has been hitherto regarded as an objection to the use of entropy diagrams that they could not be used in connection with gas and oil engines, on account of the essentially irreversible nature of the explosions and the consequent uncertainty as to whether the entropy of the mixture was calculable or could even be said to exist. M. Brunhes now shows that, under certain well-defined conditions, the entropy is both determinate and calculable.

PROF. ORESTE MURANI points out in the Lombardy *Rendiconti* that a focus-tube at a certain degree of vacuum acts like an "electric valve" for alternating currents, in that it allows the current to pass in one direction but not in the other. The notion of an electric valve appears to have been originally due to Gaugain, and it has been known that a Geissler's tube in which the electrodes have different forms may act in this way. In the case of a focus-tube there appears to be a superior and an inferior limit to the degree of exhaustion at which it acts in this manner, the superior limit corresponding to a pressure of about 0·1 mm. of mercury, and the inferior limit, which has not been determined with such certainty, corresponding to 0·07 mm. Prof. Murani considers that a focus-tube may be used to indicate the sense of a discharge in certain cases where a more direct method is inapplicable; it might be also used to convert an alternating current into a direct one, but the intensity of the latter would be very small.

THE monaural localisation of sound receives treatment at the hands of Prof. James Rowland Angell and Dr. Warner Fite in the *Psychological Review* for May. The paper reports a series of observations on the capacities of auditory localisation in a person entirely deaf in one ear, but parallel observations have in certain cases been made upon a person of normal hearing. So far as it is possible to briefly give some idea of the conclusions, it is shown firstly that the differences in the localising capacity for complex sounds in binaural and monaural hearing are, so far as concerns these subjects, interpretable as chiefly differences in the magnitude of the difference limen for locality rather than as absolute differences in the kind of localising process involved. The experiments amply sustain the introspection of the subject in pointing to qualitative differences in the sounds coming from different directions as the basis of the localisations. Such qualitative differences may be due to the damping or reinforcing of certain partial tones by the organs of the ear and the head, and it is noteworthy that generally sure tones are unlocalisable in monaural hearing. The presence of eye-reflexes was often very marked, and the final localisation was frequently made on the basis of a seeming correspondence between the eye-strains and the supposed direction of the sound. This statement, however, leaves untouched the physiological basis of the eye-movements. Finally, there is no good evidence for supposing that cutaneous sensations play any part in the localisations.

THE thermal conductivity of the living human skin forms the subject of an investigation by Mr. J. Lefèvre in the *Journal de Physique* for June. Regarding the skin as a wall about 2 mm. thick, three coefficients have to be found, namely, the surface conductivity, the true conductivity through the substance forming the skin, and the internal surface conductivity between the skin and the adjoining tissues. To find these it was necessary to determine the rate of flow of heat across a unit area of the skin, and to measure the distribution of temperature from the surface downwards. For the former purpose M. Lefèvre immersed himself in a bath of water which served as a calorimeter, for the second he used thermoelectric elements, that used for subcutaneous observations taking the form of a fine needle. The experiments show that the skin is a bad conductor, its true conductivity being about the same as that of wood, of the same order as that of gutta percha, about 5 or 6 times that of wool and 750 times that of air. The conductivity is only half as great at 5° as at 30° C. The exterior surface-conductivity of the skin in contact with water appears to be approximately independent of the temperature, but the coefficient across the surface separating the skin from the adjoining tissues increases considerably as the temperature falls from 30° to 5°, and the latter increase more than counterbalances the decrease in the true conductivity, so that the loss of heat at 5° C. is twice or thrice as great as it would be according to Newton's law.

THE new number of the *Mittheilungen* of the Vienna Geographical Society contains two papers of interest. Herr H. Anschutz-Kaempfe describes a plan for exploring the Arctic Ocean and reaching the North Pole by means of a submarine vessel. Herr V. von Loziński treats of chemical denudation in relation to geological time, and gives a valuable summary of recent work bearing on this subject. The calculations of Mr. Mellard Reade and von Romer are specially dealt with, and the latter are repeated, with modifications, employing the most recent data of Murray, Gümbel and others.

DR. G. SCHOTT gives, in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin*, an interesting forecast of some of the oceanographical results of the *Valdivia* Expedition, the full report on which may be expected next winter. The *Valdivia* observations have been combined with older material so as to bring maps of distribution of temperature, as far as possible, up to date, and from these Dr. Schott draws some important general conclusions. In the open ocean three temperature layers are recognised—a surface layer, 0 to 100 metres, in which the distribution is chiefly controlled by horizontal movements; a middle layer, 150 to 800 metres, controlled by vertical movements; and a bottom layer, beyond 1000 metres, in which horizontal movements are again specially important. A "Sprungschicht" occurs in every ocean, its mean depth being 25 to 80 metres in the Atlantic, 90 to 140 metres in the Indian, and 110 to 180 metres in the Pacific Ocean.

THE "Karlseisfeld" was first visited by Friedrich Simony in 1840, and since that date almost every change in the glacier has been carefully observed. Simony made his last photographic survey in 1890, and since his death a survey was made, in 1896, by von Groller. The retreat of the glacier during the five years following made another survey important, and this was accordingly carried out by Freiherr von Hübl. The results are published in the *Abhandlungen* of the Vienna Geographical Society, and, apart from their value as a study of the glacier, they form a model example of the application of modern methods of photographic surveying to work of the kind. The account of the survey forms the first of three parts of a report to be published under the editorship of Herr August von Böhm; the second part is to deal with the history of the glacier, and the third with its present development. In the same number of the

Abhandlungen Dr. Johan Cvijić publishes the second part of his morphological and glacial studies in Bosnia, Herzegovina and Montenegro, dealing with the *Karstpoljen* of Herzegovina and West Bosnia.

IN the *Transactions* of the Edinburgh Geological Society (vol. viii. part i. 1901) Dr. W. Mackie publishes some chemical analyses of Scottish sands and sandstones ranging in age from the Torridon Sandstone to the Blown Sands of Culbin. These analyses show that the proportions of the total alkalis follow fairly closely the results obtained from the proportions of fresh felspar in the several formations. Thus the Torridon Sandstone, an arkose, which contains fresh felspars, gave an average of 4·61 per cent. of alkali, chiefly potash. Soda is hardly represented. Hence the author doubts if such sandstone could be converted by metamorphism into a gneiss as has been suggested. The bearing of his analyses on similar questions is discussed, and he concludes (1) that a silica percentage over 78, an alumina percentage under 11, and a low percentage of lime and of total alkalis, especially of soda relatively to potash, indicate a sedimentary origin of metamorphic rocks; and (2) that a silica percentage not above 78, an alumina percentage not under 11, a high percentage of total alkalis, &c., indicate origin from an igneous rock. Mr. H. M. Cadell contributes to the same *Transactions* an important article on the geology of the Oil Shalefields of the Lothians; and Mr. Herbert Kynaston draws attention to the effects of contact metamorphism round the Cheviot granite.

THE second number of vol. ii. of the *West Indian Bulletin* has just been issued by the Imperial Agricultural Department. It is devoted wholly to a continuation of the full reports of the papers and discussions at the Agricultural Conference held at Barbados in January last. A great deal of the most useful information is brought together in these pages, the subjects dealt with being of a varied character, and not in all cases strictly agricultural. Dr. Alford Nicholls deals with the difficult question of bush fires, which he divides into five classes, approving of some, condemning others. Mr. Watts treats of soils in "orchard" cultivation, and of pine-apple cultivation in Antigua; Mr. Hart of rubber planting in the islands (illustrated); Mr. Sands of the cultivation of onions in Antigua; Mr. Meaden of breeding for beef in Trinidad, and, with Mr. Hart, of zebu cattle in the same island; and Mr. Whitfield Smith of artificial drying of cacao. Dr. Duerden's instructive communication on the marine resources of the British West Indies, which was some time ago issued as an extra number of the *Bulletin*, is reproduced *in extenso*.

THE afforestation of Ireland is advocated by Dr. R. T. Cooper in the *Irish Times* as a means of increasing the value and productiveness of the country. In Ireland there are about five million acres of unproductive land in a total acreage of 20,808,271, every square yard of which could be improved and fertilised by tree cultivation. Yet in all Ireland during the year ending June 1900 only 629 acres were planted with trees, while 1451 acres were cleared of timber. A serious attempt ought to be made to prevent this destruction of forest and recover the immense areas of "bog waste and mountain land" by a scientific distribution of trees.

AN interesting illustration of the practical importance of the recent discovery that leguminous plants possess the power of utilising the free nitrogen of the atmosphere, and thus increasing the nitrogenous constituents of the soil, is furnished by a pamphlet on shade in coffee culture, by Mr. O. F. Cook, being *Bulletin* No. 25 of the U.S. Department of Agriculture (Division of Botany). It seems that coffee growers in Central America, Venezuela and Columbia advocate a certain amount of shade for the coffee plantations, while those in Brazil and the East Indies do not. Mr. Cook suggests that the explanation of these contrary results lies in the fact that, while in the first-named countries the shade plants employed are almost exclusively leguminous trees and shrubs, in the latter they are chiefly figs, bananas and other non-leguminous plants. Hence the problem is one rather of nutrition than of insolation. A long list is given of the shade plants employed by coffee growers, and the pamphlet is illustrated by a number of photographs.

PROF. F. PLATEAU, of Ghent, has recently published several fresh papers, in the *Annales de la Société Entomologique de Belgique* and the *Mémoires de la Société Zoologique de France*, on the sources of attraction in flowers for insects. His previous conclusion, that insects are but little attracted by bright colours, was confirmed by experiments which showed that brightly coloured stuffs and scintillating metallic objects placed among the leaves had but little attractiveness for insects. With regard to the constancy of insects in visiting the same species of flower only on the same flight, he states that species of Bombus are very inconstant; *Apis mellifica* and *Anthidium manicatum* are, on the other hand, remarkably constant; species of Megachile and Coelioxys less so. The habit of constancy is attributed to a desire on the part of the insect for a saving of labour. The Syrphidæ (hover-flies) show a considerable tendency to be attracted by bright colours, whether of flowers or of inanimate objects. To this quality, and not to any æsthetic sense, is to be attributed their habit of hovering over flowers.

A WELL illustrated article by Prof. W. M. Wheeler, bearing the title of "Impostors among Animals," presents to the readers of the July number of *The Century Magazine* some of the leading facts connected with the "mimicry" of animate and inanimate objects by animals, and the consequent adaptation of the latter to their surroundings, in a pleasant and attractive manner. The first illustration shows the marvellous resemblance presented by certain bugs to the rugged bark of the stem on which they dwell, while the second displays the mimicry of orchids by various members of the Orthoptera, which assume a stationary posture with outspread wings on such occasions. Attention is specially drawn to the circumstance that while protectively coloured animals have, as a rule, a simple coloration and quiescent habits—frequently accompanied by the "death-feigning instinct"—those which depend for safety on "warning colours" present the very opposite conditions, being brilliantly and often gaudily coloured, while their habits are calculated to provoke attention and attract observation.

THE current number (vol. lxx. part iii., No. 1) of the *Journal* of the Asiatic Society of Bengal contains several interesting papers on folk customs in India. Captain W. Haig records the origin, the marriage laws, religious observances and funeral rites of the Rangari caste in Barar; in another paper he does the same for the Velama caste, and in a third communication he narrates the legendary account of Shah Abdur-r-Rahman-i-Ghazi, the warrior saint of Barar. Mr. S. Appadorai gives far too brief a paper on the heroic Godlings in Malabar folklore; and the riddles current in Bihar are recorded by Mr. S. C. Mitra. In a very interesting paper, illustrated by four plates, the Rev. P. O. Bodding describes a number of polished stone implements found in the Santal Parganas. These, as almost everywhere else, are believed to be thunderbolts. The Santals believe that a house where such a "thunderbolt" is kept is proof against lightning, and, as in the north of Ireland and elsewhere, they are also supposed to possess remarkable therapeutic power. Water in which a thunderbolt has been rubbed or placed is used, both externally and internally, to cure many ailments.

THE optical establishment of C. P. Goerz, at Friedenau, Berlin, has just produced its 100,000th lens—a Goerz double anastigmat. To have placed upon the photographic market 100,000 anastigmat lenses in eight years (since 1893) is a noteworthy record.

M. MORENA Y ANDA publishes in the *Transactions* of the "Antonio Alzate" Society of Mexico a table showing the diurnal variability of air temperature at Tacubaya for each month of the fifteen years 1884-1898. The hours of observation are 7 a.m., 2 p.m. and 9 p.m.

DR. MAX VERWORN'S "Allgemeine Physiologie" was welcomed as a valuable work when it appeared in 1894, and its scope and character were described in these columns (vol. li., p. 529). The work has been translated into English, French, Russian and Italian, and has taken its place as a standard text-book of general physiology. The third edition has now been published by Herr Gustav Fischer, of Jena.

THE syndics of the Cambridge University Press have undertaken the publication of a work on the fauna and geography of the Maldive and Laccadive Archipelagoes. An expedition, consisting of Mr. J. Stanley Gardiner, Mr. L. A. Borradaile and Mr. C. Forster Cooper, passed eleven months in these two groups, and the work will contain the scientific results of the visit. The chief object of the expedition was to investigate the interdependence of the physical and biological factors in the formation of atolls and reefs. To this end upwards of 300 dredgings were taken, a large number of soundings were run, and every group of organisms was carefully collected. The land fauna was carefully and exhaustively collected, and, being from an undoubted oceanic area, cannot fail to be of interest. The marine collections fill in an almost unknown gap between the Red Sea and the East Indies, and are the most extensive ever obtained from any coral, oceanic area. The work will be published in eight parts, of which the first will appear in October next.

IN the last *Berichte*, Nencki and Marchlewski describe the very interesting discovery of the close chemical relationship existing between the red colouring matter of the blood and the green chlorophyll of plants. Hæmatoporphyrin a derivative of hæmoglobin, and phyllocyanin obtained from chlorophyll, both yield on reduction hæmopyrrol, which is probably an isobutyl or methyl propyl pyrrol.

IN the newly issued *Bulletin International de l'Académie des Sciences de Cracovie*, L. Bruner publishes the results of his dynamic investigations on the bromination of aromatic compounds. The dependence of the velocity of bromination on the nature and position of the substituting groups in the benzene ring has been studied, and especially the catalytic activity of the most important bromine "carriers." In respect of this capacity, aluminium, chromium, iron and thallium salts, compounds of antimony and phosphorus, and finally iodine have been investigated. It is found that the catalytic activity of the bromine "carriers" depends upon the nature of the substance which is being brominated, so that the arrangement of these bodies in a general series according to their activity is not possible. For benzene and bromobenzene the order is (1) aluminium, (2) thallium, (3) iron salts, (4) iodine, (5) antimony, (6) phosphorus halogens.

THE additions to the Zoological Society's Gardens during the past week include two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, presented respectively by Mr. R. de Courcy Hickton and Mr. S. Prust; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Mould; a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. B. W. Gardom; a Cuckoo (*Cuculus canorus*), British, presented by Lieut.-Colonel J. S. Benyon; an Alligator (*Alligator mississippiensis*) from North America, presented by Mr. W. Phillips; two Mocassin Snakes (*Tropidonotus fasciatus*) from North America, presented by Captain J. B. Gilliat; a Great Wallaroo (*Macropus robustus*), four Bridled Wallabies (*Onychogale frenata*) from Australia, two Parrot Finches (*Erythrura psittacea*) from New Caledonia, two Grey-headed Porphyrios (*Porphyrio poliocephalus*), two Ceylonese Terrapins (*Nicoria trijuga*) from India, five Derbian Sternotheres (*Sternothaerus derbianus*) from West Africa, two Grey Monitors (*Varanus griseus*) from North Africa, deposited; two Griffon Vultures (*Gyps fulvus*), European, received in exchange; a Wapiti Deer (*Cervus canadensis*), three Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

LIGHT VARIATION OF THE MINOR PLANET (345) TERCIDINA.—In the *Astronomische Nachrichten* (Bd. 156, No. 3726), Herr J. Hartmann gives an account of his investigations of the variation in brightness of this small planet, first pointed out by Prof. Max Wolf, of Heidelberg, in 1899 (*Astronomische Nachrichten*, No. 3704). Two photographs were obtained on April 20 and a third on April 22, all with the large Potsdam refractor. Reproductions are given showing the trails of the planet with reference to the neighbouring stars. The period deduced is as follows:—

Beginning of increase ...	9h. 0m.	4h. 10m. = 250m.
Culmination	10h. 14m.	
End of increase	13h. 10m.	

In the same journal Prof. Max Wolf gives a reproduction of a photograph taken with a 6-inch Voigtlander objective on April 22, the period determined from this being about 240m., which is in close agreement with that determined from the Potsdam photographs. The value determined from the older observations on 1899 November 4 was 290 minutes.

UNITED STATES NAVAL OBSERVATORY.—The recent issue of vol. i. of the second series of *Publications* of the U.S. Naval Observatory contains the first results of work done at the institution since the removal from the old site and the remounting of the instruments at the new observatory. In this volume a new method of publication is initiated, the observations made with one instrument and extending over several years being given together instead of all observations being published annually. This first volume contains the reduced observations of the sun, moon, planets and many miscellaneous stars made with the 9-inch and 6-inch transit circles during the years 1894-1899.

THE COMPTOMETER.[1]

IN acceding to the editor's request to contribute an article to NATURE upon this instrument, I should like at the outset to express the feeling of curiosity with which any one, familiar with the many arithmometers now so generally in use, must introduce himself to the examination of the comptometer. He will probably know before he begins that it is a mere adding machine; that whereas any arithmometer at each turn of the handle adds or subtracts, as the case may be, any figure set upon the machine, no matter how many digits within the capacity of the machine there may be, or how many times, or how fast within the capacity of the operator he may turn the handle, so that by means of the shifting result-slide multiplication and division can be performed at a rate, and without mental effort, that is a tax upon our imagination, the comptometer is a mere adding machine in which the operator acts upon one key at a time, which adds, each time he presses it, the number on its head to the corresponding digit on the register below. While, therefore, the machine is evidently well adapted for addition, which is so simple an operation that most people believe an instrument for the purpose is not worth the expense of purchasing, it would appear at first that the process of multiplying, to be explained shortly,

[1] Chicago, U.S.A.: Felt and Tarrant Manufacturing Co. Manchester: The Calculating Machine Co.

must be so cumbersome as to leave the comptometer far behind the more automatic arithmometers and so little better than head and pencil work as to be a gain of doubtful value.

When, further, he finds out that the inventor has evaded one of the principal difficulties of arithmometer design, which relates to the carrying of the tens, but which is due to the provision that this operation must occupy the second half of the turn of the handle and must, even then, be successive all down the row so as to allow of the nearly simultaneous and overlapping operations on all the digits, in the comptometer it is not possible where carryings come in to depress two keys simultaneously, for in that case the carrying will fail. On the other hand, if the keys are operated singly as many carryings as are necessary will be accomplished.

When, again, the arithmometrician, if I may so designate one familiar with the use of the arithmometer, finds that the comptometer, like the Income Tax man, can never subtract anything (it can only add, and so apparently can never divide) his despair is likely to be complete and he might well condemn the machine as a toy.

I will not go so far as to say that this exactly represented my feeling when I began to prepare this notice, for I had known the construction of the instrument for some years and was generally familiar with it. However, I did feel that, from a mechanician's point of view, it represented a retrograde step, and it was only the knowledge that the comptometer was extensively used in the United States, where appreciation of time-saving appliances is more developed than here, that made me feel that the comptometer must have advantages perhaps more than sufficient to compensate for its operative deficiencies.

The comptometer is a neat-looking instrument cased in mahogany, occupying $14\frac{1}{8} \times 7\frac{1}{2}$ inches on the table, and it is four inches deep. On the upper surface there are, in the eight-column machine, eight columns of spring-actuated number keys, nine keys to each column. The lowest key of each column, or rather the one nearest the operator, is marked in black 1, and these are called the 1 row, the next 2, and so on up to 9. All the even keys are flat and the uneven concave, so the operator knows at once, without looking, if his finger has got one row too high or too low. At the end next the operator is a row of nine number wheels, or one more than the number of columns, on one axle, seen through windows, so that only one figure on each can be read. This is called the register. The axle terminates outside on the right in a milled head, and below this there is a liberator handle. If the operator finds any figures on the result wheels that he does not want he presses the liberator handle with one finger and begins to turn the milled head. He then turns this as far as it will go, when nine 0's will appear on the number wheels. The machine is now ready to begin. If any key is pressed down the figure shown in black on that key will immediately appear on the corresponding number wheel below. If it or any other key in the same column is pressed, the figure on it will at once be added to the figure already on the number wheel. If the result is more than 9, 1 will be carried to the next number wheel to the left. If that should happen to be already 9, one will be carried on again and it will become 0. If all the figures are 9 and 1 is added to any one, then it and all to the left will immediately become 0. The action is almost instantaneous, but not quite, as each number wheel on becoming 9 leaves a trap set which it lets off on becoming 0. The trap then adds 1 to the next number wheel to the left. If this is 9 the same thing happens again, and so on across the machine as far as 9's happen to extend; so the action is really successive and the wave of motion can just be detected if it is looked for.

Any key instantly returns to its place under the action of a spring when the finger is removed. The necessary movement of the 1 keys is $\frac{1}{4}$ inch, while for the 9 keys $\frac{5}{8}$ inch is required with intermediate movement for intermediate figures. The pressure required is moderate, but more than is necessary for a typewriter. The rate of striking the keys may become, with practice, very great, so that, though numerous strokes are required in a multiplication, the result may nevertheless be found very quickly. Judging by the time that is stated to be necessary for working certain examples, a rate of six or seven strokes a second is certainly attainable, in fact, with but little practice I find this to be possible and that the machine works correctly at this rate.

The question will naturally arise here whether there is any fear of overshooting by the wheels of the register, as they are clearly set into very rapid rotation and have to be suddenly and exactly stopped. Various methods of stopping number wheels are in use in arithmometers—spring clicks, cams like the Geneva stop in clockwork, and a mere brake; the method used here is more direct and positive than any of these, for the key at the end of its depression operates a long light lever which brings a rigid stop between two pins on the number wheel of the register, locking it absolutely and ensuring its stopping in the correct position. The driving forward of the number wheels by the keys is effected by a series of long light levers, each operated by any one of the keys of one column. The 9 key is near the fulcrum end, while the 1 key is near the number wheel end and the others are in intermediate positions. A toothed arc at the end of each lever gears with a corresponding pinion on the common axis of the number wheels, and each of these pinions drives round its number wheel by a ratchet and pawl. Each number wheel in moving from 0 to 9 raises a light lever by means of a cam to its highest position, which it lets drop on completing its turn to 0 again. The lever in its descent moves on the next wheel to the left one tooth. If, therefore, the key of that wheel is being depressed at the same time, the carrying trap will not move it an extra tooth, but will merely join with its operating lever in moving it through one unit of movement, and the carrying will be lost.

To the left of each 1 key is a little push, which may be pressed with one finger when any key in that column is being depressed. This push throws the carrying trap out of gear with the next number wheel, so that no carrying can take place. This enables the operator to alter any figure in the result, or to bring it to 0 by adding to it the necessary number without, at the same time, changing any other figure to the left. They are also used in some special operations.

I have now probably written enough to enable any one interested in these machines to understand what the comptometer is like and also its mode of operation. The next thing is to explain how a machine that can only add, and only do that one figure at a time, may nevertheless be used for performing all the ordinary arithmetical operations, such as any arithmometer will perform.

Addition needs no more explanation. The speed merely depends on the rate at which an operator can read the columns of figures and get his fingers on to the right keys. A mere dab at the key such as is desirable with a typewriter is not appropriate here, as the key must be pressed right down to its stop, otherwise it may add a number less than that printed in black upon its head. To acquire the proper stroke, high speed and certainty of getting on to the right keys evidently requires practice; it would be interesting to see a really skilled operator at work.

In most arithmometers subtraction is effected (this is most generally wanted for the purpose of division) by turning the number wheels in the reverse direction, when the carrying acts in the reverse direction also. It is merely addition backwards. There is, however, a method of in effect subtracting on a machine which, like the comptometer, does not admit of backward motion. It is to add the arithmetical complement. This, for instance, has been used in some operations in Mr. Edmondson's circular machine. If you wish to subtract, say, 7, you have merely to add 3 and prevent the machine from carrying with the push. If you wish to subtract, say, 29, you have merely to add 71 and prevent the second figure from carrying. Similarly, to subtract, say, 23456789, it is merely necessary to add 76543211, each digit to be added being 9 – the one to be subtracted except the last operative digit, which must be 10 – the one to be subtracted, or 1 more than in the case of the others. If the arithmetrical complement had to be found by the operator the machine would not be of much use, but it has not. Every key has a smaller figure in red upon it, which is 9 – the black figure on the key. All that is necessary, therefore, in subtraction is to work with the red figures, bearing in mind only that the last operative figure to the right must be taken on the next key above, and that the push belonging to the last figure on the left must also be used to prevent carrying improperly.

Multiplication of any number by another of one digit is, of course, simple enough. To multiply, for instance, 37921 by 7 the series of keys corresponding to the number 37921 are each struck seven times, or else working on the 7 row the key farthest to the right is struck once, the next to the left twice, the next nine times, and so on. Either operation will produce the right answer, but the second one is preferable because, having put the finger on the last key of the seven row, there is no more occasion to look at the machine; the eyes can be kept on the paper and the series of keys struck the proper number of blows. There is no fear of sliding off on to the next row, as the change from the concave to the level keyheads would at once be felt.

If the multiplier has more than one digit the second method is still more to be followed. Take, for instance, an example illustrated in one of the pamphlets of the company, 2253×84. You do not, of course, strike the 2, 2, 5 and 3 keys 84 times or the 8 and the 4 keys 2253 times, though if you did the right answer would be found. You get on to the 4 row and strike the last key to the right three times, the next five times and the next two twice each. Then you get on to the 8 row and, starting at the last key but one to the right, you do the same again. The total number of strokes necessary may be found by adding together the digits in one factor and multiplying the sum by the number of digits in the other. In this case $12 \times 2 = 24$ strokes. That at, say, 6 strokes a second will be four seconds for the operation. Then the result has to be read and the result wiped off ready for the next. With a greater number of digits the operation is the same.

It constantly happens in extended calculations that the result upon the number wheels has to be further operated upon. If the next operation is one of addition or subtraction, the previous result is in the proper place; the same is true if it is to be divided. But if it has to be multiplied by a new number, the natural thing is to copy it down, wipe it off the machine and multiply in the usual way. This necessity, or supposed necessity, was overcome in Mr. Edmondson's machine by the ingenious method of "working off" results from the machine as distinguished from the usual way of working results on to the machine. That process is impossible in the comptometer, as it is in every other machine except Edmondson's, but instructions are given for a method of multiplying by a figure already on the register without the necessity of wiping it out, which is equally applicable to all arithmometers. It is simply to leave it there and multiply the other factor by a number which is one less than the right one. Then, as the new product by $n - 1$ is added to that by one already there, the result is what is wanted. By beginning at the left hand side instead of the right, as explained in the directions, which are abundantly clear, each new figure to be used is read from the undisturbed number wheel most to the left, so that there is no necessity to write down the intermediate result. Also, in multiplying long decimals it is best to begin at the left, as in that case a sufficient number of figures can be found on the machine, those discarded having no meaning if the figures operated upon are the results of observations and are not absolute figures.

Division can, of course, be effected if subtraction can be, for it is merely necessary to go on subtracting the divisor from the earlier digits of the quotient until what is left in those places is less than the divisor, then to shift the place one to the right and start subtracting again. The number of times the subtraction is effected at each place is the figure of the quotient at that place. This, after all, is what every arithmometer does, and the series of indices which record the number of turns of the handle in each place enable the operator to read off the quotient when he has gone as far as may be necessary.

Now in the comptometer these counting wheels, or their equivalent, are absent, and so, unlike arithmometers, it does not leave a record of a multiplication actually effected, but only of the result. If, therefore, a wrong key has been struck, except that the result is wrong there is no means of finding it out, whereas in an arithmometer it is usual to compare the setting and the record of the counting wheels with the figures given, to be sure that the actual operation given to the machine was that intended. If any one or more of the counters indicates a wrong figure it is merely necessary to put that place into operation and make so many turns of the handle with the + or − gear, or forwards or backwards, as the case may be, to make the counter read the intended number, when the result will also become right.

In the comptometer these counters are absent, and there is no kind of record in a multiplication or addition except the result of what the operator really gave to the machine. It would therefore appear that in division there can be no record of what was done, and, therefore, that it would be necessary to write down figure at a time the number of times the set of keys were struck in each place. It is just here that a pleasant surprise is met with, and a property of the method of subtracting, by adding the arithmetical complement, is available which I do not think would be foreseen by the arithmometrician in general.

The property is this. If the arithmetical complement is added to the group of digits to the left of the dividend that would be first used in ordinary division, and if the push is not put into operation to prevent the carrying, then when the addition has been effected the right number of times the digit on the result wheels which has received these carryings will itself be the same as the number of additions, and the figures to the right of it will have become less than the divisor. All the operator has to do, therefore, is to watch this wheel and count 1, 2, 3, &c., every time he strikes the proper keys; when this wheel reads the same number as his count he then looks at the figures to the right; if they are more than the divisor he goes on striking and counting until they are less. The counting here is not necessary, but it is safe. As soon as they are less the wheel receiving the carryings records the corresponding figure of the quotient, the same number, in fact, that he will have counted.

This operation is best explained by the aid of an example. Divide 365 by 52. 365 is first set on the result wheels as far to the left as possible. Then the keys carrying the red numbers 5 and 1 in the columns over 6 and 5 are struck, while the operator watches the wheel at first showing 3 and counts 1 for each time he strikes the 5 and 1 keys. These really add 48 each time.

The series of numbers indicated below will then one by one appear:—

		365
Count	1	413
,,	2	461
,,	3	509
,,	4	557
,,	5	605
,,	6	653
,,	7	701

The operator watches the 3 gradually getting larger while he counts. When he has counted 6 it also will read 6, but the next two figures, 5 3, are more than the divisor, so he goes on. The next count, 7, then necessarily agrees with the indication of the wheel which receives the carryings, and the operative wheels to the right show 1 as the temporary remainder, so the answer at present is 7 and 1 over. If a long decimal answer is required the figures are made to slide along the keys on the rows on which they find themselves, in this case two places at first and then one place at a time, and are pressed down, the fingers alternately and simultaneously rising and falling, while the operator counts and watches the wheel receiving the carryings, and thus each new figure of the quotient is found, the time necessary for a figure varying from two to five seconds according as it is low or high. This is the time I require after no regular practice. I expect a skilled operator would require but little more than half as much. It seems strange at first that the mere process of addition should, where necessary, lead to a long decimal quotient, but, as explained above, such a result must follow.

The gradual and irregular change of the wheel receiving the carryings until it agrees with the count, so as to give a figure of the quotient, also seems mysterious. The manufacturers do not think it necessary to explain to users why this is so, but they give the following somewhat wholesome advice. "Do not worry about why the above process brings the answer. It is simply an arbitrary rule by which any and all examples in division can be computed on the comptometer, and, once understood, is so simple that it cannot be forgotten. All there is to it is that you strike the divisor on the keys just as many times as indicated by the figure in the 'next place to the left in the register,' and then, if the remainder is larger than the divisor, strike the keys again once or more times until the remainder becomes smaller than the divisor."

There is no occasion for much worry any way, for the mystery may be explained quite easily. Let $na + r$ be the dividend and a the divisor: then n is the quotient and r is "over." What is done by the machine is to add $\overline{1 - a}$ n times, counting up to n. When this has been done the result will be $na + r + n(1 - a) = n$, and r is "over."

The operation described is quite simple, easy and quick where the divisor has two figures only, and is not inconvenient with as many as four, for then two fingers of each hand may be used and the keys struck without looking at them. When the divisor has more than four figures the process is modified in an ingenious way, but in such cases the comptometer is, in my opinion, definitely less convenient than any good arithmometer.

The comptometer is conveniently available for ordinary commercial operations, such as interest and discount, as well as for merely adding up accounts. In the ordinary machine with only decimal notation the last two columns must be retained for the pence, the next two for the shillings, leaving all the rest for the pounds. However, a special build is now promised with special shilling and pence columns, so that on this any number of money entries, taken in any order, may be very quickly added up. Nevertheless, the process of dividing by 12 or 20 on the decimal machine, for which it is necessary to strike the keys marked in black 8 and 8 or 1, as the case may be, is so rapid that the pence when added up become shillings and pence on the register in a moment, and the shillings, which must be added after the pence, become pounds and shillings in even less time, and the pounds, shillings and pence so obtained are in their proper places. The comptometer arranged for British currency would, however, be the more convenient where the adding up of accounts is mostly wanted, but it does not seem as if it would meet every case that will arise. For instance, in a large retail business the number of entries to be checked of this type, 23¾ yards at 7*s.* 9¼*d.* a yard, is so great that in one case that I know of a special branch of the office is devoted to this work alone. The cost of this branch amounts to 1000*l.* a year, and yet, partly in consequence of the amazing quickness of the clerks, but chiefly because of our hopeless non-decimal system, it is not possible with much advantage to employ mechanical means of calculation to reduce this tax upon the business. Now with a decimal money system the multiplication by 23·75 in a machine would be direct and simple enough, but I do not see how this could be *directly* effected upon the British currency comptometer. I do not see how multiplication or division by numbers of several digits can be advantageously carried out.

As a last example of the way in which ingenuity has been exercised in finding a way of making this adding machine perform other operations, I may refer to the directions for finding a square root. It is not my intention to explain this process here, but simply refer to the artifice. "The simplest way to extract square root on the comptometer is to act on the principle that in the series of odd numbers, 1, 3, 5, 7, 9, &c., the square of the number of terms always equals the sum of all the terms." On this a process of addition is devised, using the red numbers on the keys, which I find, even without much practice, is surprisingly rapid for the first three figures, but which, like the ordinary head and pencil way, becomes increasingly cumbersome with a greater number.

The comptometer is like all arithmometers in that, having found one product of two or more numbers, or having any previous result on the register, any further products of two numbers may be added to or subtracted from this, one at a time, without the necessity of writing down any intermediate result or of separately finding these products; and then, when this is done, the sums or differences of all the products may be divided by a final number. If a further division is required the comptometer differs from all arithmometers except Edmondson's in that the result is found on the same register as the previous dividend, and so it might appear that any number of divisions could be effected. This is not the case, as the quotient occasionally moves up the machine towards the left and so gets out of range, whereas in Edmondson's, as the machine is arranged in a circle, the quotients and dividends may chase each other round the machine without ever coming to a dead stop. In ordinary arithmometers the quotient gets on to the counter wheels, when nothing more can be done to it unless it is again transferred to the register.

The operation, therefore, that these machines can perform with the greatest advantage is of the form

$$\frac{ab \pm cd \pm ef \pm \ldots}{r},$$

whereas the operation that is most favourable for the use of logarithms is of the form

$$\frac{a^n\, b^m\, tab^p\, \theta \ldots}{r^q\, s^t\, tab^{p'}\, \phi \ldots},$$

tab representing any of the tabulated logarithmic functions. This advantage is so great that formulæ are artificially manipulated until they are finally rammed into this form and are then said to be adapted to logarithmic computation. Now the advantages of the calculating machines referred to are so great, and they are in so many ways preferable to logarithms where they can be used, that it is just as important to adapt formulæ to mechanical computation by putting them where convenient into the first of these two forms. Then, according as they can be put into one or other of these forms, machines or logarithms should be used for the purpose of computation, and no attempt should be made to use either for work specially adapted in this way for the other.

It may perhaps be worth while, by way of example, to mention that in the large number of corrections of the scale readings to bring them to circular measure that I had to make in my experiments on the constant of gravitation, I found I could calculate $\theta - \frac{1}{3}\theta^3 + \frac{1}{5}\theta^5$ in less time on an arithmometer than was required to look up the angle in the trigonometrical tables.

A few final observations are desirable bearing on the comparison of the comptometer with arithmometers.

In the first place the comptometer makes a most aggravating noise, like a typewriter through a megaphone; but other arithmometers are noisy, none, however, so bad as this machine. The only silent arithmometer is that beautiful machine invented by Prof. Selling, but this is practically unknown in this country.

To my mind the comptometer, with its single figure operations, is not so convenient as the arithmometer for reducing and computing observations in the laboratory. Its success is only rendered possible by the fact that it is a key machine, for key strokes may be so very rapid. The operating numbers on most arithmometers are set by slides and that is relatively slow, the operation, however, by the handle afterwards is vastly more rapid. Selling's arithmometer is, however, a key machine for the setting, while the turning handle is replaced by a sliding movement, one complete slide doing the work of five turns of the handle. Again, the fact that there is no record of the operating figures actually given to the comptometer seems to be, for scientific work, decidedly a drawback.

On the other hand the construction is admirable, perfectly adapted to its purpose, and, I should judge, fairly indestructible. I would on this point only make one complaint, which, however, refers to a defect in no respect essential to the machine. I refer to the difficulty of reading the numbers on the register. The figures are elegant, with a great contrast between the thick and the thin parts, and they are upon a polished reflecting wheel face. They are seen through small windows in a polished metal plate. The result is they are not as legible as they ought to be; great care has to be taken to get a suitable light, and it is useless to sit facing a window. The 3's may be confused with the 8's, the 1's with the 4's, and the 0's with the 9's. If block figures were used, and if, further, they were dead white upon a black ground, or even the reverse, and were not seen through a shining plate, this little defect, which I am surprised to see in the product of an American shop, would be remedied.

I have made no comparison between the comptometer and the slide rule because a good slide rule, such as Gravét's, cannot be approached in convenience by any mechanism where the limited accuracy of the slide rule is sufficient, nor can wheelwork machines directly find the fourth term in a proportion in which the three other terms are numbers, their squares, or roots, or trigonometrical functions, or the reciprocals of these, nor can they give logarithms at sight.

The attempts that have been made to increase the accuracy of the slide rule by increasing its length are not, in my opinion, of much success, because to gain only one more figure ten times the length, at least, is necessary. The rule must then be broken up gridiron fashion, as in General Hannyngton's,[1] Prof. Everett's and Thatcher's, or wound in a spiral as in Fuller's, or be altogether peculiar as Tower's. When an extra figure has been gained in this way the extreme handiness of the slide rule is gone, as it can no longer be carried in the pocket, it takes longer to find the place, and, as a rule, the range is limited to mere simple proportion. Where the accuracy of 1/10 per cent. given by a 26 cm. rule, or 1/20 per cent. by a half-metre Gravét rule is not sufficient, I should prefer in general five-figure logarithms or a wheel-machine to an extended slide rule. Whether the wheel-machine should be a comptometer or an arithmometer must depend upon the character of the calculations most often met with. I have attempted in my preceding remarks to give the information necessary to enable any one to judge in his own particular case. C. V. BOYS.

[1] The Slide Rule Extended. E. and F. N. Spon, 16 Charing Cross, and Aston and Mander, Old Compton Street, Soho.

RECENT REPORTS OF THE SMITHSONIAN INSTITUTION.[1]

THE field of operations of the Smithsonian Institution is so extensive that it is impossible to survey adequately the work carried on in it. The liberality of the Institution has made many students of science acquainted with the researches and results of others, and has placed the whole world of scientific activity under an obligation. In addition, each of the departments under the direction of the Institution is a living centre of investigation, from which contributions to natural knowledge are continually emanating. These departments are the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park and the Astrophysical Observatory.

Following the precedent of several years, Prof. Langley gives, in the body of his report referred to in the footnote, a general account of the affairs of the Institution and its bureaus, while the appendix presents more detailed statements by the persons in direct charge of the different branches of the work. Independently of this the operations of the National Museum are fully treated in a separate volume of the Smithsonian Report, and the Report of the Bureau of American Ethnology constitutes a volume prepared under the supervision of the Director of that Bureau.

Parts of Prof. Langley's report are given below, together with references to some of the contents of the Smithsonian Report for 1899, and the Annual Report of the National Museum, recently received. Two recent reports of the Bureau of Ethnology will be noticed separately.

Astrophysical Researches.—Experiments in the solution of the problem of mechanical flight have been continued, and the Astrophysical Observatory has been active in the investigation of the solar spectrum. The first volume of Annals of the Observatory has been issued. It is devoted primarily, though not exclusively, to the investigation of the infra-red solar spectrum, its absorption lines and its variations in terrestrial absorption. This research, and the development of the sensitive bolographic apparatus with which it has been carried on, have largely occupied the Astrophysical Observatory since its foundation, and are a continuation of researches in which Prof. Langley was engaged for many years at the Allegheny Observatory.

As readers of NATURE are aware, successful observations were made of the solar eclipse of May 28, 1900. A considerable number of photographs of the corona were secured, some of which are upon an unprecedentedly large scale, and these, it is believed, will be of value in investigations of the nature of this still enigmatical solar appendage. A photographic search for hitherto unrecognised objects near the sun developed the fact that even in an ordinary sky, in an eclipse in which the reflected sunlight was brighter than usual, stars as small as the 8·3 magnitude could be secured.

The apparatus employed was designed, not so much for this, however, as for the obtaining evidence of possible intramercurial planets, but upon this latter point no final opinion can be given. Certain suspicious objects are found on the plates, but unfortunately observations of the same kind at other stations were unsuccessful, so that there is nothing with which to compare them. Studies are still going on, however, and it is possible that this part of the observations may yet yield results of interest.

The delicate and difficult observations upon the heat of the inner corona were made by means of the bolometer, and appear to have been quite successful, being perhaps the first trustworthy observations of the kind; they lend some additional weight to the view that the corona is something analogous to an electric phenomenon.

The Hodgkins Fund.—The different branches of research now progressing under grants from the Hodgkins fund are making satisfactory advances.

Prof. William Hallock, of Columbia University, New York, has supplemented his report of last year by a summary of the further progress of his investigation of the motion of an air particle under the influence of articulate speech. The instruments which Prof. Hallock has invented, and is now perfecting, have proved a great aid in this research, and will, he states, enable him to settle definitely the question of phase differences in the components of a complex sound.

Prof. A. G. Webster, of Clark University, reports the completion and successful application to the use for which it was designed of the new apparatus, perfected with aid from a Hodgkins grant, by means of which it is now possible to measure the intensity of rapidly varying sounds with an accuracy not hitherto attained. A grant has been made to Prof. Louis Bevier, of Rutgers College, for an investigation of vowel-timbre on the basis of the phonographic record.

The meteorological investigations with kites have been successfully continued at Blue Hill under the direction of Mr. Rotch with the assistance of a grant from the Hodgkins fund. In addition to these investigations, a Hodgkins grant has been made to enable Mr. Rotch to carry on a series of experiments in space telegraphy, it being thought that the unprecedented heights attained by kites might materially extend the range of communication by this method. In the preliminary experiments, however, kites were not used, sufficient elevation being attainable without them, but when the difference between the stations was increased from one mile to three, kites were employed to raise the transmitting and receiving wires. In the later experiments it was found, not unexpectedly, that the long wires, carried up and supported by kites, collected so much electricity as to interfere with and greatly complicate the messages sent from station to station. These interruptions seem to show that the limit of elevation for the receiving wire was under these conditions less than 500 feet. The greatest distance covered in the experiments was approximately twelve miles, from a wire supported by a kite about 200 feet above Blue Hill to the tower of Memorial Hall in Cambridge, which was used as the receiving station. These experiments draw attention to the fact that electrification increases with the altitude to which the wire is carried, and that it is always present, although varying with the meteorological condition of the atmosphere.

Dr. Carl Barus has been given a grant from the Hodgkins fund in aid of his experiments on atmospheric condensation. This research is supplemental to the experiments already conducted by Dr. Barus, as described in *Bulletin* No. 12, of the Department of Agriculture, and will be (1) a study of the origin, activity and growth of the condensation producing dust particles; their reactions on each other, their relation to electric radiation, &c.; (2) a study of the growth, &c., of water corpuscles after condensation; the reaction of corpuscles of different sizes on each other, &c.

A grant has been approved on behalf of Prof. Dr. R. von Lendenfeld, of the University of Prague, for a study of the motion of birds in actual free flight, a subject to which, although primarily known as a zoologist and meteorologist, Dr. von Lendenfeld's attention has been directed for years, and for the better understanding of which he has made numerous anatomical preparations, physiological observations, &c. The investigations of Dr. von Lendenfeld have been aided by the Society for the Advancement of Scientific Research in Bohemia, and also by the Austrian Government.

A grant from the Hodgkins fund has been made to Dr. V. Schumann, of Leipzig, for the prosecution of researches in connection with the spectral relations of atmospheric air. The apparatus by means of which Dr. Schumann has heretofore secured such noteworthy results being chiefly of his own invention, he has been permitted to apply the present grant to the further perfection of his instruments before entering upon his special experiments, which will be definitely reported upon as they progress.

Standards of Colour.—Mr. Robert Ridgway, curator of ornithology in the National Museum, published a number of years ago, for the use of naturalists, a handbook on colour, and he requested a grant from the Institution for a new edition. It appeared to Prof. Langley that a work upon a more extended scale and a somewhat different plan would be of value primarily to naturalists, but also in every department of science, to artists, and in many branches of industry.

At the present time there is practically no uniformity in the common use of colour names, one name designating, as a rule, as many as half a dozen different shades; nor is there any absolute method commonly available by which a person in one place can

[1] Report of Prof. S. P. Langley, secretary of the Smithsonian Institution, for the year ending June 30, 1900. Pp. iv + 117.
Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1899. Pp. lxiii + 672.
Report of the U.S. National Museum for the year ending June 30, 1899. Pp. xv + 598. (Washington: Government Printing Office, 1901.)

describe to a person in another the exact shade or tint meant by a given name. The production of a work which would obviate these difficulties and make available what might be called the "constants of nature" in colour, is directly in line with previous publications of the Institution in endeavouring to establish standards whereby a definite nomenclature in scientific and popular writing might be introduced.

Prof. Langley, after consulting with others expert in the matter, decided that it would be desirable, not only to secure more permanent tints, but to connect every tint published in the book with some definite wave-length in the spectrum, whether the solar spectrum or a composite one. The investigations of Prof. Rood and others show that it is difficult to do this directly, but that it can be effected by the use of intermediate means of comparison.

Again, experiments must be made to determine how far this large object (of connecting every tint employed with some definite wave-length or combination of wave-lengths of light) is practicable. If it be fully so, the work may be said to be in one sense something absolutely permanent, relating as it will to standards which can never alter with time, so that, as has been said, those who expect that their writings will be more permanent than the planet itself should take this method of illustrating them. The work promised such magnitude that a committee was appointed, and is now considering the subject.

Collected Papers.—The General Appendix to the Annual Report of the Smithsonian Institution may be termed a "source-book" of scientific history. In consists of reprints and translations of authoritative but popular scientific articles which appeared during the year of the Report. Some are addresses delivered in institutions concerned with the diffusion of knowledge, and others are papers contributed to scientific and other periodicals, and collectively they form an epitome of advance and opinion in all departments of science. There are in the volume before us (1899) no less than thirty papers of this kind, among them being translations of the following: influence of the wave-theory of light on modern physics, by Prof. Cornu; on the sense of smell in birds, by M. X. Raspail; have fishes memory? by Herr L. Edinger; the garden and its development, by Dr. P. Falkenberg; sea-charts formerly used in the Marshall Islands, with notices on the navigation of these islanders in general, by Captain Winkler; the peopling of the Philippines, by Dr. R. Virchow; list of the native tribes of the Philippines and of the languages spoken by them, by Prof. F. Blumentritt; and the sculptures of Santa Lucia Cozumahualpa, Guatemala, in the Hamburg Ethnological Museum, by Herr Herman Strebel.

National Museum.—Details in regard to the work of the U. S. National Museum are given in an appendix to Prof. Langley's report. To the geological collections were added some interesting fossil animals secured from the fields of Wyoming, and a large amount of zoological material was collected in Cuba and Porto Rico. There has also been transferred to the Museum the extensive and very valuable series of vertebrate fossils collected by the late Prof. Marsh during his connection with the United States Geological Survey. This collection aggregated five car-loads, and is particularly rich in specimens of the gigantic Dinosaurs, besides fifty skulls of Titanotherium, probably the best specimens in existence.

The Annual Report of the Museum for 1899 is largely devoted to a description of the collection of non-metallic minerals in the department of applied geology, by Mr. G. P. Merrill. The term non-metallic is used to designate minerals which, as exhibited in the Museum, are utilised in other than metallic forms. The subjects of remaining papers in the Report are:—A Primitive frame for weaving narrow fabrics, and pointed bark canoes of the Kutenai and Amur, by Dr. O. T. Mason; an early West Virginia pottery, by Mr. W. Hough; and a descriptive catalogue of a collection of objects of Jewish ceremonial in U. S. National Museum, by Drs. C. Adler and I. M. Casanowicz.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. G. S. TURPIN, headmaster of the Swansea Intermediate and Technical School, has been appointed to succeed Dr. Gow as headmaster of the Nottingham High School. Particulars as to the vacancy thus caused at Swansea will be found in our advertisement columns.

THE council of University College, London, have appointed Mr. J. D. Cormack, of the University of Glasgow, to the chair of mechanical engineering in this College, vacant by the resignation of Prof. Hudson Beare on his appointment as regius professor at Edinburgh.

The Education Bill (No. 2), was read a second time in the House of Commons on Tuesday, after a long and animated debate. As a consequence of the Cockerton judgment, the question had to be determined whether School Boards were the proper authorities to deal with secondary education or not; and the Government decided against them. The Bill is the first step towards the establishment of single local authorities connected with County Councils for the control of the whole of the work of secondary education in their districts.

THE Liverpool City Council unanimously adopted the following resolution at a meeting held on July 3:—"That the Council has observed with much satisfaction the growth and progress of the University College, and in view of the fact that the college authorities are taking steps to procure the establishment of a separate University for Liverpool records its opinion that it is desirable in the interests of higher education in the city that such a University should be established." It is understood that, though there has not yet been any appeal to the public, about 100,000*l.* has already been promised for Liverpool University, which will bring up the capital value of University College to about 600,000*l.*, and the promoters are sanguine that there will be little difficulty in raising this to 750,000*l.* The council of University College have elected Dr. E. W. Marchant to the lectureship in electrotechnics vacated by Mr. Alfred Hay's appointment to a professorship at Coopers Hill.

THE University of Birmingham is fortunate in having a strong man like Mr. Chamberlain to plead its cause and advance its interests. At the first congregation of the University, held on Saturday last, he again directed attention to the national importance of higher education and research, and referred to the liberal provision made for work of this kind in other countries. "I am convinced," he said, "that unless we overcome the innate conservatism of our people in regard to the application of the highest science to the commonest industries and manufactures in our land, we shall certainly fall very far behind in the race." Though the fact involved in this statement has been persistently brought forward in NATURE for many years. it cannot be too frequently reiterated in public to rouse wealthy citizens to a sense of their responsibilities as regards provision for national progress, and create a higher regard for scientific work than is at present possessed by Englishmen in general. It is not necessary to enlarge here upon the facilities for scientific work abroad, for scarcely a week passes without our having to record munificent donations by States and individuals for the erection of buildings in which such work can be carried on under favourable conditions. Mr. Chamberlain mentioned in his address that the Charlottenburg Technical High School cost half a million of money, and this is but one instance of many. A modern University ought at least to secure an equal sum of money to build and equip its scientific side, especially when the ideals are those sketched by Mr. Chamberlain in the following words:—"I venture to lay down four qualifications as necessary to a perfect University. In the first place, it should be an institution where all existing knowledge is taught. Such a University may, perhaps, never yet have been attained; want of means may always prevent it, but at least that was the object at which we should aim, and we should never rest satisfied until we can say that no student desirous of instruction in any branch of learning shall be turned hungry away from the doors of this University. No doubt the enormous development of knowledge, and especially of its scientific side, during the present century requires a certain specialisation in the teaching of that knowledge, and I think it may be desirable, I think it may be necessary, that Universities also should be specialised, and that one University should pay more attention than another to particular studies; but I believe at the same time that it would be fatal if in our desire as a modern University to give a special development to the practical and thorough teaching of our scientific work, it would be a great mistake, I say, if we were to exclude or to neglect the older branches of learning. Well, then, in the second place a University is a place where the knowledge that has been acquired has to be tested. And as to that I will only say that in the multiplication of examining bodies I hope that nothing will be done, either by us or by our successors, to lower the standards of proficiency, whether in the ordinary pass or in the highest honours. Then the third feature to which I should call attention, and which I am inclined to say is the most important of all, is that a University should be a place where knowledge is increased and where the limits of learning are extended. Original research, the addition of something to the total sum of human knowledge, must always be an essential part of our proposals. We want to secure that those who teach in this University shall never cease to learn, and that those who are students shall unite with them in the work of fresh and new investigation. And, lastly, a University is a place where the application of knowledge must be indicated and directed. That perhaps brings us nearer to what may yet be the distinctive feature of our University. At all events we start with the belief that here we are going to combine theory with practice, and to see that in our University we shall combine both in one course of instruction, with due regard to the needs of our own time and of our own district. And now, if I may summarise in one sentence what I have been saying, it is that a University should be a place where knowledge is taught, tested, increased and applied."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, June 19.—Mr. W. H. Dines, president, in the chair.—A paper by Mr. H. Helm Clayton, of the Blue Hill Observatory, U.S.A., on the eclipse cyclone, the diurnal cyclones and the cyclones and anti-cyclones of temperate latitudes, was read by the secretary. The author has discussed the meteorological observations made along the path of the total solar eclipse in the United States on May 28, 1900, and also those made during three previous eclipses. He finds that a cyclone follows in the wake of the eclipse—though the changes are very minute and feeble—the fall of temperature developing a cold-air cyclone in an astonishingly short time, with all the peculiar circulation of winds and distribution of pressure which constitute such a cyclone.—A paper, by Mr. F. Napier Denison, of Victoria, British Columbia, on the seismograph as a sensitive barometer, was also read by the secretary. A Milne seismograph was installed in 1898 at the Meteorological Office, Victoria, B.C., and the author has since that time compared its movements with the changes of atmospheric pressure recorded by his "aërograph." He finds that when the barometric pressure is high over the Pacific slope from British Columbia southward to California, while off the Pacific coast the barometer is comparatively low, the horizontal pendulum of the seismograph tends to move towards the eastward. This movement appears to be due to a distortion of the earth's surface, caused by the heavier air over the Pacific slope depressing the underlying land surface below its normal position, while, on the other hand, the comparatively light air over the adjacent ocean tends to allow the sea and earth beneath to rise above its normal level. It has been found that when an extensive storm area is approaching from the westward, and often eighteen to twenty-four hours before the local barometer begins to fall, the pendulum of the seismograph swings steadily to the eastward, completely masking any diurnal fluctuations that might have existed, as the storm area approaches, and in the event of it being followed by an important high area, the pendulum will begin to swing towards the westward before it is possible to ascertain this area's position on the current weather charts.

Anthropological Institute, June 19.—Extraordinary joint meeting with the Folklore Society. Prof. A. C. Haddon, F.R.S., in the chair.—Prof. Haddon vacated the chair in favour of Mr. E. W. Brabrook, president of the Folklore Society.—Mr. E. S. Hartland exhibited the collection of Musquakie beadwork and other objects presented by the late Miss Florence Grove to the Folklore Society, and to be deposited in the Museum of Ethnology at Cambridge.—Mr. R. Shelford exhibited two charms against stomach-ache from Borneo.—Mr. H. Balfour read a paper, by Mr. W. G. Aston, C.M.G., on Japanese Gohei and Ainu Tirao.—Mr. N. W. Thomas read a paper, by Mr. E. Tregear, on the spirit of vegetation.

DUBLIN.

Royal Dublin Society, May 22.—Sir Howard Grubb, F.R.S., in the chair.—Prof. Hartley, F.R.S., and Mr. Hugh Ramage communicated a paper upon the banded flame-spectra of metals. This was a continuation of some former work on flame spectra at high temperatures by Prof. Hartley, published in the *Phil. Trans.*, in which it was shown that fluted and banded spectra are characteristic of many metals. The list is now extended, banded and fluted spectra of copper, gold, palladium, zinc, cadmium, aluminium, beryllium, lanthanium, indium and thallium have been photographed and the principal bands in their spectra measured. A banded spectrum has also been obtained from iridium. In well-defined groups, such as magnesium, zinc, cadmium, aluminium, indium and thallium, the spectra appear to be homologous.—Prof. Hartley communicated a paper on a theory of the molecular constitution of supersaturated solutions. The chemical constitution of these solutions, which exhibit the well-known phenomenon of sudden crystallisation when either a crystal of the same salt or one of the same constitution and isomorphous with it gains access to the liquid, has been thus explained by the author. When a supersaturated solution is formed the salt in solution is a definite hydrate, but it is not the same hydrated salt as that which crystallises out. The cause of the supersaturation is the greater solubility of the one hydrate over the other at a given temperature; and its conversion into the other by combination with some of the water, acting as a solvent, causes its sudden solidification. In cases where the supersaturated solution is prepared by digesting a dehydrated salt in cold water, the course of change is first hydration, secondly solution, and thirdly crystallisation. Reference is made to the work of H. Le Chatelier, Wyrouboff, and others.—Sir Howard Grubb communicated a note on a case of true stereoscopic effect obtained from a single picture, which he demonstrated by means of a model.—Mr. F. W. Moore exhibited and described a living specimen from the Botanic Garden, Glasnevin, Dublin, showing the germination of the double cocoa-nut (*Lodoicea sechellarum*).

EDINBURGH.

Royal Society, June 17.—Prof. Sir William Turner, K.C.B., in the chair.—Prof. Cossar Ewart, in a paper on in-breeding, gave the results of a number of experiments he had tried on pigeons, rabbits, mares and goats, and examined in the light of these the views as to the injurious effects of in-breeding which were held by certain naturalists. Thus Darwin had concluded that in-breeding was injurious; other biologists, including Weissmann, that it was not. Similarly, Huth and Westermark differed as to the harmfulness of consanguineous marriages. The general result of his own experiments led Prof. Ewart to the conclusion that in-breeding led to loss of constitutional vigour and sometimes of size, but not to loss of fertility; and the diversity of view held by naturalists he regarded as being due to the fact that members of one family often differed in constitution to a marked degree, brothers and sisters, for example, differing more than their parents, and there being occasionally greater similarity between second cousins than between first cousins. It was also pointed out that, in certain circumstances, in-breeding by arresting reversion (which was favoured by crossing) tended to favour the appearance of new varieties.—Mr. F. H. A. Marshall read a paper on hair in the Equidæ. It was found that the hairs of the three principal types of zebra were fairly distinct, while the Somali zebra stood quite by itself, a conclusion agreeing with that of Nathusias. The hairs of horses showed considerable variability dependent largely on the breed, while those of zebra-horse hybrids, so far as the observations went, were fairly constant in character. The hairs of the mane, as well as those from the sides of the body, were also dealt with. The paper concluded with a reference to a suggestion by Nathusias that, if the telegony hypothesis were true, we might expect to find evidence of it in the hair characters of the "subsequent foals." Such evidence was, however, utterly lacking.

PARIS.

Academy of Sciences, July 1.—M. Fouqué in the chair.—Chemical equilibria; phosphoric acid and the chlorides of the alkaline earths, by M. Berthelot. The author's recent experiments on the subject are continued, the reactions dealt with in this paper being those occurring between phosphoric acid, monosodium phosphate or disodium phosphate, and calcium, barium or magnesium chloride. It is found that the number of equivalents of the alkaline earth entering into combination with a molecule of precipitated phosphoric acid varies from 2 to 4, according to the nature of the substances and the time which has elapsed since the commencement of the reaction.—New treatment of niobite; preparation and properties of fused niobium, by M. Henri Moissan. The native mineral, consisting chiefly of niobic and tantalic acids together with iron, manganese and silica, is heated with charcoal in the electric furnace, a fused mass of niobium and tantalum combined with carbon being thus obtained. The two metals are separated by Marignac's method, based on the different solubilities of sodium fluoniobate and fluotantalate, the former salt being finally calcined and fused with charcoal. Niobium is thus obtained as a very hard, metallic mass, having a melting point above 1800°; it is almost unacted on by acids, and does not decompose water vapour at a red heat. When heated in oxygen, it burns with the production of niobic acid.—New nebulæ discovered at the Paris Observatory, by M. G. Bigourdan.—Observations at sea of the comet of May 1901, by MM. Doué and Rivet. The observations were made in the course of a voyage from Tahiti to Panama.—On a mechanical interpretation of the principles of thermodynamics, by M. André Séligmann-Lui.—On the indices of refraction of mixtures of liquids, by MM. J. de Kowalski and Jean de Modzelewski.—The dielectric constant of a mixture of liquids has been shown not to be connected by any simple law with that of its constituents, and it seemed of interest to determine whether this anomaly held with regard to the index of refraction, which is closely connected with the dielectric constant. Experiments with mixtures of alcohol and benzene, alcohol and toluol, and ether and chloroform have shown, however, that such is not the case, the index of refraction of each of the pairs of mixed liquids being readily calculated from the indices of its constituents.—Hertzian waves in storms, by M. F. Larroque. A demonstration of the production of Hertzian waves in storms and their transmission to great distances.—Acidimetry of arsenic acid, by MM. A. Astruc and J. Tarbouriech. If methyl orange is employed as indicator, one molecule of arsenic acid is neutralised by one molecule of potash, soda or ammonia and by half a molecule of baryta, strontia or lime, identical results being obtained in the cold and on heating. With phenolphthalein, however, two molecules of an alkali or one molecule of an alkaline earth are required; on boiling, no difference is observed in the case of the former, but one and a half molecules of baryta, strontia or lime are then required for neutralisation.—On the uncoloured compound of sodium tetrazotolylsulphite with ethyl-β-naphthylamine and its conversion into a colouring matter, by MM. A. Seyewetz and Blanc. The coloured substance, a red insoluble powder, is formed by the exposure to light of the uncoloured compound, and is identical with the product of the action of ethylnaphthylamine hydrochloride on tetrazotolidine chloride.—On the action of benzaldehyde on sodium menthol and new methods for the preparation of benzylidenementhone, by M. C. Martine. Sodium menthol resembles sodium borneol in its action on benzaldehyde, the product of the reaction being benzylidenementhone; this compound is also formed by the action of benzaldehyde on the sodium derivative of menthone.—Combinations of camphor with β-hydroxy-α-naphthaldehyde, by M. André Helbronner. The new compound, $C_{23}H_{26}O_2$, which is designated ethoxynaphthalcamphor, crystallises in brilliant white crystals melting at 100°; it is dextrorotatory. On reduction with sodium amalgam it yields a compound melting at 112°, which bears the same relation to the parent compound as benzylcamphor to benzalcamphor. Metoxynaphthalcamphor, which has also been prepared, melts at 78° and its reduction product at 96°.—Action of bromacetophenone on sodium acetylacetone, by M. F. March. The reaction studied gives rise to a triketone of the constitution $(CH_3-CO)_2=CH-CH_2-CO-C_6H_5$, which forms large, colourless crystals melting at 57-58°; on treatment with soda it yields acetophenonacetone.—Action of hydrogen sulphide on acetylacetone, by M. F. Leteur. When hydrogen sulphide is passed into a solution of acetylacetone in concentrated hydrochloric acid, an abundant deposit of needle-shaped crystals is produced. This compound melts at about 163°, and is shown by analysis and by cryoscopic molecular weight determinations to have the formula $(C_5H_8S_2)_2$.—Influence of sodium fluoride in the saccharification, by seminase, of the carbohydrates contained in the seeds of leguminous plants, by M. H. Hérissey. Sodium fluoride, which was used as an antiseptic in the study of the saccharification, was found to exert a marked favourable influence on the process.—On epithelial centrosomes, by M. P. Vignon.—Observations on the root of vascular cryptogams, by M. G. Chauveaud.—On the vegetation of punctiform nostoc in the presence of different carbohydrates, by M. R. Bouilhac. Sucrose, maltose or starch may replace dextrose in the cultivation of nostoc, whilst with lactose or lævulose only a very feeble vegetation is obtained.—Generality of the fixation of metals b the cell-wall, by M. H. Devaux. The fixation of metals by the cell-wall in plants, previously demonstrated in the case of injurious metals such as copper, silver and lead, is now shown to be a very general phenomenon. The proportion of metal absorbed is always small, and is not sensibly increased by the use of more concentrated solutions.—On the optical data relative to the macle of pericline, by MM. F. Pearce and L. Duparc.—On the presence of Devonian strata containing *Calceola sandalina* in the Western Sahara, by M. G. B. M. Flamand.—Action of currents of high frequency on the urinary secretion. Information furnished by chemical analysis, by MM. Denoyés, Martre and Rouvière. During electrical treatment there is an increase in the amount of urine, and in the urea, uric acid, total nitrogen and salts contained therein.—Passage of carbon monoxide from the mother to the fœtus, by M. Maurice Nicloux.—Cellular heredity, by MM. A. Charrin and Gabriel Delamere.—On a reaction characteristic of pure waters, by M. H. Causse. Pure, uncontaminated water restores the colour of crystal violet which has been previously decolourised by sulphurous acid, but has no action on decolourised magenta or on paradiazobenzene sulphonate. In the presence, however, of human or animal excreta the colour of the two last mentioned reagents is restored, whilst the decolourised crystal violet is unacted on.

NEW SOUTH WALES.

Linnean Society, May 29.—Mr. J. H. Maiden, president, in the chair.—Notes on the botany of the interior of the Colony, part iii., by Mr. R. H. Cambage. Part iii. is descriptive of the botany of the country extending from the Bogan to the Lachlan, *viâ* Nymagee.—Revision of the Genus Paropsis, part vi., by Rev. T. Blackburn.—The nature of the bacteroids of the leguminous nodule and the culture of *Rhizobium leguminosarum*, by R. Greig Smith. The bacteroids of the leguminous nodule are neither higher nor lower types of growth, but are normal bacteria contained in a bulky branching capsule. A medium prepared from leguminous plants is not essential for the growth of *Rhizobium* as claimed by Hiltner. The author has grown the organism for more than a year on media devoid of all plant infusion.—On one of the so-called honeysuckles of Lord Howe Island, by J. H. Maiden. In the Society's *Proceedings* for 1898 (p. 126), the author described a tree under the name *Cupania Howeana*. He believes that this is identical with the plant described by Radlkofer in 1886 as *Guioa coriacea*, and gives the complicated synonymy of the species. The author tabulates the radical alterations that Radlkofer proposes in the nomenclature of Australasian Sapindaceæ and submits them for further consideration of Australian botanists since they were not adopted by Mueller.

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