THURSDAY, MARCH 24, 1881

MACQUORN RANKINE'S SCIENTIFIC PAPERS

Miscellaneous Scientific Papers by W. J. Macquorn Rankine, C.E., LL.D., F.R.S., late Regius Professor of Civil Engineering and Mechanics in the University of Glasgow. From the Transactions and Proceedings of the Royal and other Scientific and Philosophical Societies and the Scientific Journals. With a Memoir of the Author by P. G. Tait, M.A., Professor of Natural Philosophy in the University of Edinburgh. Edited by W. J. Millar, C.E., Secretary to the Institute of Shipbuilders in Scotland. With Portrait, Plates, and Diagrams. (London : Charles Griffin and Co., 1881.)

THE volume before us contains thirty-seven papers of rare scientific interest written by the late Prof. Rankine, who died now eight years ago. As to the cause of this long interval the Editor gives us no hint, nor is there anything in the volume to explain it. All the papers are reprints, without note or comment, except such as is contained in the concise but extremely graceful Memoir. These papers are not by any means all Rankine's original works. They are principally those relating to Thermodynamics and Hydrodynamics. There are however two important papers on the latter subject which are not contained in the volume ("On Stream Lines," *Philosophical Magazine*, 1865; "On the Mathecal Theory of Stream Lines," *Phil. Trans.* Royal Society, 1871). These can hardly have been omitted by design, as in the very last paper contained in the volume the author resumes the subject, directing attention to his paper of 1865, while the paper of 1871 is the most general and important paper Rankine wrote on this subject, besides being his last work.

The first twenty-seven papers contain the development by Rankine of that most modern of mathematical sciences, Thermodynamics, from its foundation-stone to the complete edifice as it exists at the present day. This by no means constitutes Rankine's entire work, nor do we think it his most useful work. But it is the largest gem in the casket, and should he be forgotten in all the rest this alone will secure for him a foremost place amongst those who have left their mark on philosophy.

The rapidity of the development of this branch of science is unrivalled. As profound as anything ever brought to light by the power of reason, it only occupied Rankine four years from the publication of his first paper until the theory was completed and applied to all cases. That the burning of coal was necessary to the production of steam, which was necessary for the working of an engine, and that the proportion of coal burnt bore some relation to the work done, were facts which for 200 years had been forcing themselves into notice, and gradually there had come to be an idea that in some way heat was the same thing as other forms of mechanical energy. But this was all, till, in 1843, Dr. Joule published his first experimental determination of the mechanical equivalent of heat. Published in an obscure way, it was some years before this novel but definite relation between heat and energy excited notice. The first published notice is by Thomson in 1849, although that Rankine had known it for some time previously is shown by the first of these papers, published in July of that year. In December of the same year Rankine sent in the Papers III. and XIV.,[1] containing the elements and some applications of his theory, and in 1854 he had published the complete theory and its applications to various engines, making instant use of the splendid experimental results just then obtained by Regnault. From this time it has been as possible definitely to forecast the result to be expected from any kind of engine as from 1690 to predict the behaviour of the moon.

From a philosophical point of view, there was a keen race in discovery between Thomson, Rankine, and Clausius, a race in which Thomson had the start, but which was neck and neck between Rankine and Clausius. But from the practical point of view Rankine was alone. And in this respect these papers, as indeed all his others, have a value both intrinsic and as examples of method which even transcends their philosophical value.

It was Rankine's practical knowledge which gave him his great advantage, but he had in some respects an advantage in having based his theory by means of an hypothesis on the fundamental laws of motion. Rankine worked from an hypothesis of his own creation as to the molecular constitution of matter, which was perfectly definite and capable of including all the phenomena which he had to consider. The definiteness of his hypotheses gave that definite form to his formula which suggested many points otherwise overlooked.

But as often happens, the definiteness of his hypotheses was also his source of weakness ; he assumed the atoms of matter to be masses of fluid subject to eddies and vibrations, but otherwise at rest. This suited the conditions of his problem, but it was only an hypothesis, and as it was definite, so any phenomenon with which it was incompatible sufficed to disprove the hypothesis and bring down the edifice raised upon it. And such phenomena, those of diffusion, existed ; although they did not come within the range of his work.

Rankine was himself fully alive to his position, and having once obtained his ideas and framed his formulæ, took and acknowledged a hint from his contemporaries, Thomson and Clausius ; and having shown that Carnot's theorem, which they had modified and made the basis of their reasoning, was a consequence of his molecular vortices, he adopted a general law as the base of his reasoning, and cut himself off from his hypotheses. This was easy for him to do, for, as may be seen in § 15*a* of Paper III., he had with no small care framed his hypotheses so as to fit the same law, though expressed in other words. This article is also interesting as showing the unlimited faith he must have reposed in the design and care of Providence. Not only does he conceive each atom of matter to possess a fluid atmosphere, in which exist a number of similar cyclones or eddies, symmetrically placed all over the atom, but he required that wherever two atoms touched there two eddies should face, and so exactly as to be coaxial. Many complicated properties were attributed by Newton and others to the corpuscles of light, but such a demand as is here implied on the attention of Providence has probably never been equalled

[1] Why this paper is placed so far out of its chronological order does not appear.

—a whole crew of Maxwell's demons on each atom would be required to warp and moor for every movement that might occur. But so true was Rankine's knowledge of mechanics that all this elaborate refinement did not prevent his hypothesis leading him to correct results.

This refined organisation, however, which renders his hypothesis in the highest degree improbable, suggests a most important consideration. For the almost infinite complexity of his particular arrangement indicates almost to the extent of a proof that the results he obtained must depend upon circumstances so general as to be independent of any particular hypothesis, so long as it is in conformity with the laws of motion, and hence the trail of these general circumstances is crossed.

In Rankine's hypothesis the temperature comes out as a direct measure in any particular substance of the kinetic or actual energy of the molecular motion. This conclusion, to which he adhered in the final foundation of his theory, is general, but it does not appear to be the most general conclusion of which our present experiments admit. It led Rankine to give a definite form as well as name to his thermodynamic function, which forms the fundamental equation of all the mathematical work. But it was subsequently shown that the differential equation to the same lines could be obtained without the assumption with regard to temperature, and then it did not appear that there was sufficient experimental data for the complete determination of the constants which enter into the integral. This is owing to the hitherto impossibility of determining the exact form of the adiabatic curve for solids and liquids. With gases it is different, and with these Rankine's law is found to fit, but so might a law framed on the supposition that in other cases the kinetic energy was some other function of the temperature. What is proved therefore is not that the temperature is a direct measure of the kinetic energy, but that this is some function of the temperature. This is apparently all that has yet been accomplished, so that Rankine's definite conclusion must be looked upon as suggested rather than proved by experiment. There can be no doubt however that this definiteness led to a vast development of the subject, and hence it was no mere fancy or partiality for his own view which led him to adhere to that form of second law which included his earlier view. Nor will the study of Rankine's earlier papers be time wasted on the part of those who seek to understand this extremely difficult subject. They will there find a model of the machinery by which the general result might be obtained, and if, as is the case with most new inventions, the machinery is unnecessarily complex, it is still the only machine which has accomplished the results.

They will also find, what must for ever add an interest to these papers, the first use of the terms thermodynamic function, adiabatic curve, potential energy, and others now in general use ; for Rankine's nomenclature, to a great extent his notation, and entirely his graphic method, have been universally adopted.

Rankine's methods have been called "uncouth," "diffuse and obscure," and without doubt they must seem all this to those who come to the subject with all the latest inventions in the form of mathematical machine tools in perfect working order,—just as the axe or adze must seem barbarous when there is a planing machine at hand to do the work, and the material has been prepared for it. But let the shape required be of a novel kind, or let the material be in the rough, and then how does it fare with the planing machine ?

Like that of Green, the whole career of Rankine is one rebuke to those who would exhaust the finest material on this earth—the best brain of our youth—converting it into elaborate mechanism only adapted to reduce, in however elegant a manner, already prepared billets to elegant and improved copies of masterpieces which, having once been shaped, although roughly with primitive tools, can never have to be shaped again. The material at last existed for a great mathematical edifice, of which the want had long been felt, and our great mathematical workshop was crowded with the most refined mechanism rusting for want of material to work upon. But this material was in the rough, and while waiting for some one to strip off the bark the chance was lost, for the obscure, self-taught mechanic who set to work with axe and adze did not stop at the bark, but with rapid and well-directed strokes brought out the form divine. However uncouth Rankine's methods may be, they have the great merit that they require nothing but a bold front—the result being obtained without adventitious aid. They are inscrutable to those who, having learnt the relations between quantities as expressed by symbols, have forgotten if they ever knew the purpose of their formulæ. But to the reader who thinks Rankine's methods are a statement of his thoughts, and though often a rough task, any one who succeeds in understanding Rankine finds to his satisfaction that he has done more than this, that he understands what Rankine understood.

Nor is this true only of his great work. What seems to us his most useful work is that of showing how the elementary mathematical methods were sufficiently adaptable to be applied to almost all cases of practical mechanics. The results are only approximate ; but where neither the data nor the desired result can be exactly measured, this is all that could be obtained, were the methods never so exact. One might as well set bricks by Sir Joseph Whitworth's millionth-of-an-inch machine as use the exact equation of thermodynamics to determine the probable work to be obtained from a steam-engine.

The graphic method was Rankine's great weapon. This, which is probably as old as any mathematical method, had been long neglected, except that it was sometimes used for engineering purposes. Rankine early perceived its applicability to the subjects he had to teach, and in his treatises on Applied Mechanics, Shipbuilding, and the Steam-Engine there are many instances of its novel and useful application which have been copied far and wide, while his graphic treatment of the subject of thermodynamics has been universally adopted. But the height of his achievement in the application and development of the graphic method is only reached in his papers on the motion of fluids.

These papers, with the omission already noticed, are collected at the end of the volume, and they constitute by no means its least valuable part. They are comparatively his later work. The first, "On the Exact Form of Waves at the Surface of Deep Water," was published in 1862, after his thermodynamical work was essentially complete.

Both the method and matter of this paper are unique. The results are obtained by a simple geometrical study of rolling circles. And there for the first time definite reasoning is adapted to the actual proportions of deep-sea waves, all previous work on the subject having been based on the assumption that the height of the wave is small compared with its length.

It is however in the next paper that he first shows what may be done by Maxwell's method of the graphic use of families of surfaces or curves. Here we have what is invisible in the fluid itself and had only been expressed by complex algebraical formulæ—the internal motion of the fluid—shown in such a way that not only the direction but the magnitude of the motion at every point may be taken in at a glance as well as definitely measured, and all deduced by simple but rigorous geometrical methods. The credit of this, which is certainly one of the highest achievements in the art of expression, must be divided. It was Faraday who first conceived the force of a magnet expressed by a family of lines; and it was Maxwell who discovered the rigorous method of drawing Faraday's lines; while Rankine realised in this the means of applying and expressing the principles of the steady flow of fluids propounded by Stokes now forty years ago.

In these papers on Hydrodynamics, as in all his other work, Rankine had a practical purpose in view. In this case it was the skin resistance and wave resistance of ships. And if, owing to the neglect of friction in the fundamental equations of motion, some of the results are still doubtful, yet in this respect the work is on a par with all the rest that has been done on this subject. And these papers, owing to the clear conception they convey of the internal motions of fluid and the direct purpose of the means adopted to elucidate these, afford by far the best chance for any one wishing to pursue the subject up to the highest position it has at present attained.

That Rankine himself owed much to having early directed his thoughts to fluid motion appears in all his work, as well as being shown by his theory of molecular vortices—a strictly hydrodynamical conception—amongst the intricacies of which nothing but his exact knowledge of the subject could have kept him straight.

It must be remembered however by those who would make a like use of such knowledge that Rankine did not begin his career by the study of mathematics; but that as an engineer from his birth, as we are told in the Memoir, he first became aware of the circumstances and problems of mechanics, and only evolved or acquired his mathematics as he found them necessary to his work. In this way his knowledge of mathematics must have included the knowledge of the necessity for each step. It was necessity first, and then method or invention; and not, as is too often the case with those who begin to learn mathematics before they are aware of what it is they are to do, all means and no ends.

In Rankine's text-books, as in his original papers, the ends are always kept in view. It is often impossible for others to follow him unless they begin by actually mastering the circumstances of the problem and trying to solve it for themselves, then if they honestly fail they will find that Rankine will help them; while if they succeed they will find that Rankine was before them. These books, both as regards originality of matter and the attention paid to the circumstances of each problem, have more the character of original papers than orthodox text-books. From this as well as his other writings it is clear that he acquired his knowledge of mathematics from the original works of the master, and not from text-books.

His example should therefore be the best recommendation for all those who would really understand mechanics to read the works direct from the hand of this master—a task which, with the aid of this volume, they may now accomplish without that trouble of search which, small as it is, leaves many a masterpiece on the shelf in some dark corner, while a mutilated and garbled extract disgusts the reader and discredits the thinker.

OSBORNE REYNOLDS

THE FERNS OF NORTH AMERICA

The Ferns of North America; Coloured Figures and Descriptions, with Synonymy and Geographical Distribution, of the Ferns of the United States of North America and British North American Possessions. By D. C. Eaton, Professor of Botany in Yale College. The Drawings by J. H. Emerton and C. E. Faxon. 2 Vols. quarto, pp. 352 and 285; 81 Plates. (Boston: S. E. Cassino, 1880.)

THIS handsome work, which has been brought out in parts, issued about one every two months, beginning with 1878, is now completed. Although ferns have long been popular in the United States, both with collectors and cultivators, this is the first large illustrated monograph of the indigenous species which has been attempted. For our own country we have several, of which the best known are Hooker's "British Ferns," with coloured figures, in large octavo; Lindley and Moore's "Nature Printed Ferns," in more than one edition; and Newman's "British Ferns," in which the plates are uncoloured woodcuts; but of the American ferns there are but few figures, and those widely scattered in general works, and even leaving figures out of the question there has been no descriptive handbook specially devoted to them, so that those who wanted to work at the subject have been placed at a great disadvantage. Prof. Eaton, who is the grandson of a well-known botanical author, has been universally recognised for the last twenty years as the leading authority on the subject. He has a large library and general collection of his own, has visited Europe and studied the American ferns in the public herbaria of the Old World, has proved himself in other departments of botany to be a careful and judicious systematist, and he is a teacher of botany of many years' experience, and has been looked up to for a long time by all the collectors of ferns throughout the Union as their referee in cases of doubt and difficulty; so that he has had every advantage for dealing with his subject in a thorough and exhaustive manner, and as he has been ably seconded by his two artists, the result is a monograph which is thoroughly satisfactory in every way, and which will be universally accepted both at home and in Europe as a standard work.

The geographical area which it covers is the whole of the American continent, from the Pole to the southern boundary of the United States. The true ferns only are included, not the Lycopodiaceæ, Equisetaceæ, and Rhizocarps, which are monographed along with the ferns by

Hooker, Milde, and in the earlier editions of Newman. In North America the order is represented by 139 species and 31 genera. The number of species is quite double what we have in the whole of Europe. The northern area outside the United States produces very few species that have not been found within the bounds of the Union. As in Europe there are no Cyatheaceæ, Marattiaceæ, nor Gleicheniaceæ. Of the other sub-orders the Schizœaceæ, which we do not possess, are represented in the United States by three genera and four species. Ceratopteris, of which Prof. Eaton makes a special sub-order, is also American, but not European. The other four sub-orders—Polypodiaceæ, Hymenophyllaceæ, Osmundaceæ, and Ophioglossaceæ—are represented, both in America and Europe. One peculiarity of ferns is that the genera show exceedingly little tendency to geographical localisation. The nearest approach to this that we have in North America is the predominance of Pellæa, Cheilanthes, and Nothochlæna, which are allied dwarf types with a greater power of resisting drought than any other set of ferns, and which are represented in this area by a large proportionate number of endemic species. These three genera take up thirty-nine species in North America against four for Europe. Out of the 139 species about forty are endemic, and about forty are European, the latter including several of our high mountain types, such as *Cystopteris montana*, *Aspidium Lonchitis*, *Polypodium alpestre*, *Woodsia ilvensis*, *glabella*, and *hyperborea*. The southern boundary of the States corresponds broadly with the limit in a northern direction of the great tropical flora of Equatorial America, the richest tropical flora in the world. But out of the 139 ferns at least twenty are characteristically widely-spread tropical species which do not extend beyond Florida, which have several of them only been discovered there within the last few years. Such are *Ophioglossum palmatum*, *Aerostichum aureum*, *Polypodium aureum*, *P. Phyllitidis*, *P. Plumula*, and *P. pectinatum*, *Vittaria lineata*, and *Nephrolepis exaltata*. Amongst the remaining species there are some curious cases of a *rôle* of distribution it is difficult to explain or understand. *Adiantum pedatum* and *Osmunda cinnamonea* are examples in ferns of a considerable group of American plants which reach Asia by way of Japan and run down through China to the Eastern and Central Himalayas; *Pteris serrulata*, found lately in America in Alabama, and South Carolina, reappears only in China; *Pellæa andromedæfolia*, which from California passes down the Andes to Chili, reappears in Cape Colony. *Nothochlæna tenera* is supposed to be divided between Southern Utah and the Andes of Bolivia and Chili, but here I think that the States plant will most likely have to rank as a distinct species. *Aspidium mohrioides*, long supposed to be endemic in extra-tropical South America, has been discovered lately by Mr. Moseley in Marion Island, and by Mr. Lemmon in one place at an elevation of 8000 feet above sea-level amongst the mountains of California.

As regards the limitation of genera and species Prof. Eaton differs but little from Sir William Hooker, as the English author's views are expounded in his great monograph of the ferns of the whole world, his "Species Filicum." Prof. Eaton treats Hymenophyllaceæ and Ceratopterideæ as distinct sub-orders; the former at any rate a decided improvement upon Sir W. Hooker's classification, and he maintains Ophioglossaceæ as a distinct order. In genera the principal deviations are that he keeps up Phegopteris as distinct from Polypodium, and merges Nephrodium in Aspidium.

A very curious North American fern is *Asplenium ebenoides* of Scott. It is very rare, and always grows in company with the walking leaf (*Camptosorus rhizophyllus*) and *Asplenium ebeneum*, two common American species. These are very dissimilar plants, but *A. ebenoides* is quite intermediate between them. Prof. Eaton seems not disinclined to the idea that it may be produced by natural hybridisation, as was suggested by the Rev. M. J. Berkeley in the *Journal* of the Royal Horticultural Society for 1866, p. 87.

An observation of Prof. Eaton's under *Nothochlæna Fenaleri* is interesting as bearing upon Milde's classification of ferns into a catadromous and anadromous series, according as to whether their lowest secondary branches originate on the posterior or anterior side of the pinnæ. Prof. Eaton notes that in this species there is always a decided inequality in their origin; but that it is sometimes on the anadromous, and at others on the catadromous plan.

J. G. BAKER

KÖLLIKER ON ANIMAL DEVELOPMENT

Grundriss der Entwickelungsgeschichte des Menschen u. der höheren Thiere. Von Albert Kölliker, Professor der Anatomie an der Universität Würzburg. (Leipzig: W. Engelmann, 1880.)

THIS book is essentially a reproduction of Prof. Kölliker's large treatise on Embryology, with a great part of the detail and controversial matter omitted, and is intended for the use of medical students. The larger work has more the character of a monograph on the development of birds and mammals than of a text-book; and as such, though of very great value to those engaged in teaching and research, is necessarily too bulky for the use of ordinary students. We think, therefore, that Prof. Kölliker has done very wisely in publishing the work before us; and we need hardly say that, his larger treatise having been already universally recognised as one of the most important contributions to embryology during recent years, the present work may safely be regarded as an accurate statement of the facts of avian and mammalian embryology. We may add that no trouble has been spared in the illustrations, which fully come up to the high standard characteristic of German works of this class.

While, however, we can say this much in praise of Prof. Kölliker's treatise, we cannot help recognising that it has some rather serious defects. Prof. Kölliker is an extremely objective writer. He describes with great clearness the objects as they present themselves to the observer, but he scarcely ever attempts to connect them together or to point out the general principles which underlie the mass of detail with which he has to deal. In his larger work this peculiarity is of comparatively small importance, in that those who are likely to use it are able to supply the general principles for themselves; and the work has already become a great mine of facts to which every anatomist who is engaged in studying the morphology of vertebrates will necessarily turn.

In a book however intended for medical students, it is, in our opinion at least, of the utmost importance that the facts of embryology should not merely be stated in succession, but that their significance should be pointed out. Embryology is of but little practical value to a medical student, and the small amount he must necessarily know could be given in a very few pages, and is, we believe, usually to be found in works on human anatomy. Considered however as an educational instrument, embryology is of the utmost value. It gives to the student an insight into the meaning of the structures which he meets with in his dissections, and by so doing often renders details of anatomical structure comparatively easy and pleasant of acquisition, which would otherwise be a great and almost repulsive strain on the memory.

Embryology should be taught to the medical student as a comparative science; with the facts duly marshalled, their significance pointed out, and general principles deduced from them. In such a form it ought to constitute an important part of medical training, which every medical school of any pretence to excellence should impart to its students.

We would venture to call attention to the following instances as illustrative of what we consider the unsatisfactory treatment of certain parts of the subject to be found in Prof. Kölliker's work. In dealing with the phenomena of segmentation Prof. Kölliker makes no effort to point out that the differences in the early development of the mammal and bird are in the main the result of the presence of food yolk in the one case and its absence in the other. After reading his very careful and elaborate treatment of the primitive streak, the student would, we think, be left in complete ignorance of the real significance of this interesting structure.

Again, in his account of the placenta, which he describes in man and the rabbit, he has so little to say as to any comparison between the two that we are at a complete loss to understand why he should have made any mention of the former.

In his account of the development of the vascular and excretory systems we are struck with the almost entire lack of any attempt to put the facts which have been so admirably described to their legitimate use, viz. to the explanation of the arrangement of these and other structures in the human body, and of the presence of rudimentary organs.

In making these strictures on Prof. Kölliker's work we should be sorry to convey the impression that we underestimate the value of this in most respects admirable treatise. It has already become justly popular in Germany, and we trust that it will also become widely known in this country.

OUR BOOK SHELF

Bulletin of the United States Geological and Geographical Survey of the Territories, 1879-80. Vol. v. (Washington, 1880.)

THE publications issued by the American Government under the above title are so appreciated in this country that it seems unnecessary to compliment Dr. Hayden and his coadjutors on the appearance of another of their useful volumes. During the last few years, however, there have been brought out by the U.S. Department of the Interior some works by Dr. Elliot Coues, which for patient industry must compare with any that have ever been compiled in scientific literature. The title of the volume now before us reads as follows:—Art. 26. Third Instalment of American Ornithological Bibliography, by Dr. Elliot Coues, U.S.A., and consists of 545 octavo pages of small print. How many titles of papers and books are quoted in this laborious treatise we should be sorry to have to count. The labour must have been enormous, and it is only those who have to follow the intricate windings of synonymic literature who can appreciate the work here performed by Dr. Coues. We learn that we may expect at some future time a similar conspectus of titles relating to the ornithology of the Old World, but although the present volume professedly deals with American Birds only, many standard works of general interest are passed in review by the author, who exhibits great judgment as a critic. Taking Gray's "Hand-List of Birds" as a basis of classification to follow, Dr. Coues treats of each family separately, and then in chronological order he records every work, every paper, and every note which directly or indirectly affects the American species, and as regards each year the publications are separately entered under the authors' names in alphabetical order. We must however again warn ornithologists that so many collateral references are given to Old World papers where the families are at all cosmopolitan, that therefore no one writing on any group of birds can afford to neglect this book. As for Dr. Coues himself, we can only imagine the sigh of relief with which he must have corrected the last proof of such a toilsome undertaking, although he must have been assured beforehand of the heartfelt gratitude of every ornithological *confrère* throughout the globe. R. B. S.

(i.) *Exposition Géométrique des Propriétes générales des Courbes.* Par Charles Ruchonnet (de Lausanne). Quatrième édition augmentée. (Paris, 1880.)

(ii.) *Éléments de Calcul approximatif.* Par C. Ruchonnet (de Lausanne). Troisième édition revue. (Paris, 1880.)

HAVING noticed both these works on the appearance of the last previous editions in 1874, we need say little here. The reasoning in i., we may remark, is always upon the curve itself, and is not derived by taking the limiting form of the inscribed polygon; and similarly in the case of surfaces. The work has grown from 160 pp. to 174 pp., and there is one more plate of figures.

The pamphlet ii. is, what it is stated to be, a revised form of the last edition. It consists of 64 pp. in place of 65 pp.

Geschichte der geographischen Entdeckungsreisen im Alterthum und Mittelalter. Von J. Löwenberg. (Leipzig und Berlin: Otto Spamer, 1881.)

THIS is a volume in the publisher's Illustrated Library of Geography and Ethnology. It is, as its title indicates, a History of Geographical Discovery in Antiquity and during the Middle Ages. The story is brought down to the time of Magellan and Martin Behaim. The first book, under the heading of Night and Morning, treats of the earliest dawn of geographical knowledge with the Hebrews, Egyptians, Babylonians, Phœnicians, Greeks, and Romans; the second book embraces the period from Herodotus to Ptolemy; the third, the Middle Ages; and the fourth the Century of Discovery, in which Spain and Portugal did such splendid work. Herr Löwenberg has evidently taken great pains to master his subject, and has been quite successful. He treats it in considerable detail, both in its historical and scientific aspects; the arrangement is excellent, and while popular and attractive in style, the work seems to us to be accurate and altogether trustworthy. There are numerous illustrations, some of them rather fanciful, but most of them useful and appropriate—portraits, ships of various periods, maps, some of them reproductions of very early ones, and

places and monuments illustrative of various countries. Altogether the work is a really good specimen of its kind. Another volume will bring the story down to the present time.

LETTERS TO THE EDITOR

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

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

The Tide Predicter

I SEE in your last number (p. 467), among the editorial notes, the following:—"Mr. Roberts of the *Nautical Almanac* office is authorised, by resolution of Council of the Secretary of State for India, dated August 7, 1880, to make it generally known that his Tide Predicter may be employed for the preparation of Tide Tables for any port for which the requisite data are forthcoming."

I think it right to call your attention to the fact that the Tide Predicter is in no sense of Mr. Roberts's invention or design. He was employed in 1873 by me, as chairman of the British Association Tidal Committee, to calculate the number of teeth in the wheels of the first Tide Predicter (now the property of the British Association, permanently deposited in South Kensington Museum), and to superintend its construction in London by Messrs. A. Légé and Co. The second Tide Predicter was made for the India Office, according to my advice, by Messrs. A. Légé and Co. of London, under the superintendence of Mr. Roberts. In respect to the plan of the wheelwork, which is wholly due to Messrs. Légé, it is a copy of the first instrument. It is an improvement on the first instrument in having twenty tidal components instead of ten, and in having the well-known rigorous method of the slide (Thomson and Tait's "Natural Philosophy," § 55, or "Elements of Natural Philosophy," § 72) for producing simple harmonic motion in a straight line from circular motion, instead of the approximate method of pulleys centred on crank-pins, which for simplicity and economy I used in the first instrument. WILLIAM THOMSON

The University, Glasgow, March 19

The Magnetic Storm of 1880, August

THE Astronomer-Royal has handed to me a copy of the photographic record of the variations of magnetic horizontal force as registered at Toronto during the disturbed period of August 11 to 14 last. The records of declination and vertical force were imperfect and have not been received.

The comparison of the Greenwich and Zi-ka-wei (China) curves for the same period (NATURE, vol. xxiii. p. 33) indicated that the commencement and end of disturbance (especially the commencement) occurred nearly simultaneously at both places, and this circumstance is now further corroborated by the Toronto horizontal force curve.

In what follows, the reference throughout is to Greenwich time.

The disturbance at Toronto commenced on August 11 at 10.20 a.m. At Greenwich (NATURE, vol. xxiii. p. 33) it commenced also at 10.20 a.m., and at Zi-ka-wei at 10.16 a.m.; at Melbourne (NATURE, vol. xxii. p. 558) it commenced at 10.33 a.m.

Disturbance ceases at Toronto at about midnight of August 11, and at Greenwich and Zi-ka-wei also at about or near midnight, but it dies out more or less gradually, not allowing the limit of disturbance to be always very precisely fixed.

Sudden motion is again shown (after some hours of quiet) at Toronto on August 12 at 11.40 a.m.; also at Greenwich at 11.40 a.m.; some minutes sooner at Zi-ka-wei; and at Melbourne at about 11.38 a.m.

Disturbance again dies out more or less gradually at Toronto on August 14 about 7 a.m.; at Greenwich and Zi-ka-wei at about 6 a.m.; and at Melbourne at about 7 a.m.

The commencement of disturbance in the above instances is definite, and the agreement in time, considering the widely-separated geographical position of the four places concerned, is noteworthy. The cessation of disturbance is less definite, as has been already remarked, but even here the discordance in time is not very wide. WILLIAM ELLIS

Royal Observatory, Greenwich, March 12

Prehistoric Europe

I MUST adhere to my decision not to play the part of Secutor any further to a glacial Retiarius in the arena of NATURE. If his net be strong enough to carry the Upper Pleiocene and the Pleistocene mammalia of Europe, as well as Palæolithic man and the Neolithic skull of Olmo, I wish him joy of them. If, further, he will kindly give me the proof that the mammalia of Auvergne, considered Upper Pleiocene by Falconer, Gaudry, Gervais, and other leading palæontologists, are, as he terms them, "a hash up," they shall be properly served and *iced*, if necessary, in my second edition.

I feel however that it is only right for me to notice the new gladiator who springs to the aid of his friend. The antiquity of man in the Victoria Cave is solely due, as it appears to me, to the *perfervidum ingenium* (I speak in all respect) of Mr. Tiddeman. It was first based on a fragment of fibula which ultimately turned out to belong to a bear. Then it was shifted to the cuts on two small bones, which were exhibited and discussed at the British Association, at the Anthropological Institute, and at the Geological Society of London. The bones are recent, and belong to sheep or goat, two domestic animals introduced into Britain in the Neolithic age. The cuts have been probably made by a metallic edge. Numerous bones of the same animals, in the same condition and hacked in the same way, occurred in the Romano-British refuse-heap on the top of the clay, and frequently slipped down over the working face to the bottom of the cutting before I resigned the charge of the exploration to Mr. Tiddeman after nearly four years' work. There were frequent slips afterwards. Under these circumstances the reader can decide whether it is more probable that the mutton-bones in question did slip down from a higher level to be picked out at the bottom, or that there is evidence of "interglacial" (J. Geikie) or "preglacial" (Tiddeman) man possessed of domestic animals and probably using edged tools of metal. The mutton-bones seem to me to prove so much on the latter hypothesis, that they may be thrown aside without further thought.

The reindeer (bones of feet) was found in 1872 along with fox, rhinoceros, elephant, hyæna, and bison in the cave at the lower horizon, which afterwards was proved to contain the hippopotamus. It was omitted in Mr. Tiddeman's lists up to 1876, when I called his attention to the fact. Then he wrote that the fact that it was so found was "noteworthy," and that "these remarks [his generalisations] were made solely on the evidence which passed through your present reporter's hands since he undertook to conduct the exploration of the cavern" (Brit. Ass. Rep., 1876, p. 118). Surely it is too late, in his letter to NATURE (March 10, 1881), to recall this on the grounds that these remains were discovered in a shaft, that my exploration was not carried on so accurately as his own, and further, that because he did not find the reindeer in the lower strata that I did not. It is not for me to compare my own experience in cave-hunting with his, or to point out the value of negative evidence. The exploration while under my charge was *not* carried on by shafts only. When the hyæna-layer was reached it was followed in the deep cutting visited by the British Association in 1873. The presence of reindeer in the hyæna-layer renders Mr. Tiddeman's views untenable which are based on its assumed absence. Most of these points have been so fully argued out before the above-mentioned societies, that I am sorry to be obliged to repeat them in this letter. W. BOYD DAWKINS

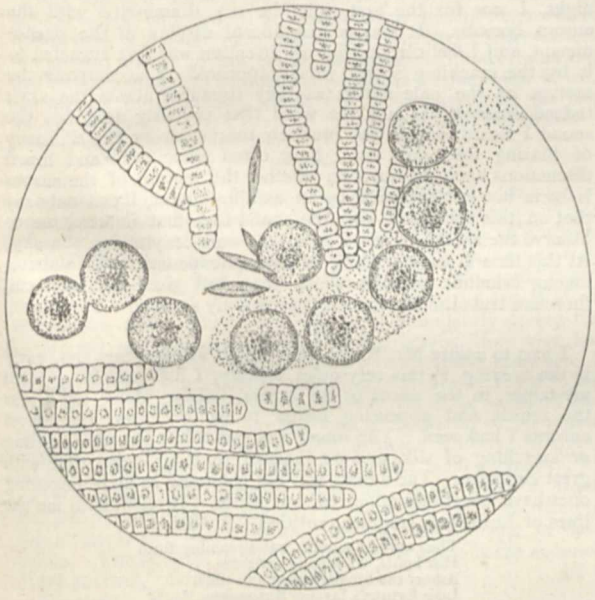
Owens College, March 11

Oceanic Phenomenon

H.M.'s surveying ship *Alert* was recently engaged in searching for a "shoal" which was reported as existing some 200 miles to the southward of Tongatabu, in the South Pacific. In the course of the survey—which I may add tended to disprove the existence of any such shoal—it was observed that for several days the sea-surface exhibited large discoloured patches, due to the presence of a fluffy substance of a dull brown colour, and resembling in consistency the vegetable scum commonly seen on the stagnant water of ditches. This matter floated on the surface in irregular streaky patches, and also in finely-divided particles impregnated

the sea-water to a depth of several feet. Samples for examination were obtained by "dipping" with a bucket, as well as by the tow-net. It seemed to be a Confervoid Alga.

On slightly agitating the water in a glass jar, the fluffy masses broke up into minute particles, which, under a magnifying power of sixty diameters, were found to be composed of spindle-shaped bundles of filaments. Under a power of 500 diameters these filaments were seen to be straight or slightly-curved rods, articulated but not branching, and divided by transverse septa into cylindrical cells, which contained irregularly-shaped masses of granular matter. These rods, which seemed to represent the adult plant, measured $\frac{1}{2000}$ inch in width. On carefully examining many samples, some filaments were detected, portions of which seemed to have undergone a sort of varicose enlargement, being more than twice as wide as the normal filaments. These propagating filaments (if I am right in so calling them) were invested by a delicate tubular membrane, and contained some granular semi-transparent matter, in which was imbedded a row of discoid bodies; the latter appearing as if about to be discharged from the ruptured extremity of the tube. These bodies measured $\frac{1}{1000}$th of an inch in diameter: when seen edgewise presented a



lozenge-shaped appearance, and were devoid of cilia or striæ. Conjugation was not observed.

On allowing a jarful of the sea-water to stand by for twenty-four hours it was found that the confervoid matter had all risen to the surface, forming a thick scum of a dull green colour, while the water had assumed a pale purple colour, resembling the tint exhibited in a weak solution of permanganate of potash.

From November 24 to 29, during which time the ship traversed slowly a distance of 330 miles, the sea contained these organisms. For the first three days the large patches were frequently in sight, and during the rest of the time the surrounding water presented a dusty appearance from the presence of the tiny spindle-shaped bundles. On the evening of the 26th an unusually dense patch was sighted and mistaken for a reef, being reported as such by the look-out-man aloft.

Sydney, January 24 R. W. COPPINGER

Feeding a Gull with Corn

IN Prof. Semper's recently-published work on the "Conditions of Existence as they Affect Animal Life," a review of which from the pen of Prof. Lankester appeared in your columns a fortnight ago (vol. xxiii. p. 405), allusion is made on pp. 67, 68, and elsewhere to John Hunter's celebrated experiment of feeding a gull with corn. Prof. Semper, however, seems not to have been aware of the precise nature of the result of Hunter's experiment. He says: "The English anatomist Hunter purposely fed a sea-gull for a whole year on grain, and he thus succeeded in so completely hardening the inner coat of the bird's stomach, which is naturally soft and adapted to a fish diet, that in appearance and structure it precisely resembled the hard, horny skin of the gizzard of a pigeon."

The original account, I believe, of Hunter's experiment, was published in Sir Everard Home's "Lectures on Comparative Anatomy" (vol. i. p. 271, 1814), and an extract from that work is appended to the description of Hunter's original preparation, still preserved in the College of Surgeons, in the descriptive catalogue of that collection (vol. v., 1833, pp. 149-50, Prep. 523). What Hunter succeeded in effecting was to very much increase the thickness of the *muscular* walls of the gizzard, which, as may be seen by comparing his specimen (No. 523) with that of the stomach of another gull close by, have become developed to an extent about double their usual size. There is no manifest increase in the thickness of the "inner"—or so-called "epithelial"—coat of the stomach visible in the preparation, nor do Home or Owen allude to any such feature in their descriptions. Hunter's experiment, therefore, simply comes under the numerous well-ascertained instances of the increased development, consequent on increased use, of muscle, and has no real connection with the "modifying effects of food," such as that produced in canaries by feeding them on cayenne pepper, and others cited by Semper. W. A. FORBES

Zoological Society's Gardens, N.W., March 18

Dynamics of "Radiant Matter"

As the chief object of Mr. Preston's paper under the above title in NATURE, vol. xxiii. p. 461, seems to be to support Le Sage's "shelter theory" for gravity, you will perhaps let me point out one objection to that theory in any form which has hitherto been deemed conclusive, and with which Mr. Preston does not deal. It is that under it gravity would not vary, as it is known to do, equally with mass, but would vary *not* equally.

The theory applies perhaps so long as you consider only the case of isolated atoms, but it fails entirely when applied to clusters of atoms.

Observation shows that gravity varies only with distance and with mass; but if it were caused by any form of shelter hitherto imagined, it would vary also with density and with bulk in such a way that a pound of, say water, would weigh more than a pound if raised into steam, because its atoms, in loose order as steam, would give each other less shelter from the action of the kinetic æther than when in close order as water, and in such a way also that two spheres of, say iron, each weighing one pound, would weigh less than two pounds if welded into one sphere, because some atoms in the one sphere would be better sheltered than any atoms in the two spheres. WM. MUIR

March 21

The Oldest Fossil Insects

MR. S. H. SCUDDER has published (Anniversary *Memoirs* of the Boston Society of Natural History, 1880, pp. 41, plate 1) a memoir on the Devonian Insects of New Brunswick. The fragments of the six described species were discovered by the late Prof. C. F. Hartt in 1862, and have been since 1865 described in several papers by the same author. The new paper is a very detailed and elaborate one, with entirely new and improved figures, and is followed by a number of conclusions, as the final result of his work (Report, *Amer. Journ. of Sci.*, Feb. 1881). The conclusions would be of prominent importance for the history of the evolution of insects, if they could be accepted without reserve. Of course facts and conclusions should be able to stand the most severe test; and that is not the case with this publication. "As the simpler Devonian insects have certain special relations," he says, "with the Ephemeridæ, their description is preceded by an account of the wing-structure of the modern Mayflies as a basis of comparison" (p. 4).

The simple fact that not one of the described species has any relationship to the Ephemeridæ is sufficient to cause us to object to his descriptions and conclusions related to this family. This statement is not based upon a difference of opinion, but simply on the evidence of facts which cannot be denied by any one conversant with the families Ephemeridæ and Odonata.

Platephemera antiqua is a part of the apical half of the wing, without the tip, of a gigantic dragonfly. The suddenly narrowed second cubital space is to be found in Isophlebia of the Solenhofen slate. The imperfectness of the fragment allows no further conclusions.

Gerephemera simplex is a diagonal fragment of the middle of

a wing of a gigantic dragonfly. The reverse has a small part of the base, not to be seen in the obverse, with a straight sector crossing the horizontal ones. The same arrangement is to be seen in Isophlebia. Every other character important for nearer determination is wanting in the fragment.

Lithentomum Harttii.—The fragment is very insufficient, and recalls the venation of the Sialids, and among them those of the Chauliodes type.

Homothetus fossilis.—This is a Sialid of the Corydalis type, with a small number of transversals. The basal vein, spoken of as homologous with the arculus of the Odonata, and as proving a synthetic type, is the part in which the wing breaks off easily in actually living species. I have not seen the type.

Xenoneura antiquorum.—Some details given for this species are not exact. It has not been observed that parts of one wing cover the other; I can only say that the wing belongs to the Neuroptera, and that the venation is nearer to the Chauliodes type than to any other. The famous "stridulation" apparatus at the base is justly retracted by the author.

Four new families are proposed for these insects by the author. One of them, the Atoxina, is now out of the question, as Gerephemera belongs to the Odonata. The three others are only indicated by extremely vague characters, in fact by no characters at all. Can science accept such families? I believe not.

I omit *Dyscritus vetustus* because this fragment is undeterminable.

My conclusions are, that two of the insects belong to the Odonata, three to the Sialids. There is no Ephemerid among them, nor any synthetic species. The proofs for my statements will be given in a detailed paper. H. A. HAGEN

Cambridge, Mass.

Ice-Casts of Tracks

As I was riding along the highway late this afternoon, my attention was attracted to a phenomenon no less curious than beautiful. A couple of days ago there was a fall of a few inches of very damp snow, after which the temperature fell rapidly, and this morning everything was frozen hard. A large dog had trotted along in the snow while it was yet damp, and where it lay upon the old drifts by the road-side. To-day the sun has been shining very warm, cutting away all the new snow and leaving the tracks of the dog in exquisitely perfect ice-casts, thin as writing-paper, and standing on the most delicate thread-like columns, about an inch above the surface of the old snow.

Lyons, N.Y., March 7 J. T. BROWNELL

Migration of Birds

THE following extracts from a work entitled "Bible Customs in Bible Lands," by Henry J. Van Lennep, D.D. (1875), may prove interesting to some of your readers, as containing important and reliable evidence with regard to the migration of birds, which has formed the subject of two recent letters in NATURE.

Speaking of the great numbers of small birds which inhabit Western Asia, as compared with Europe and North America, Dr. Van Lennep explains the circumstance by the fact that "even those of feeblest wing have an easy road from Palestine, Syria, and Mesopotamia, by the Isthmus of Suez, and over the narrow Red Sea, to their winter quarters in tropical Africa, while nature has provided them with *extraordinary means* of conveyance from Asia Minor southward across the Mediterranean . . . The swallow, and many other birds of similar powers of flight, are able to cross over the entire breadth of the Mediterranean, especially by taking advantage of a favourable wind. But many birds are quite incapable of flying over a surface of 350 miles from headland to headland across the Mediterranean without alighting, and would require many days, and even weeks, to perform the trip through Syria and Palestine. Such are the ortolans, darnagas, bec-figs, wren, titmouse, smaller thrushes and finches, with a hundred other diminutive specimens of the feathered tribes . . . and as the severity of the winter would be fatal to them, not only in Asia Minor but even in Syria and Palestine, He who is ever mindful of the smallest of His creatures has provided them with means of transportation to a more genial clime. Many of them, indeed, find their way downward from Palestine into Arabia and Egypt, but this would be difficult, if not impossible where lofty mountains and broad seas intervene, and to meet such cases *the crane has been provided*. . . . Most of these birds are migratory. In the autumn numerous flocks may be seen coming from the north with the first cold blasts from that quarter, flying low, and uttering a peculiar cry as if of alarm, as they circle over the cultivated plains. Little birds of every species may then be seen flying up to them, while the twittering songs of those already comfortably settled upon their backs may be distinctly heard. On their return in the spring they fly high, apparently considering that their little passengers can easily find their way down to the earth."

As Dr. Van Lennep has "spent almost a lifetime in the East," I conclude he has been an eye-witness of the above facts, and therefore his testimony is conclusive. G. A.

Bath, March 16

Sound of the Aurora

WITH reference to the question mooted in last week's NATURE (p. 459) by M. L. Rouse as to the sounds emitted by auroræ, perhaps the accompanying extracts may be of interest.

Brighton, March 20 EDWD. ALLOWAY PAUKHURST

"*Record of a Girlhood*," *F. A. Kemble. Vol. I.*

"Standing on that balcony [at Edinburgh] late one cold clear night, I saw for the first time the sky illuminated with the aurora borealis. It was a magnificent display of the phenomenon, and I feel certain that my attention was first attracted to it by the crackling sound which appeared to accompany the motion of the pale flames as they streamed across the sky; indeed *crackling* is not the word that properly describes the sound I heard, which was precisely that made by the *flickering* of blazing fire; and as I have often since read and heard discussions upon the question whether the motion of the aurora is or is not accompanied by an audible sound, I can only say that on this occasion it was the sound that first induced me to observe the sheets of white light that were leaping up the sky. At this time I knew nothing of such phenomena or the debates among scientific men to which they had given rise, and can therefore trust the impression made on my senses."

I BEG to assure Mr. Rouse that about fifteen years ago, early in the evening, in this very quiet locality, I listened, along with my father, to the sound of an aurora, pulsing above us, across the zenith, and appearing nearer to us, or lower, than most auroras I had seen. The sound was somewhat like the rustling or switching of silk, and we listened to it for some time with great curiosity. The aurora was not coloured, as more imposing ones have sometimes appeared, but white. It recalled to me the lines of Burns in a fragment entitled "A Vision."

"The cauld blue north was streaming forth
Her lights, wi' hissing eerie din;
Athort the lift they start and shift,
Like fortune's favours tint as won."

Dumfriesshire, March 20 J. SHAW

Tacitus on the Aurora

WITH reference to the passage of Tacitus, "Germ." 45, quoted in NATURE, vol. xxiii. p. 459, I would suggest that the reading *equorum*, proposed by some commentators, is far happier than *deorum*. "It is believed that a sound is heard, that the forms of the horses and rays from a head are seen." R. O. S.

Heidelberg, Germany

Aberration of Instinct

As an instance of "Aberration of Instinct," or I should rather say of *instinct at fault*, may be mentioned the following:—It is well known, I believe, that rooks in attacking young mangold-wurtzel pick out the plants to obtain the wireworm at their roots. It happens that plants most infested with these insects are the most flagged in the leaf. Now a neighbour whose sowing had been a partial failure transplanted some young wurtzels into the vacant places. These of course for a few days presented a flagged appearance, and were all seized on by the rooks to the exclusion of the rest. Poor disappointed creatures, what must have been their chagrin at finding no wireworm as they evidently expected!

T. H. WALLER

Waldringfield Rectory, Woodbridge, March 16

Squirrels Crossing Water

A CORRESPONDENT in NATURE (vol. xxiii. p. 340) is surprised to learn of the squirrel taking to the water. It is not an un-

common thing for them to do so here, and they are frequently drowned in making attempts beyond their strength.

Some years ago I was rowing on Lake George in this State, when I observed one of these little animals in an open place, where from the course he was pursuing he must have swum nearly half a mile. He seemed almost exhausted, and when I held my oar towards him he readily accepted the invitation to come on board, ran up the oar, and then to my surprise ran up my arm and ascended to my shoulder! I do not know whether he simply followed his climbing instincts, or whether he sought an elevated point to get an observation. However this may have been, after a short pause he descended and took his station in the bow of the boat, from which in a few minutes he plunged into the lake and struck out for land. He evidently miscalculated his remaining powers, for he was unequal to the effort, and soon gladly availed himself of a second opportunity of gaining a place of refuge. He now sat quietly while I rowed him towards the land, evidently satisfied that he was in friendly hands, and that his wisest plan was to remain as a passenger. When close to the shore he made a flying-leap and scampered for the trees, doubtless grateful in his little heart for the kindness that had helped him over the critical part of his voyage.

This was near the narrows of the lake, where it is about one mile in width, with groups of islands which shorten the traverses to less than a quarter of a mile. My little friend however had not availed himself of the easier and more circuitous route, but had boldly undertaken a directer course and a longer swim, which, but for the timely rescue, would very likely have been his last aquatic attempt. FREDERICK HUBBARD

New York, March 10

IN connection with a recent letter in NATURE on the squirrel taking to water, the following facts may be of interest:—While camping for two summers recently in the wilderness of northern New York, I was much surprised at frequently seeing squirrels crossing the ponds and lakes of the region. We would sometimes find several of these strange navigators in the course of an afternoon's row. They were seen most abundantly during the early part of July; indeed, later in the season, they were but rarely found. During many summers of camping elsewhere I have never seen them take to the water. It has occurred to me that the explanation of this peculiarity (if it be such) of the squirrels of this locality may be found in the nature of the region visited; for we find there a most intricate water-system, the whole region being dotted with ponds and lakes connected by small streams. The necessity of taking to the water at times has perhaps enabled the squirrels to overcome their aversion to this element, and they have thus become semi-aquatic in their habits. The squirrel to which reference is made is the common "red squirrel," *Sciurus Hendsonius*. C.

Worcester, Mass., March 8

IN the autumn of 1878 I was salmon fishing in the River Spey, a few miles from its mouth, where the stream was broad, strong, and deep—when just beyond the end of my line I perceived a squirrel being carried down, but swimming higher out of the water than is usual with most animals. Its death by drowning seemed inevitable, as the opposite bank was a high, perpendicular cliff of Old Red Sandstone, where even a squirrel could hardly land. However it swam gallantly on, heading straight across the stream, and finally, after being swept down a long distance, emerged on the other side, where a burn intersected the rock, and fir-trees grew down to the water's edge. The left bank, where the squirrel must have entered the river, was low and shelving, and it selected a spot, accidentally or otherwise, whence the current carried it opposite to an easy landing-place on the right bank. CECIL DUNCOMBE

March 18

THE LATE MR. E. R. ALSTON

THE death of Edward Richard Alston, which took place at his rooms in Maddox Street on the 7th inst., leaves a vacancy in the thin ranks of the working naturalists of this country that will not be easily filled up. At the time of his death Mr. Alston was secretary to the Linnean Society, a member of the Council of the Zoological Society, and treasurer to the Zoological Club, and up to within a few days of his decease was engaged in active zoological work. Mr. Alston, who died of phthisis at the early age of thirty-five, although somewhat retiring in disposition, was of a particularly kind and amiable nature, always most friendly with those with whom he was brought into contact, and ready to help them by advice or assistance. Mr. Alston was of Scotch parentage, and a native of Ayrshire. Being from infancy of delicate constitution he was educated chiefly under private tuition, and did not go to school or college. Notwithstanding these disadvantages he was a good scholar and a neat and concise writer, and had an excellent acquaintance with comparative anatomy. Taking early to the pursuit of natural history he became a contributor to the *Zoologist* and other popular journals, principally upon mammals and birds. Mr. Alston's first important paper was an account (published in the *Ibis*) of his journey to Archangel, made in 1872, in company with his friend Mr. J. Harvie Brown, in which excellent observations are given on the summer migrants and other feathered inhabitants of that previously little explored district. Shortly afterwards Mr. Alston moved his head-quarters to London during the first part of the year, and undertook the compilation of the portion of the *Zoological Record* relating to mammals, which he carried on in a very painstaking and methodical way for six years (1873-78). A new edition of Bell's British Mammals, which had long been called for, appeared in 1874. Mr. Alston, although he is only credited with having "assisted" in this work, was, we believe, its virtual compiler. From that date also he became a frequent reader of papers at the meetings of the Zoological Society and author of several excellent memoirs in the *Proceedings*. Amongst these we may call special attention to his revision of the genera of Rodentia, published in 1876, as a most successful exposition of the many difficult points connected with the arrangement of this group of mammals, and to his memoirs on the Mammals of Asia Minor, collected by Mr. C. G. Danford (1877 and 1880). Mr. Alston's last and most important work, which he had fortunately just brought to an end before his untimely death, was the "Mammals" of Salvin and Godman's "Biologia Centrali-Americana"—a great work on the fauna and flora of Mexico and Central America. The first part of this was published in 1879, the eighth number containing the completion of the Mammals in December last. The death of this promising naturalist, when in the full tide of work, must be a subject of universal regret among all lovers of science.

RECENT MATHEMATICO-LOGICAL MEMOIRS

THE Boolian reform of logical science is at last beginning to manifest itself and to bear the first-fruits of controversy. Thirty years ago Boole's remarkable memoirs were treated as striking but almost incomprehensible enigmas. Even De Morgan did not know exactly how to regard them, and in his "Syllabus of a Proposed System of Logic" (p. 72) thus allows their mysterious truth:—"In these works the author has made it manifest that the symbolic language of algebra, framed wholly on notions of number and quantity, is adequate, by what is certainly not an accident, to the representation of all the laws of thought." But time and the efforts of several investigators have cleared up much of the mystery in which Boole wrapped his logical discoveries. The controversies now going on touch rather the precise form to be given to the calculus of logic, than the former question of the new logic against the old orthodox Aristotelian doctrine.

The most elaborate recent contributions to mathematico-logical science, at least in the English language, are the memoirs of Prof. C. S. Peirce, the distinguished mathematician, now of the Johns Hopkins University, Baltimore. Not to speak of his discussions of logical ques-

tions in the *Proceedings* of the American Academy of Arts and Sciences (vol. vii. pp. 250-298, 402-412, 416-432), we have from him the wonderful investigation contained in his "Description of a Notation for the Logic of Relatives, resulting from an Amplification of the Conceptions of Boole's Calculus of Logic" (*Memoirs* of the American Academy, vol. ix. Cambridge, U.S., 1870, 4to). The contents of this remarkable treatise, which fills sixty-two quarto pages, demand the most careful study, but it would be quite impossible in this article to enter upon such study. Prof. Peirce has however quite recently interpreted his own views in a new memoir "On the Algebra of Logic," of which the first part, completed by the author in April last, was printed in the *American Journal of Mathematics*, vol. iii., and issued in September (4to, 57 pp.). After noticing the beautiful typography in which the *American Journal* rejoices, we find in this memoir a very careful inquiry as to what is really the form and nature of logical inference.

Prof. Peirce treats in succession of the Derivation of Logic, of Syllogism and Dialogism (a new name for a form of argument), of Forms of Propositions, the Algebra of the Copula, the Internal Multiplication and the Addition of Logic, the Resolution of Problems in Non-relative Logic, with a further chapter on the Logic of Relatives. The fundamental point, however, which is under discussion in the first two chapters touches the nature of the copula. There is abundance of evidence to show that given a few elementary forms, it is possible to spin out logical or mathematical formulæ simply without limit. But the superstructure rests entirely upon the basis of elementary truth contained in the first axioms. In logical science it is emphatically true that "C'est le premier pas qui coûte." There is a momentous choice to be made at the outset, and if we then take a wrong view of the nature of the logical copula, we can never come right again by any amount of development or formulisation.

Prof. Peirce after mentioning that four different algebraic methods of solving problems in the logic of non-relative terms have been proposed by recent English and German logicians, adopts a fifth, which he thinks is perhaps simpler and certainly more natural than any of the others. Peirce commences by expressing all the premises by means of the copulas $-<$ and $\overline{-<}$, "remembering that $A = B$ is the same as $A -< B$ and $B -< A$" (p. 37). These new symbols are to be interpreted so that $A -< B$ means (A implies B), in the way that water implies liquidity, or all water is liquid. The symbol $\overline{-<}$ is the negative of the above, so that $C \overline{-<} D$ means that C does not imply D. He then lays down five other processes which give the elementary theorems of the calculus, showing how to develop, simplify, transpose, and infer equivalency by these symbols. As however these processes occupy two quarto pages in their first statement, it is evident that they cannot be reproduced here. The question which really emerges is not as to the power and originality shown by Prof. Peirce, about which no reader of his memoirs can entertain the slightest doubt, but as to the wisdom of the first step, the selection of the relation expressed by the symbol $-<$ instead of that expressed by the familiar sign of equality $=$. Prof. Peirce begins by remarking that $A = B$ is the same as $A -< B$ with $B -< A$. For instance, all equilateral triangles are equiangular, and all equiangular triangles are equilateral. But though these two assertions are equivalent to "equilateral triangle = equiangular triangle," Prof. Peirce elects to treat the two parts of the apparently compound proposition separately, his reasons being given partially on p. 21. This is not the first time that the same choice has been made; for, not to speak of Aristotle and the Aristotelians generally, De Morgan elected to base his systems of logic upon inclusion and exclusion, instead of upon equality. In his symbols $X \parallel Y$ is compounded of $X)) Y$ and $X ((Y$ (Syllabus, p. 24), that is to say all Xs are all Ys is made of all Xs are Ys and all Ys are Xs. Now without going far afield, I believe that a sufficient reason may be given for holding that both De Morgan and Peirce have chosen wrongly. A class is made up of individuals, and the very conception of a class thus implies the relation of identity expressed in $A = B$. If I say the colour of glacier ice is identical with the colour of pure rain water, it is impossible to break this assertion up into "The colours of glacier ice are among those of pure rain water," and "The colours of pure rain water are, &c." The colour is one indivisible and identical. Now if there is at the basis of all reasoning an elementary assertion of the form $A = B$, which is incapable of resolution into anything simpler, this sufficiently proves that Peirce's $A -< B$, or De Morgan's $A)) B$ cannot be the original elementary form of assertion. Moreover, when we say that all equiangular triangles = all equilateral triangles, the real basis of assertion is that each possible equiangular triangle is identical with one possible equilateral triangle. The plural is made up of the singular, and the singular is incapable of logical decomposition. You may decompose $A = B$ into As are Bs, and Bs are As, but ultimate decomposition gives us $A' = B'$, $A'' = B''$, $A''' = B'''$, A′, A″, &c., being individuals.

It is highly curious, however, that this very question arises again with reference to the so-called Calculus of Equivalent Statements recently published by Mr. Hugh MacColl, B.A., in the *Proceedings* of the London Mathematical Society (First paper, November 1877, vol. ix. pp. 9-20; Second paper, June 13, 1878, vol. ix. pp. 177-186; Third paper, vol. x. pp. 16-28; Fourth paper, vol. xi.; see also *Mind*, January 1880, pp. 45-60, and the *Philosophical Magazine* for September 1880).

There can be no doubt that Mr. MacColl has shown much skill in devising neat symbolic forms, and much power in using them. Comparing his processes with those of De Morgan, for instance, it is impossible not to admire their symmetry and lucidity. But when we touch the real point, the nature of assertion and inference, I am obliged to hold that Mr. MacColl has, like De Morgan and Peirce, elected wrongly. What De Morgan expressed by $X)) Y$, and Peirce by $X -< Y$, MacColl puts in the form $x : y$, calling the assertion an *implication*. Curiously enough, he professes never to treat of things, but only of assertions, so that with him $x : y$ means that the assertion x implies the assertion y, or whenever x is true, y is true. Having carefully considered Mr. MacColl's proposals, I felt obliged to write of them in a recent publication as follows:—"It is difficult to believe that there is any advantage in these innovations; certainly, in preferring implications to equations, Mr. MacColl ignores the necessity of the equation for the application of the Principle of Substitution. His proposals seem to me to tend towards throwing Formal Logic back into its Ante-Boolian confusion."

In a paper printed in the *Philosophical Magazine* for January 1881, Mr. MacColl takes me to task and invites me to make good the charge about Ante-Boolian confusion, by entering into a friendly contest in the problem columns of the *Educational Times*. Having just recently spent the better part of fifteen months in solving other people's problems, and in inventing some two or three hundred new ones, published in "Studies in Deductive Logic," I certainly do not feel bound to sacrifice my peace of mind for the next few years by engaging to solve any problems which the ingenuity and leisure of Mr. MacColl or his friends may enable them to devise. I therefore decline his proposal with thanks. But I can easily explain what I mean by ante-Boolian, or what comes to much the same thing, anti-Boolian confusion. The great reform effected by Boole was that of making the equation the corner-stone of logic, as it had always been that of mathematical science. Not only did this

yield true and simple results within the sphere of logic, but it disclosed wonderful analogy between logical and mathematical forms, to which De Morgan adverts in the passage quoted above. All true progress in the philosophy of those fundamental sciences depends upon ever keeping in view the fundamental identity of the reasoning processes, as depending on the process of substitution, practised explicitly by algebraists for some two or three centuries past, and implied in the geometrical reasoning of Euclid.

But Mr. MacColl takes a backward step; he says he can make a simpler notation by taking $\alpha : \beta$ instead of my $\alpha = \alpha\beta$. In regard to form there is absolutely no novelty in the implication, for it is simply De Morgan's X)) Y, or the ancient Aristotelian proposition A is B. It is true that Mr. MacColl makes his terms consist of assertions, so that all his assertions would appear to be assertions about assertions—a needless complexity, landing us in the absurdity that a calculus of equivalent statements has no means of exhibiting the statements themselves. Mr. MacColl claims indeed considerable advantage for his notation on the ground that in the syllogism $(\alpha : \beta)$ $(\beta : \gamma) : (\alpha : \gamma)$, the very same relation which connects α with β, and β with γ, connects also the combined premises $(\alpha : \beta)$ $(\beta : \gamma)$ with the conclusion $\alpha : \gamma$. He thinks that my notation is very clumsy and roundabout, because, as my propositions treat of things or qualities, I should have to use words to express the inference of one proposition from others. In that case Mr. MacColl must bring the like charge of clumsiness against the whole body of mathematicians, because their equations are between things or their magnitudes, and they still use language "hence," "therefore," &c., to express the fact that certain equations lead to other equations. If there is any mathematical sign to denote inference, it is rarely used, unless it be the familiar '.' and .'., which are merely shorthand signs.

Mr. MacColl however, while pointing out the excellence of his implications, objects to my statement that he rejects equations in favour of implications on the ground that his method admits of both forms: "As a matter of fact," he says, "I employ both, sometimes even in the same problem. In my first paper . . . I adopt the equational form throughout; in my second and third papers, which relate entirely to questions of pure logic, I generally adopt the implicational form, as the simplest and most effective; while in my fourth paper, which treats of probability, I mainly adopt the equational form." There is nothing which I can see in this to contradict my objection that Mr. MacColl rejects equations *in favour of* implications. Mr. MacColl uses implications as "the simplest and most effective," but he adopts the equational form, I suppose, when he finds it indispensable; if not, why does he not hold to his simple and effective implication? If he finds one form best in logic and the other in mathematics, then he is ante-Boolian, because it was the whole point of Boole's labours to establish identity of method in logic and mathematics. I have really no wish to condemn Mr. MacColl's calculus or to enter into controversy with him, but in the interests of truth and sound science I must assert my belief that his implication $\alpha : \beta$ is at the best but a shorthand rendering of $\alpha = \alpha\beta$, which is Boole's form adopted by me. I have not said, and do not undertake to say, that Mr. MacColl's formulæ are not concise and neat. But a shorthand notation is bad if it obscures the real nature of the reasoning operation, and the fact that Mr. MacColl always keeps the equation in the background as a reserve method to call into operation when needed, shows to my mind that his methods are mistaken in a philosophical point of view. The very name of his method is "The Calculus of Equivalent Statements," and the word equivalent sufficiently implies that the equation is at the bottom of the matter. The end of it all then is that $\alpha : \beta$ has one letter less in it than $\alpha = \alpha\beta$, and to save the trouble of writing this one little letter Mr. MacColl would have us obscure all the grand and fertile analogies which Boole disclosed to the astonishment of mathematicians in 1847 and 1854. Mr. MacColl says: "The question whether the implication $\alpha : \beta$ or its equivalent the equation $\alpha = \alpha\beta$ should be preferred in a symbolical system of logic, must be decided on the broad grounds of practical convenience." It is not however a question of practical convenience, but of philosophical truth which is at issue, and in thus playing fast and loose with the equation, Mr. MacColl shows his entire want of comprehension of what is involved in the Boolian reform of logic. It may be added that were Mr. MacColl to discard implications and use only the equations which he admits are equivalent to them, there would be no formal difference between his calculus and that modified form of Boole's calculus which I proposed in 1864, and have been ever since engaged in developing, excepting indeed Mr. MacColl's unaccountable adoption of assertions as terms.

Perhaps it ought to be added that Boole, both in his "Mathematical Analysis of Logic," and in his great "Laws of Thought," introduces chapters on what he calls "Secondary Propositions" or Hypotheticals, which deal, like Mr. MacColl's assertions, with the truth of other assertions; but nothing emerges from Boole's discussion of secondary propositions except that they obey exactly the same formal laws as primary propositions, and are of course expressed equationally.

W. STANLEY JEVONS

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

III.

THE animals we now speak of are again inhabitants of North-Eastern Asia—a country which, as before remarked, has of late years produced a considerable number of accessions to the list of Mammals. Both of them also belong to the great group of Ruminants—which is of special interest, as embracing all the animals upon the flesh of which civilised man principally subsists.

6. The Japanese Goat-Antelope (*Capricornis crispa*). For many years Siebold's "Fauna Japonica" was almost our only authority on Japanese zoology. The Dutch, having long had a monopoly of Japan, were enabled to stock their great National Museum at Leyden with a host of objects unknown to the other cabinets of Europe, but of which their travellers and residents managed to obtain specimens from various parts of the land where they only were permitted to penetrate. The "Fauna Japonica," although Japan is now open to all the world, still remains the best work of reference on the mammals of Japan. In it will be found the first description of the singular goat-like antelope of which the Zoological Society have recently obtained their first living example, drawn up by the celebrated naturalist Temminck, formerly director of the Leyden Museum. Temminck named the animal *Antelope crispa*, from the rough coat of hair which covers it, and tells us that it inhabits the higher alps of the Japanese Islands Nippon and Sikok, and is known to the Japanese as the "Nik." But a more complete account of its habits has lately been published by Capt. H. C. St. John in his recently-issued "Notes and Sketches from the Wild Coasts of Nipon." Capt. St. John tell us that the Japanese chamois, as he calls it, "is a very difficult animal to find, and to bag when found; they keep to the highest mountains, and to the highest and must rugged peaks of these ranges. I have hunted them with the natives, and with their dogs, and this often; and yet only once, although often close to the creatures, have I had a

[1] Continued from p. 417.

glimpse of one, much less a shot. On one occasion I was lucky enough to see one, and this was by mere accident, and when not in search of game. I have often been told fabulous stories about the Nigou, the native name for this wary animal. They were supposed to have one horn, and to use this single frontal ornament as a means of hanging on to trees as well as in self-defence. After some years of anticipation and endeavour to get even a dead specimen, I got a couple, and then, strange to say, several others were brought to me. A young male, alive, was caught, after its mother was shot. Only one specimen of all that were brought to me by the native hunters had both their horns intact—always one, and often both, being more or less broken. In hunting them with dogs, it soon became evident why this was so generally the case. The Japanese, who knew the animal's habits intimately, invariably placed me near some huge bare slab of rock, on which the Nigou, when pressed

FIG. 6.—The Japanese Goat-Antelope.

by the dogs, was expected to appear, and on looking at these slippery sloping platforms, I tried to conjecture—when waiting for the animal to appear—where, if I knocked one over, it would tumble, and what shape or form it would be in by the time it stopped. I could then easily understand why the horns were usually so damaged.

"I have no doubt also they are often caught in the bushes or trees by the slightly turned-back horns, on their falling and reaching the foot of these rocks; hence the origin of the story of their holding on to the trees.

"The young one which was brought to me alive was the most fierce little thing I ever saw. Any dog, large or small, that approached its cage, down went its head, and with a quick sudden spring the creature invariably came bang up against the wooden bars. Its horns were about two inches long, as sharp as needles, and quite capable of inflicting a very nasty wound.

"The colour of the 'Nigou' is a brownish slate; the older they get the lighter-coloured they become. Until I actually had one in my hands, I was unable to decide whether they had a beard or not, and was pleased to find they do not possess this ornament—therefore they are true antelopes, and not goats."

For their unique specimens of this scarce animal the Zoological Society are greatly indebted to the energetic co-operation of one of their Corresponding Members, Mr. H. Pryer of Yokohama, Japan, by whom it was transmitted as a present to the Collection in April, 1879. The animal was then quite young, but has now attained full stature, and presents a very singular and characteristic appearance—quite different from that of either goats or antelopes—which is well shown in Mr. Smidt's drawing (Fig. 6).

The goat-like or mountain antelopes, to which the presents animal belongs, constitute a small group of the family Bovidæ, which is distributed over the mountain chains of Eastern Asia and its islands. The nearest geographical neighbours of the Japanese animal are *Capricornis Swinhoii* of Formosa, and *C. caudata* of China. In the Himalayas the genus is represented by *C. bubalina*—the Thaar or Tahir of Indian sportsmen, and in the higher ranges of Sumatra by *C. Sumatrensis*. In the Rocky Mountains of North America is found a far-separated member of the same group, which is known as the "Mountain Goat" by the American hunters (*Antilocapra Americana*). Our European Chamois (*Rupicapra tragus*) is not very distantly related to these animals.

7. Lühdorf's Deer (*Cervus Luehdorfi*).—The existence in North-Eastern Asia of a large deer of the same form as the North American "Wapiti" has long been known, although the animal has never been very clearly identified. By some authors it seems to have been referred to the Red-deer (*Cervus elephas*), by others to the Persian Deer (*C. Maral*), whilst the horns upon which the name *Cervus eustephanus* was founded by Blanford (in the Zoological Society's *Proceedings* for 1875) appear to belong to the same species. It is only quite recently however that examples of this fine animal have reached Europe alive, and its form and characters have become better known. In the autumn of 1876 two pairs of this deer were sent by Herr Lühdorf, the German Consul at Nicolajefsk, on the Pacific coast of Siberia, as a present to the Zoological Garden of Hamburg. They had been brought down the river Amoor from the far interior, having been obtained from some Nomads in the Bureati Steppe of Northern Mantschuria. The strangers throve well in their new quarters at Hamburg under the care of Director Bolau, and propagated their species. Several male fawns having been produced, one of them was parted with in exchange to our Zoological Society in London, and received in the Regent's Park in May last. From the specimen thus obtained, which is at present unique in this country, the accompanying illustration has been prepared.

It will be at once evident to those who are acquainted

with the various forms of true deer, that the new stag from Amoorland is exceedingly like the Wapiti. The resemblance indeed of the two animals is so close that except for the character of the horns it would be exceedingly difficult to distinguish them. But so far as can be ascertained from an examination of the present specimens, which is now believed to be nearly four years old, and from the particulars given of other horns by Dr. Bolau in his description of the present animal,[1] Lühdorf's deer, as regards the character of its antlers, more nearly resembles our red deer than its American ally.

The discovery of a deer so closely allied to the Wapiti in Eastern Asia is a fact of special interest in geographical distribution. Taken in connection with other similar phenomena which have lately come to light, it tends to show very evidently that Northern America owes its many resemblances to the Palæarctic fauna, not to any former land connection between Europe and North America, as was formerly supposed by the advocates of the fabulous "Atlantis," but to a bygone extension of land between Eastern Asia and Western America. By some such passage there can be little doubt that the ancestors of the Wapiti, the American Bears, the Mountain Goat, and the Rocky Mountain Sheep found their way into the New World, to the more original fauna of which they have no sort of relationship.

FIG. 7.—The Lühdorf's Deer.

METEOROLOGY IN MEXICO[2]

THE intertropical position of Mexico, on a high plateau between two continents and two vast oceans, renders the investigation of its meteorology peculiarly interesting. It is now more than four years since this problem was begun to be worked out with no little ability by the Mexican meteorologists, and, when the resources of the country are taken into account, with a spirit and liberality deserving of every commendation. This praise will not appear overstrained when we say that we have now before us for the city of Mexico a statement of the pressure, temperature, humidity, clouds, rainfall, direction and velocity of the wind, ozone, and other miscellaneous phenomena for every hour of the night as well as of the day, from March 6, 1877, down to October 16, 1880; and on the same sheet, in addition to the above, a daily statement of the chief meteorological elements for some thirty stations situated in various parts of Mexico, and at heights varying from 7 to 8189 feet above the sea. Annual *résumés* are also before us, that for 1879 having been received some time since.

During 1879 the mean atmospheric pressure at Tlacotalpam, situated near the sea and only 11 feet above it, was 29·938 inches, rising to the maximum, 30·075 inches in January, and falling to the minimum 29·851 inches in August. This seasonal distribution of the pressure holds good till the more elevated stations are reached, when pressure remains pretty constant during the year. This peculiarity becomes strongly marked at Zacatecas, the highest station, 8189 feet above the sea, where the January and July pressures are the same, and the lowest mean, that of March and August, falls only 0·016 inch below the annual mean, and the highest, that of November, rises only 0·024 inch above it. At all the stations the singular protrusion of a high pressure into the Atlantic and adjoining regions in the height of summer is represented in the means.

Of the greatest possible interest are the curves of the diurnal oscillations of the barometer, deduced from the hourly observations at the central station at Mexico, these curves being quite distinct, so far as we are aware, from the curves of any other intertropical place for which observations exist. The peculiarity lies in this, that while the morning maximum and the afternoon minimum remain large at all seasons, the morning minimum diminishes in amount as the summer advances; and during the strictly summer months it does not even fall so low as the daily mean. Now this is an outstanding peculiarity of the curves of diurnal pressure in the extra-tropical inland region of the great Europeo-Asiatic continent, and it becomes the more pronounced the more we advance into the interior of that continent. This result, viewed in connection with the other diurnal curves, forms a very valuable contribution to this difficult branch of the science.

The mean temperature for 1879 at Mexico, 7434 feet high, was 59°·5, May being the warmest month, 64°·6, and December and January the coldest, 55°·4; and these were generally the months of extreme temperature over the

[1] *Abh. d. Nat. Vereins zu Hamburg*, 1880, p. 33.

[2] "Datos Meteorologicos: Resumen de las Observaçiones practicadas en varios Lugares de la República durante el Año de 1879." (Por el Ingeniero Civil V. Reyes. (Mexico, 1880.) "Boletin del Ministerio de Fomento de la República Mexicana." Tom. ii. iii., iv v.

different districts of Mexico. The period of the year when temperature is highest is also the period when the air is driest, the mean relative humidity of Mexico for April and May for 1878 and 1879 being only 42. The mean temperature of Tlacotalpam, the lowest station, was 77°·5, and of Zacatecas, the highest from which mean temperatures are published, 61°·7. The difference of the two is thus 15°·8, and as the difference of height is 8178 feet, the fall of temperature with the height is comparatively slow, being only one degree for each 518 feet.

At Mexico during 1879, out of the 8760 observations made of the wind, 4156 cases were reported as calm, being nearly a half of the whole of the observations. By far the most frequent wind is the north-west, which was observed 1299 times; next follow the north-east, 789 times, and north 636 times; and the least frequent, south, 174 times, and south-west 278 times. As regards direction, the prevailing winds at Mexico were a point to the north of east in February and March, from which they gradually worked round to north-east in the beginning of May, north in July, north-west in September, thence again to north in the end of November, and back to east in February. On these changes of the wind, considered with reference to the Gulf of Mexico and the Pacific, largely depends the rainfall. The rainy season extends from about the middle of May to the end of October; but at eastern stations showers are of not infrequent occurrence from November to April, when prevailing winds are northerly and easterly. The largest annual rainfall was 89·16 inches at Tlacotalpam, and the least 15·66 inches at San Luis Potosí. Thunder and lightning are of common occurrence during the summer months, these phenomena occurring on 66 per cent. of the days during June, July, and August. During the five months from December to April thunderstorms occur only on 7 per cent. of the days. The position of Mexico, as already stated, marks it out as a region peculiarly suited for the investigation of some of the more interesting meteorological problems, particularly those which concern the vertical distribution of the phenomena, in connection with which an increase to the number of low-level stations on the Gulf of Mexico and the Pacific sea-boards is very desirable.

ON THE IDENTITY OF SOME ANCIENT DIAMOND MINES IN INDIA, ESPECIALLY THOSE MENTIONED BY TAVERNIER

HAVING recently endeavoured to correlate the diamond deposits of India, I have been surprised to find what a mass of contradiction exists in both Indian and English literature as to the identity of some of the most famous mines which were worked little more than 200 years ago.

In this brief account I propose to give results, not the steps which have led me to them. Tavernier about the middle of the seventeenth century visited and described three diamond-mines, which were named respectively Raolconda in the Carnatic, Gani, called Coulour by the Persians, and Soumelpour on the Gonel River.

Raolconda, Tavernier says, was five days distant from Golconda and eight or nine from Bijapur, and most writers with signal unsuccess have tried to fix it accordingly. But elsewhere Tavernier gives nine stages, aggregating probably 189 miles, on the road from Golconda to Raolconda, so that in the first statement the distances were probably transposed. With these new indications we are led to an old town called Rawdukonda, lat. 15° 41′, long. 76° 50′. I have not yet succeeded in obtaining any independent testimony of the existence of diamond-mines at this locality, but hope to be able to hear more about it ere long.

Gani, or Coulour, where Tavernier says the Great Mogul diamond was found in the sixteenth century, has been variously located by authors, being supposed by many to be identical with Gani Purtial, on the Kistua River; but I am satisfied from the evidence afforded by old maps that it is to be identified with Kollur, lat. 16° 42′ 30″, long. 80° 5′, which is also on the Kistna, about twenty-six miles further to the west. Now as to this word Gani, which has been treated of as a proper name, its recurrence in connection with two different localities suggests that it means mine. In fact since G and K are interchangeable letters in some Indian languages we should probably read for Gani *Kan-i*, or the mine of Purtial or of Kollur.

If, as seems most probable, the Koh-i-nur is identical with the Great Mogul diamond described by Tavernier, and that the great age claimed for it by the Hindus is to be regarded as mythical, then in fact for the first time the identity of the source from whence this famous diamond was obtained may be regarded as settled. Maps of the eighteenth century indicate diamond mines at Gani (*i.e.* Kan-i) Kollur, though local memory of their former existence appears to have died out.

Soumelpour, on the Gonel River of Tavernier, has generally by recent authors been identified with Sambalpur, on the Mahanadi, in the Central Provinces. But Tavernier's somewhat precise indication of its position has led me to the conclusion that it was situated much further to the north, namely, in the valley of the Koel River, a tributary of the Sone. At about the distance stated by Tavernier (which I calculate to be the equivalent of eighty miles), to the south of the well-known fortress of Rhotas, there are near the banks of the Koel River (*i.e.* Tavernier's Gonel) the remains of an ancient town called Semah, which word is identical with *Semul* (the native name of a species of cotton-tree, *Bombax Malabaricum*), Semulpour, or the town of the *Semul*, is therefore, it seems probable, Tavernier's Soumelpour. The position of Semah is lat. 23° 45′, long. 84° 21′; it is included in the sub-division of Palamow, in the Chutia Nagpur Province. There is independent evidence of important diamond mines having existed in a neighbouring part of Chutia Nagpur in the sixteenth century, but there have been none in operation there for many years.

The last locality is Beeragurh, which is mentioned in the *Ain-i-Akbari*, and also in several other native writings. This is unquestionably identical with the modern Wairagarh in the Chanda district of the Central Provinces, where excavations locally known to have been diamond mines are still to be seen. Wairagarh is in lat. 20° 26′, long. 80° 10′. Many allusions which I believe to refer to this locality might be quoted. One of the fifteenth century by Nicolo Conti is of especia interest. He says that at Albenigaras, fifteen days journey north of Bijapur (Bijengalia), there is a mountain which produces diamonds. The method of obtaining them, which he describes on hearsay, is similar to that of the celebrated Arabic myth which the travels of Sindbad the sailor and of Marco Polo have made familiar to every one.

The idea of the diamonds being collected by throwing pieces of meat freshly cut from a slaughtered cow or buffalo into a valley inhabited by venomous serpents, which pieces, with diamonds sticking to them, were picked up by birds of prey and recovered from them by the diamond-seekers, probably took its rise from some sacrificial custom in connection with the worship of the sanguinary goddess of riches, whom Heyne ("Tracts," p. 95) alludes to under the name of Ammarwaru, as the partners of the mine. The pieces of meat cut from the victim were probably thrown about over the ground, and were naturally picked up and carried off by the birds. This I believe to have been the foundation upon which the fabulous superstructure was erected.

Beeragurh, or Wairagarh, is, as the crow flies, about 324 miles from Bijapur, northwards, and the distance might therefore have been accomplished in fifteen days.

In the name *Al*benigaras there is sufficient resemblance to the name Beeragurh with the Arabic prefix *Al* to make it probable that they were identical. V. BALL

Calcutta, January 12

NOTES

WE hear that good progress is being made with the reprint of the late Prof. A. H. Garrod's scientific papers, the publication of which may be expected early in the summer. It will form a volume of about 500 octavo pages, illustrated by more than thirty plates and about 200 woodcuts. Mr. Hubert Herkomer, A.R.A., the well-known artist, has most kindly undertaken to execute an etching of the late professor, as a frontispiece to the volume. The edition will be limited to a very small number of copies only, most of which are already subscribed for. Those who wish to add their names to the list of subscribers before it is closed, are requested to communicate at once with the secretary of the Garrod Memorial Fund, 11, Hanover Square, W., who will also be glad to receive subscriptions already promised. Cheques to be crossed "London and County Bank, Hanover Square."

WRITING to the *Times* on Friday last, Mr. Sclater calls attention to the fact that the collection of birds of the late John Gould, the ornithologist, had been offered to the Trustees of the British Museum for 3000*l.*, and expressed a hope that there will be no difficulty on the part of the Treasury in sanctioning the expenditure. The collection is stated to embrace about 1500 mounted and 3800 unmounted specimens of humming-birds, being the types from which the descriptions and figures in the celebrated "Monograph of the Trochilidæ" were taken. There are besides 7000 other skins of various groups, amongst which are splendid series of the families of Toucans, Trogons, Birds of Paradise, and Piltas.

THE following course of lectures will be given by Members of the Committee on Solar Physics appointed by the Lords of the Committee of Council on Education:—An Introductory Lecture, by Prof. Stokes, Sec. R.S.; April 6. A Lecture on the Practical Importance of Studying the Influence of the Sun on Terrestrial Phenomena, by Lieut.-General Strachey, R.E., C.S.I., F.R.S.; April 8. Two lectures on the Connection between Solar and Terrestrial Phenomena, by Prof. Balfour Stewart, F.R.S.; April 27 and 29. Six lectures on Spectroscopy in relation to Solar Chemistry, by Mr. J. Norman Lockyer, F.R.S.; May 4, 6, 11, 13, 18, and 20. Three lectures on the Photography of the Infra-red of the Spectrum in its Application to Solar Physics, by Capt. Abney, R.E., F.R.S., May 25 and 27, and June 1. The lectures will be delivered in the Lecture Theatre of the South Kensington Museum at 4 p.m. on the days stated above. Admission will be by tickets, which may be obtained, as far as there is room, on application by letter to the Secretary, Science and Art Department, South Kensington, S.W.

WE must remind our readers that the French Association will hold its next session in April at Algiers, beginning on the 14th. Those who have been enrolled members will have the advantage of half price for railway travelling, and of a special steamer from Port Vendres to Algiers. This ship will leave Marseilles on the 11th, calling at Port Vendres on the 12th. The lists were closed some time ago, but by addressing, without loss of time, M. Gariel, General Secretary of the Association, Paris, Rue de Rennes, all particulars relating to the excursions, which are very numerous and attractive, some of them including a tour in the Algerian Sahara, will be given. An industrial exhibition has been organised in Algiers, with races, *fêtes*, and inauguration of the Algerian Institute, which is directed by M. Pomel, Senator. Mr. F. Maxwell-Lyte, Hon. Foreign Secretary of the Association, Science Club, Savile Row, will be happy to afford further information to intending English visitors.

THE arrangements for the International Medical and Sanitary Exhibition are progressing so satisfactorily that it promises to be the most important Sanitary Exhibition hitherto organised in this country. Applications for space are now being rapidly sent in, as the 31st inst. is the last day fixed by the Committee for receiving them. Up to March 15 applications for 984 feet had been received by the Committee. The Certificates of Merit which are to be given will be valuable awards to the public and to the successful exhibitors on account of the high character of the list of jurors, which already includes among many other the following:—Medical Section: Christopher Heath, F.R.C.S., Wm. S. Playfair, M.D., Charles Higgins, F.R.C.S., Chas. S. Tomes, F.R.S., Prof. John Marshall, F.R.S., Dr. Robert Farquharson, M.P., the president of the Pharmaceutical Society, C. H. Golding-Bird, F.R.C.S., Lionel Beale, F.R.S., W. B. Carpenter, C.B., F.R.S., J. S. Bristowe, M.D., Major Duncan, R.A., Surgeon-General Longmore, C.B., E. H. Sieveking, M.D., &c., &c.; Sanitary Section: Sir Joseph Fayrer, K.C.S.I., M.D., F.R.S., Geo. Aitchison, F.R.I.B.A., Edwd. C. Robins, F.S.A., T. Roger Smith, F.R.I.B.A., F. J. Monat, M.D., Alfred Waterhouse, A.R.A., Capt. Douglas Galton, C.B., F.R.S., Ernest Hart, M.R.C.S., Prof. Corfield, Wm. Eassie, C.E., Roger Field, M. Inst. C.E., R. Thorne Thorne M.B., Prof. Prestwich, F.R.S., &c., &c. In addition to the interest taken in the Exhibition by medical men, architects, and manufacturers, the general public have recognised the importance of the work thus initiated by the Executive Committee of the Parkes Museum of Hygiene by subscribing to the Guarantee Fund, which at the meeting of the Committee last Tuesday was reported to amount to 1026*l.* 7*s.* At this meeting the Secretary read a letter from Mr. MacCormac, the Hon. Sec. General of the International Medical Congress, forwarding the following resolution which had been unanimously passed by the Executive Council of the International Medical Congress at their last meeting:—"That the sum of fifty pounds be guaranteed to the Committee of the International, Medical, and Sanitary Exhibition, to be held at South Kensington in connection with the Parkes Museum of Hygiene, on the occasion of the International Medical Congress."

THE programme for the annual meeting of the Iron and Steel Institute on the 4th, 5th, and 6th of May has just been issued. The first item on the programme is the presidential address of Mr. Josiah T. Smith, the president-elect, whose experience as one of the earliest and for many years one of the largest stee manufacturers in this country, and as the head of the most extenworks of their kind in the world, will give his address an exceptional interest. The papers to be read cover pretty fairly the whole field of the manufacture and application of steel for shipbuilding purposes. A paper will be read by Mr. Alexander Wilson of Sheffield on the manufacture of armour plates. The subject of the manufacture of steel and steel plates will be dealt with by Mr. Sergius Kern of Russia, who will describe improvements recently practised in Russia; while the experience lately gained in the practical use of steel for shipbuilding purposes will be dealt with in a paper by Mr. Denny of Dumbarton, at whose works on the Clyde a considerable amount of steel shipbuilding has been turned out during the last two years. The important question of the relative corrosion of iron and steel will be discussed by Mr. William Parker of Lloyd's. Another paper is promised by Capt. Jones, manager of the Thomson Steel Works, Pittsburg, on the manufacture of Bessemer steel and steel rails in America.

SCIENTIFIC honours are being paid to John Duncan, the weaver botanist. Recently the Inverness Scientific Society and

Field Club elected him an honorary member with a gift of 5*l.*, and the Banff Field Club gave 1*l.* 1*s.* When his story was first told by Mr. Jolly in *Good Words* in 1878, the Largo Naturalists' Society, one of the most active in the country, elected him an hon. member. The Edinburgh Field Naturalists' Club have lately issued a special circular and appeal on his behalf. Last week he was elected an hon. member by the Aberdeen Natural History Society, when a sketch of his life was given by Mr. Taylor, one of his pupils. Miss E. Brown has sent us 1*l.* for the John Duncan Fund.

WE see from a long article on the subject in the New York *Nation*, that the "Reports on the Total Solar Eclipses of July 29, 1878, and January 11, 1880, issued by the U.S. Naval Observatory," have appeared. We have not received a copy of the work yet, but from the article in the *Nation* it is evidently a valuable contribution to some of the questions suggested by solar eclipses.

THE Commission Supérieure of the Paris Electrical Exhibition has already deliberated on all the demands sent by French electricians. The utmost liberality has prevailed, and only a few technical questions have been reserved for more mature deliberation. But the authorisations will not be made definitive until after April 1, when the list of would-be exhibitors will be closed. The resolution of the Society of Telegraph Engineers and Electricians to organise the English section has been received with great satisfaction.

WE take the following from the *Gardener's Chronicle*:—Dr. Aitchison, Surgeon-Major in the Punjaub army, whose collections in the Kurrum Valley we alluded to on a former occasion, has returned from Afghanistan with another extensive collection of dried plants, and is now at Kew engaged in working them up. Amongst other interesting museum objects Dr. Aitchison has brought home specimens of *Chamærops Ritchieana*, a palm that covers miles of the alluvial plains with a dense bushy thicket. Frequently too it occurs as a branching tree fifteen to twenty-five feet high, but then usually in the vicinity of other trees or buildings. Dr. Aitchison's specimens illustrate this peculiarity exhibited by comparatively few other palms.

WE are glad to learn that the museum building begun some time ago under the auspices of the Perthshire Society of Natural Science is approaching completion. To equip and endow the museum a bazaar will be held in Perth towards the end of the year.

THE translation of Nägeli and Schwendener's treatise on the Microscope is approaching completion. Messrs. W. Swan Sonnenschein and Allen now announce its speedy issue to the public, which they trust will be effected during the present spring. The English editors, whose names will appear on the title-page, are Mr. F. Crisp (Secretary of the Royal Microscopical Society) and Mr. J. Mayall, jun., F.R.M.S., though several others have collaborated in the work. Messrs. Sonnenschin and Allen also announce for immediate issue an illustrated "Manual of Insects Injurious to Agriculture," by E. A. Ormerod, whose "Report of Injurious Insects for 1880" we reviewed in a recent number; and a second edition of "Prantl's Text-Book of Botany," by Vines, greatly revised, the first edition of which appeared last year.

WHERE is Mackay? "Here," we fancy a score of our readers will reply; but none of them would be "the real Mackay," as they say in the North, at least not the Mackay whose local habitation we inquire after. Happily we can answer our own question from the Christmas number of the *Mackay Standard*, a fact that shows that our Mackay must be considerably to the fore somewhere. "Mackay, according to the single archive at present extant to which we have been able to attain access, was first discovered by a gentleman of the name of Mackay, a Scotchman as his name would denote. That this is correct is more than probable, but it does not appear that, beyond giving his name to the place, he ever did anything to render himself famous. It may accordingly be accepted as a fact that he discovered the existence of the Pioneer River on which the town is situated, and the date of this discovery is placed at 1861, so that within a few days Mackay is twenty years of age. The Mackay District is in latitude 21° 10′, and is situated at a distance of 625 miles to the north-west of Brisbane, on the Pioneer River." So then Mackay is nobody at all, but a flourishing new town (it would be a "city" in the States) in Queensland, with shipping and wharves and warehouses, and prosperous sugar-mills, and "Clifton-on-the-Sea," a fashionable summer resort of the Mackayites, twelve miles off. The municipality (3450 acres) is said to have fifty miles of streets under its control; there is nothing said about houses, so most of them may not have left the quarry or the brick-kiln yet. The population of the district is given as 7500.

ON Friday will take place at Père Lachaise the inauguration of the monument erected by public subscription to Crocé-Spinelli and Sivel, the two victims of the tragic *Zenith* ascent. Speeches will be delivered by M. Paul Bert, Professor of Physiology to the Sorbonne, who organised the ascent; M. Hervé Mangon, director of the Arts-et-Métiers, who was the president of the Société de Navigation Aérienne, then in office; and M. Gaston Tissandier, who was a party in the ascent, and escaped by a marvellous concurrence of circumstances.

ON Wednesday last week at 12.10 a.m. another shock of earthquake was felt at Casamicciola and Lacco Ameno. All the people fled to the open country; much consternation exists, as the people fear other shocks. Little damage was done, only a few injured walls and a tile factory have fallen. Vesuvius quiet.

A RATHER severe shock of earthquake was felt at Agram on March 17 at 3h. p.m., duration two seconds. It was accompanied by wave-like motions of the ground.

IT is announced that the entire length of the St. Gothard Railway between Airolo and the Lago Maggiore will be finished by the end of June; but the great tunnel, owing to difficulties about the vaulting, cannot be completed before November.

THE Conseil d'Hygiène of Paris has just issued a large 4to volume of 700 pages recounting all the precautions taken against several so-called "Industries Insalubres" practised in Paris. The work of the Conseil d'Hygiène extends over a period of five years, from 1872 to 1877, and relates to more than 200 industries in some of their essential details. Amongst the recommendations made are a refrigerating machine for dead-houses and a special establishment for cleansing contaminated objects with superheated vapours. Amongst the curious observations is the analysis of a parasitic vegetation developing on bread for the military. It appears the original sporulæ were brought from Germany by soldiers taken prisoners in the Franco-German war, returning home.

AS the preparation of dynamite has acquired great importance, M. Gobi shows (*Memoirs* of the St. Petersburg Soc. of Nat.) that formerly the best dynamite was made with the "Kieselguhr" of Hanover, which can absorb as much as 75 per cent. of nitroglycerine, but is now made with the diatomaceous deposits from Randanne, in the department of Puy-de-Dôme, which can absorb from 73 to 78 per cent. of nitroglycerine. It is worthy of notice that both these formations have been described by Ehrenberg. It is obvious that the good quality of dynamite prepared from these two deposits depends upon the porosity of the small *débris* of the frustules of the microscopical diatoms, and that, when determining the qualities of a diatomaceous

deposit, we must take into account not only its purity, but also the size of the diatomaceæ it contains; thus, M. Gobi recommends especially those deposits which contain mostly frustules from the species of *Epithemia*, *Navicula*, *Synedra*, and *Melosira*, their frustules being of a greater size and more porous than those of the *Fragillaria*, *Cocconeis*, *Nitzschia*, &c. As to the use of pounded coal or bricks, and of sand, it ought to be quite given up.

AT the Annual Meeting of the Davenport (U.S.) Academy of Sciences on January 6 a very satisfactory report was given of the condition of the Society and of the good work it is doing. The president gave an address, in which he sketched the progress which has been made in a knowledge of the Mound Builders, the prehistoric people of the Mississippi Valley, to whose remains the Academy has all along devoted special attention.

A SMALL well-printed *in memoriam* volume on the late Prof. Benjamin Peirce has been issued at Cambridge, Mass. It consists of the various notices, poems, addresses, &c., that appeared in consequence of his death, including three funeral sermons.

THE third *Annual Report* of the Dulwich College Science Society speaks hopefully of its condition. The Society has been steadily progressing, and has already collected a museum "which would do credit to many an older society." The *Report* contains abstracts of several of the papers and lectures given during the year.

AN encouraging Annual Report (the forty-seventh) has been sent us from the York School Natural History Society; all its sections have evidently been doing well. In connection with this we are glad to notice that, under the title of the *Natural History Journal and School Reporter*, the journal conducted by the Societies in Friends' Schools has assumed a new and more attractive form, at the same time that its programme has been somewhat extended. The two numbers for February and March contain some creditable original papers.

A SECOND edition of Mr. W. C. Wyckoff's "Silk Goods of North America" has been published; the first edition was noticed in NATURE, vol. xx. p. 574.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by Mr. C. Drake Sewell; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mrs. Fuller; a Common Badger (*Meles taxus*), British, presented by Mr. Rocke; a Black-winged Peafowl (*Pavo nigripennis*) from Cochin China, presented by Mr. J. Marshall; a Rough-eyed Cayman (*Alligator sclerops*) from South America, presented by Mr. Arthur C. Ponsonby; a Horrid Rattlesnake (*Crotalus horridus*) from Brazil, presented by Mr. C. A. Craven; a Jararaca (*Trigonocephalus atrox*) from Brazil, presented by Dr. A. Stradling, C.M.Z.S.; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; a Goral Antelope (*Nemorhædus goral*), two Bar-headed Geese (*Anser indicus*) from India, purchased; a Javan Chevrotain (*Tragulus javanicus*) from Java, a Red Bird of Paradise (*Paradisea sanguinea*), a Twelve-wired Bird of Paradise (*Seleucides albus*), a Manucode (*Manucodia atra*) on approval.

OUR ASTRONOMICAL COLUMN

THE SOLAR PARALLAX.—In a communication to the Academy of Sciences of Paris on the 7th inst., M. Puiseux has discussed the observations of internal contacts during the last transit of Venus, which were made at stations occupied by the French expeditions. These include observations of second and third contacts at Pekin, St. Paul, Nagasaki, Saigon, and Kobé, and of second contact at Noumea. Seventeen equations are furnished by these data, and various combinations are made by Halley's method and by the method of Delisle. The former method supplies twelve separate results, the concluded parallaxes varying from 8″·78 to 9″·17, which are arranged according to the amount of the parallax factor: the simple arithmetical mean is 8″·98. On Delisle's method the combinations for second contact give fourteen values between 8″·86 and 9″·20, of which the mean is 9″·01, and those for third contact furnish ten values between 8″·63 and 8″·90—the mean being 8″·92. These figures considered with respect to others which have been obtained from observations of the same transit and on other methods, cannot be said to enlighten us materially as to the true amount of the sun's mean parallax. M. Puiseux thinks the observations of contact in 1874 have not given results so accordant as astronomers had looked for, but he nevertheless is far from discouraging efforts to secure observations of contacts in 1882; the phenomena in 1874 did not present that geometrical simplicity which had been formerly expected, but presented a succession of phases which were the more difficult to identify in the records of the observers according as the telescopes employed were more dissimilar; and he urges (1) that the different stations should be provided with telescopes of large aperture, to be employed under as identical circumstances as practicable, and (2) that the observers should be exercised "à l'aide d'appareils convenables," to appreciate in the same manner the appearances which the contacts may offer. The former consideration at least is too well understood as of paramount importance to be likely to be overlooked by any of the national committees now engaged in arranging for the most efficient observation of the transit in 1882.

VARIABLE STARS.—Minima of Algol occur by Schönfeld's formula on April 3 at 10h. 51m. G.M.T., and April 6 at 7h. 40m., and the next series observable in this country commences on May 13 at 14h. 17m.

In the uncertainty that exists with respect to the period of Ceraski's circumpolar variable, the following calculated times of minima are only to be regarded as rough indications:—

	h. m.		h. m.
April 3 ...	12 56 G.M.T.	April 18 ...	11 58 G.M.T.
8 ...	12 37	23 ...	11 38
13 ...	12 17	28 ...	11 19

A constant period of 2·49326 days is here assumed. Prof. C. H. Peters publishes details of his observations of a number of new variable stars (*Astron. Nach.*, No. 2360), and Dr. Dunér notifies the variability of the red star Schj. 57 *a*, which stands thus in the *Durchmusterung*:—

	h. m. s.		° ′
9·4m. ...	R.A. 5 17 32·7 ...	Decl. +	34 2·1

This star was invisible in the Lund refractor on January 20, but was well seen on February 23; in September and October, 1878, he had confirmed its fiery-red colour, and found the spectrum of the Class III. *b*. V Herculis varies from 8m. to 12m., and the period seems to be about 290 days; the next maximum may be expected in October of the present year.

ANCIENT ASTRONOMY.—In No. 2 of the new periodical, *Urania*, is an elaborate paper by Prof. Schjellerup of Copenhagen, "Sur le Chronomètre Céleste d'Hipparque," in which he discusses the question "Comment les anciens astronomes ont-ils déterminé l'heure de la nuit, et à quelle exactitude ont-ils pu parvenir?" In this paper he has calculated by the strict trigonometrical formulæ (an investigation of which is prefixed) the positions of the forty-four stars mentioned in the third book of the only work of Hipparchus which has descended to us. His "Three Books of Commentaries on the phenomena of Aratus and Eudoxus," printed for the first time in 1567 (Lalande, "Bibliographie," p. 91) from two manuscripts of the Biblioth. Mediceæ and the Library of the Vatican. Petau brought out a new edition, in which he availed himself of an ancient well-written manuscript preserved in the Bibliothèque Royale, and which forms part of the third volume of his "Uranologion." Prof. Schjellerup gives the Greek text essentially after the edition of Petau, with as nearly as possible a literal translation. He concludes his paper with the remark, "Dans l'état actuel on peut prouver que les Astronomes d'Alexandrie ont pu déterminer le temps sidéral presqu'à une minute près." It contains the right ascensions and declinations of the stars in question for every hundredth year, from −300 to +100, with the amount of proper motion to the respective epochs, and is a production which merits the attention of those who are interested in the Astronomy of the Ancients.

THE ACADEMY OF SCIENCES, PARIS.—At the annual public sitting of the Paris Academy on the 14th inst. the Lalande Prize

was awarded to Mr. E. J. Stone, director of the Radcliffe Observatory, Oxford, for his great catalogue of southern stars, involving newly-determined places of all the stars observed by the French astronomer Lacaille during his memorable visit to the Cape of Good Hope, in the years 1751 and 1752; the observations for the catalogue having been made while Mr. Stone occupied the position of Her Majesty's Astronomer at the Cape. The commission to whom the consideration of the award was referred consisted of MM. Faye, Mouchez, Lœwy, Janssen, and Tisserand, who have called attention in their Report to the "fundamental importance" of the Catalogue, in view of the study of the proper motions, &c., of the stars in the southern heavens.

At the same sitting the Valz Prize was adjudged to M. Tempel of Florence for his numerous cometary discoveries.

The Damoiseau Prize (10,000 francs) has been again proposed for 1882. It had been offered without response in 1869, 1872, 1876, 1877, and 1879; the subject on all occasions being the same and a very important one in the actual state of astronomy, viz., "To review the theory of the satellites of Jupiter, to discuss the observations and to deduce the constants which it contains, and particularly that which furnishes a direct determination of the velocity of light; and lastly, to construct special tables for each satellite."

BIOLOGICAL NOTES

ALGÆ OF THE GULF OF FINLAND.—M. Chr. Gobi made an excursion along the borders of the Gulf of Finland in the summer of 1879 with the object of investigating the algæ of this district. In spite of the weather being of the most unfavourable character he was enabled to work out the whole south-west coast of this district, from St. Petersburg to the comparatively open sea at Hapsal. Along the southern coast of the Island of Kotlin, on which Cronstadt is built, and also along the opposite coast shore at Oranienbaum, chlorophyllaceous algæ were almost exclusively met with, and these belonging to species to be also met with in the fresh waters of the adjoining lands, for example, three distinct species of Cladophora (among these *C. glomerata*), several forms of the genera Oedogonium, Spirogyra, Zygnema, and other filamentous Mesocarpeæ; various Desmidiaceæ (Cosmarium, Closterium, Scenedesmus), a much-branched, very fine, almost hair-like Enteromorpha (apparently *E. salina*), also various oscillatoriaceous forms and diatoms. Besides at Cronstadt an Ulothrix, more commonly in the early summer months, and a Merismopœdia (probably *M. Kützingii*) at Oranienbaum, the pretty *Spirulina Jenneri*, amidst various Oscillatoria, was met with, also Vaucheria, and in larger quantities *Hydrodictyon utriculatum*, in the various stages of development (middle of August). About seven versts west of Oranienbaum Tolypothrix was met with in some quantity, forming floating ball-shaped masses. By the end of July some excursions to the environs of Hapsal led to the discovery of the interesting Phœospore, which up to this had only once been found by Pringsheim at Heligoland, and called by him Streblonema; in Hapsal Bay it lived on Ruppia, several Charas, and in company on these with *Ulothrix confervicola*, which latter grew in great abundance on these plants and on Ceramia and other red algæ. It is interesting to note that along with marine forms there grew some of the fresh-water filamentous algæ, such as Spirogyra, Zygnema, and in large quantities that half fresh-water species *Monostroma Balticum*. Out in the bay towards the open sea the red algæ increased in number, but the merging of the fresh-water forms into those of a truly marine type could be well studied in the Bay of Hapsal. (*Botanische Zeitung*, February 20.)

THE "BLAKE" CRUISE.—Numbers 1 and 2 of volume 8 of the *Bulletin* of the Museum of Comparative Zoology at Harvard College contain preliminary reports on the Echini collected during the cruises of the *Blake*, by Alex. Agassiz, and on the Crustacea by Alphonse Milne-Edwards, have just reached us. The report on the Echini contains descriptions of thirteen new species belonging to such genera as Dorocidaris, Cœlopleurus, Asthenosoma, Phormosoma, Palæotropus, and Schizaster. Perhaps no group of animals has received such marked additions to its ranks through the deep-sea dredging expeditions. There was a time, and that not long ago, when we remember that the prevalent idea was that in this class new species were scarcely to be expected to turn up. Alphonse Milne-Edwards' report, of which the first part only is published, treats of the Brachyurous Decapods and of a portion of the Macrura. Many new genera and species are described, and several are figured. One very remarkable new genus, Corycodus, is formed to receive a somewhat mutilated example, which however exhibits characters different from any known Crustacea, belonging apparently to the family Dorripedæ. Its carapace is globular, and intimately connected to (soudée) the sternal plastron and between the insertion of the articulations of the first and those of the second pair of feet there is to be found a considerable space. Some very interesting new genera belonging to the Paguridæ are described. Among the new species of the Galatheadæ there are no less than eleven belonging to the genus Munida; and a new genus allied to Munida, Galathodes is described with ten new species. It is evident that the number of species belonging to the Crustacea have been very largely increased by the deep-sea exploration carried on by the United States Coast Survey-steamer *Blake*.

FOOD OF BIRDS, FISHES, AND BEETLES.—The State Legislature of Illinois authorised at its last session an investigation of the food of the birds of the State, with especial reference to agriculture and horticulture, and a similar investigation of the food of the fishes, with especial reference to fish-culture. As a result several Bulletins have been issued from the State Laboratory of Natural History, of which the last just received (No. 3) contains a report on the food of fishes by S. A. Forbes, the director of the Laboratory, the class especially reported on being the Acanthopteri, and another on the food of birds by the same. A very interesting series of notes on the food of predaceous beetles, by F. M. Webster, is added. Many species are proved to be vegetarians, sometimes doing the growing crops a good deal of mischief.

PHYSIOLOGICAL SIGNIFICANCE OF TRANSPIRATION OF PLANTS.—Prof. Weiss concludes from experiments (Vienna Acad. *Anz.*) that transpiration is only prejudicial to the functions of plants, excepting the process of lignification of the cell-walls, which it favours; hence it is to be regarded as a necessary evil for plants. Prof. Weiss also obtains striking evidence in favour of Wiesner's theory of heliotropism; and he seeks to prove that through transpiration certain inorganic constituents of the ground are carried to plants in excess, and are got rid of on the fall of leaves in autumn, and consequently that transpiration is also the cause of the influence exercised by the nature of the ground on the quantitative composition of the ashes of plants. The view that the stronger growth of non-transpiring plants is due to mere expansion of cells without simultaneous over-production of organic substances, is controverted.

SIGNS OF DEATH.—Observations with regard to the last manifestations of life in animals variously killed have been lately made by Drs. Verga and Biffi (*Real. Ist. Lomb. Rend.*). The following conclusions are arrived at:—1. in the higher animals, when sensibility, circulation, and respiration have ceased, the life of histological elements of the nervous centres, especially of the ganglionic system and the spinal cord, remains for a short time. 2. Contraction of the pupil and of the spleen are effects of this reduced latent life, and more remarkable effects, in guinea-pigs, rabbits, and cats, are the constant and uniform movements of inward curvature, which have the significance of respiratory efforts, presented under like conditions by the dog and the ass. 3. These movements appear in the animals whether drowned in water, or hung, or bled to death. 4. They indicate the point beyond which the organism loses the power of recovery.

CLASSIFICATION OF STATURES.—In view of the increasing need of exactness in anthropological descriptions, Prof. Zoja has lately proposed in the Lombard Institute a system of classification of human statures. He first constitutes three divisions, denoting by the terms *mesosoma*, *megasoma*, and *microsoma*, medium, high, and low stature respectively. At the ends of the series are added divisions for gigantic and dwarfish statures, *gigantosoma* and *nanosoma*. Each of these five classes is divided into three parts, on this plan: *medium mesosoma*, *hypermesosoma*, and *hypomesosoma*. To attach numerical values to all these fifteen divisions is more difficult. The author makes 2·00 metres the division between very high and gigantic stature, and gigantosoma ranges from that point up to 2·51 m. or more (hypergigantosoma). On the other hand 1·25 m. is made the limit between very low and exceptionally low stature; and nanosoma ranges from this to 0·74 or less (hyponanosoma). Medium stature (or mesosoma) ranges from 1·60 m. to 1·70 m.

EQUUS PRJEVALSKI.—The St. Petersburg Geographical Society has just published a pamphlet, by M. Poliakoff, on the

Equus Prjevalski, a new species of wild horse discovered in Central Asia. It was killed by hunters who were sent from the post of Zaisan, and its skull and skin were sent to the St. Petersburg Academy of Sciences. M. Poliakoff discusses at length the relations of this new species of horse to our domestic horses, and illustrates his memoir with drawings of the new horse and of its anatomical features.

SIR JOHN DALZELL'S ANEMONE.—Many of our readers will be glad to hear of the good health and wonderful activity of this celebrated sea anemone. From the annual address of the president of the Botanical Society of Edinburgh, as published in the recently issued part of this Society's *Transactions*, we learn that the late Dr. James M'Bain was the faithful custodian of that *Actinia mesembrianthemum*, which, among naturalists, has long borne the honourable appellation of "Granny," and which, though having entered upon her fifty-second if not her fifty-ninth year of existence, has not yet ceased to people the waters with her progeny, for from the 4th day of March, 1879, to the 4th day of October in the same year, on which occasion the last official registry of birth occurs, she has given origin to twenty-seven young ones. This is nothing to her prolific powers in 1857, for in one single night in that year she gave birth to no less than 240 young ones. This would have put Priam himself to shame, seriously alarmed Malthus, and taxed all the energy of all the accoucheurs in Edinburgh and its surrounding districts. She was gathered from the rocks at North Berwick by Sir John Dalzell, and at his death was handed over to the care of Prof. John Fleming, then to Dr. James M'Bain; he on the prospect of his decease was most solicitous to find a proper guardian for such a treasure. Some to whom he spoke declined to undertake so responsible a duty, till at last Mr. Sadler, the curator of the Royal Botanical Gardens at Edinburgh, cordially responded to the request, and when last heard of the old lady was doing well.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on March 14 Mr. James Stewart, C.E., of Livingstonia, read a paper on Lake Nyassa and the Water-route to the Lake-region of Africa. In his preliminary observations he remarked upon the fact that, though the lake is but 350 miles in length, no fewer than seven different languages are spoken on one side only, all belonging to the Great Bantu group, and that natives from the south end cannot understand those at the north end. He dwelt upon the advantages the Livingstonia missionaries enjoyed for performing geographical work at an exceedingly small cost, though their other duties prevented them from doing very much. Mr. Stewart afterwards gave an account of his journey up the western side of the northern part of the lake and thence to Tanganyika and back. During this he passed one stream, the Mera, which he thinks may be considered one of the most remote of the sources of the Congo. Mr. Stewart concluded by stating that he was shortly about to return to Lake Nyassa, where he hoped to have opportunities for resuming his geographical work in opening a route to the south end of Lake Tanganyika.

WE have the new numbers of several geographical journals before us. In the March number of *Petermann's Mittheilungen* Herr Richard Buchta describes his journey, in considerable detail, to the Nile Lakes in 1878. To accompany a map of the South Argentine Pampas Herr H. Wichmann summarises the latest information we have on that region. M. Sibiriakoff describes his journey in the *Oscar Dickson* to the mouth of the Jennissei in 1880. This number contains the geographical necrology of the past year, besides the usual monthly summary.—In the *Zeitschrift* of the Berlin Geographical Society Herr C. J. Büttner in a long paper gives some valuable directions for the study of the Bantu group of languages. Herr K. Himly has a short paper on some of the forms of Turkish, Mongolian, and Chinese names of places in books of geography. Herr Gustav Niederlein describes in a long paper some of the scientific results of an Argentine Expedition to the Rio Negro in Patagonia. Appended is a reproduction on a large scale of Dr. Kiepert's map of the new boundaries in the Balkan Peninsula.—In the *Verhandlungen* of the same Society is a paper by Herr K. Kessler on the Caucasus and their exploration, and some valuable remarks on the thickness of the ice formed each year in the Arctic regions, and its connection with Arctic temperatures.—The first number of vol. iv. of the *Deutsche geographische Blätter* (Bremen) contains a long paper by Dr. Lindemann on the woods of the Bavarian Spessart, and by the same author a summary of recent Arctic work.—To the December number of the *Bulletin* of the French Geographical Society M. De Castries contributes a paper on the region of the Wed Draâ; M. Ch. Velain, geological notes on Upper French Guana; and M. H. Duveyrier, on the question of the sources of the Niger.

DR. RAE sends us the following extract from a letter to him by Capt. Howgate, dated Washington, March 4, 1881:—"I write . . . to tell you that Congress has given the appropriation asked for the continuance of our work *viâ* Lady Franklin Bay, and also for an expedition *viâ* Behring Strait—ostensibly to look after the *Jeannette*, but also to prosecute the work of discovery in that direction. In addition to this it is propable that the Signal Service will this year establish the Point Barrow station, making a noble programme of Arctic work for the United States, and one in which I take just pride, for it is the direct result of my persistent work, since 1877, in raising public interest in the cause."

THE preparations for the commencement of the survey of Eastern Palestine are now complete. The War Office have granted to the Committee of the Palestine Exploration Fund the services of Lieut. Conder, who executed most of the survey of Western Palestine, and Lieut. Mantell, both of the Royal Engineers. The party will include the two non-commissioned officers (now both pensioners) Black and Armstrong, who first went out in the year 1871. Lieutenants Conder and Mantell started for Beyrout on Tuesday evening, March 15, and the men will follow with the instruments. The work will be commenced in the north—the land of Bashan.

FROM a Buenos Ayres paper we learn that the long-promised exploring expedition to Neuquen, the most fertile spot perhaps in all South America, and part of the territory secured by General Roca's memorable expedition, has at last started, and important results are expected from it. This territory lies along the foot of the Andes, is watered by innumerable streams flowing from the great range into the Rio Neuquen, one of the two rivers which form the Rio Negro, and presents facilities for agriculture unknown in any other part of the Republic.

THE current number of *Les Missions Catholiques* contains a long letter from Père Schmitt, written from Mboma on the Lower Congo, in which he describes a journey lately made to the foot of the Yellala Falls. He paid a visit to the station of the Livingstone (Congo) Inland Mission at Matadi or Matavi, which is situated on the left bank of the Congo, opposite Mr. Stanley's settlement at Vivi. Owing to the whirlpools in the river, landing at Matadi was accomplished with great difficulty. From Père Schmitt's account, the spot hardly appears to have been well chosen, being a melancholy sort of place, covered with rocks, as its name imports. The mission establishment consists of five or six tents, the interior of which reminded the visitor of a bazaar. On the return journey Père Schmitt spent a few days at Noki, where he had an opportunity of collecting information respecting the Congo region from the son of the king, who had been educated at St. Paul de Loanda.

ACCORDING to the *London and China Express*, the sole obstacle to the contemplated maritime surveying operations in China and Japan, under the direction of the United States Hydrographic Office, has been removed by the consent of the Russian Government to the occupation of an astronomical station at Vladivostock by United States naval officers. They are to proceed there at once, and by telegraphic exchange of time signals, working from Vladivostock through Japan and China to Madras, will determine with great exactness the longitudes of Yokohama, Nagasaki, Shanghai, Amoy, Hong-kong, Manila, Saigon, and Singapore.

THE Wellington correspondent of the *Colonies and India* states that the New Zealand Government have just succeeded in acquiring a large tract of land at Rotorua, in the famous Hot Lake district, every acre of which the Maoris have hitherto jealously preserved. Even now tourists from all parts of the world visit this wonderful and beautiful district, but, when it is made more accessible, it is thought that Rotorua will become a great sanatorium for India and the colonies.

KING OSCAR of Sweden has just conferred decorations on Prof. Virchow, Dr. Nachtigal, and Herr William Schönlank, in recognition of their services in the cause of geographical discovery and commerce.

DR. BAYOT has been deputed by the French Minister of Marine to explore the upper part of the Niger.

ON THE CONVERSION OF RADIANT ENERGY INTO SONOROUS VIBRATIONS[1]

MESSRS. GRAHAM BELL and Sumner Tainter (American Association for the Advancement of Science, Boston, August 27, 1880) have shown that under certain conditions intense rays of light, if allowed to fall with periodic intermittence upon thin disks of almost every hard substance, will set up disturbances in those disks corresponding to this periodicity which result in sonorous vibrations. Mr. Bell (*Journal* of the Society of Telegraph Engineers, December 8, 1880) has subsequently shown that such effects are not confined to hard substances, but that they can be produced by matter in a liquid or gaseous form.

These discoveries have elicited a considerable amount of interest, and have led to the inquiry whether the sonorous effects are due, as the discoverers themselves surmised, to *light*, or as the president of the Royal Society, Prof. Tyndall, and others have suggested, to radiant *heat*.

Messrs. Bell and Tainter have partially answered this question by showing that the disturbances are not necessarily due to light, for they found that sheets of hard rubber or *ebonite*—a substance opaque to light—do not entirely cut off the sounds, but allow certain rays to pass through, which continue the effect. M. Mercadier, who has studied the subject with great care (*Comptes rendus*, December 6, 1880), has shown that the effects are confined to the red and ultra-red rays. Moreover Mr. Bell has shown that gases, such as sulphuric ether, which Prof. Tyndall has proved to be highly absorbent of heat rays, while they are transparent to light rays, are remarkably sensitive to this intermittent action. Dr. Tyndall has more recently read a paper before the Society (*Proc.* Roy. Soc., January 3, 1881) proving that these sonorous effects are a function of all gases and vapours absorbing radiant heat, and that the intensity of the sounds produced is a measure of this absorption.

The negative proof of Messrs. Bell and Tainter can be rendered positive if it can be shown that ebonite is *diathermanous*.

By very careful experiments made upon the diathermancy of different materials, ebonite proved to be as diathermanous as rock-salt.

It is therefore clear that the sonorous vibrations of Bell and Tainter are the result of disturbances produced by some thermic action rather than by any luminous effect.

Now the questions arise, Is this thermic action expansion and contraction of the mass due to its absorption of heat? Or is it a disturbance due to molecular pressure similar to that which produces the rotation of the radiometer? Or is it due to some other cause?

The argument against the first assumption when applied to hard disks is that *time* is a material element in such actions, and that the rate of cooling of warmed diaphragms is too slow to admit of such effects. Lord Rayleigh (NATURE, January 20, 1881) has questioned the validity of this argument, and has shown that if the radiating power of the body experimented on were sufficiently high a slow rate of cooling would be favourable to rapid fluctuations of temperature. It became desirable to test this point experimentally. Very delicate apparatus was constructed for the purpose.

Heat from various sources and at various distances, from bright lime-light to dull heat from hot metallic surfaces, was allowed to fall through rotating vanes intermittently on different bodies; but notwithstanding every precaution, and the many materials used, not more than six interruptions per second could be produced, although the system was beautifully sensitive to the smallest changes of temperature.

It was evident from these experiments that the sonorous effects of hard disks could not be explained by the change of volume due to the impact of heat rays and their absorption by the mass of the disk.

Is the action then due to molecular pressure similar to that which produces the rotation of the radiometer?

It is quite true that the radiometer effect is one visible only in very high exhaustions, but Mr. Crookes (*Phil. Trans.*, 1878, Part i., § 220) detected "the existence of molecular pressure when radiation falls on a black surface in air of normal density."

Whenever radiant energy falls on an absorbent surface in air, such as a disk of blackened wood, its wave-length is degraded or lowered, and it is converted in thermometric heat. The molecules of air striking this warmed surface acquire heat, and move away from it with increased velocity, and as action and reaction are always alike in moving away, they give the body a "kick." Since there is no such action on the other side of the disk, there is a difference of pressure between the two sides which gives it a tendency to move away from the source of energy. The effect is very much smaller in air at ordinary pressures than in air at a very low vacuum, because in the former case the mean free path of the molecules is very small, and the rebounding molecules help to keep back the more slowly approaching molecules. Nevertheless, molecular pressure is experienced, and if of sufficient magnitude and rapidity, it ought to produce sonorous vibrations. It seemed probable that the element of time does not enter here so prominently as in the previous case, for the radiometer effect is a mere surface action of the disk, and not one affecting its mass. Hence it was hoped that the retarding effects would be eliminated. If the sonorous action, therefore, be due to a radiometer action, a difference of effect would be observed if the side of a disk *exposed* to the source of energy be either blackened by lamp-black or camphor carbon, or if it be polished or whitened.

An apparatus was constructed similar in principle to that described by Messrs. Bell and Tainter.

An ebonite disk well blackened on one side when exposed to the intermittent rays was found to produce sounds, while a similar ebonite disk equally well-whitened, gave slightly less intense sounds. A zinc disk blackened gave weak sounds, while a similar disk polished gave sounds much weaker. A mica disk blackened gave scarcely any sounds at all, while a clean mica disk gave slightly better sounds.

These effects were produced many times and on different occasions, and they were so unsatisfactory as to throw doubts on the accuracy of the radiometer explanation. They were not so decided as theory led one to anticipate. The effects produced by the zinc disk, though very weak, favoured the theory; those given by the mica disk completely refuted it; while those given by the ebonite disks were almost of a neutral character.

The question occurred whether in Bell and Tainter's experiments *the disks vibrated at all*.

A delicate microphone was fixed in various ways on the case holding the disks. Although the sounds emitted in the hearing-tube were quite loud, scarcely any perceptible effect was detected on the microphone. Had the disk sensibly vibrated, its vibrations must have been taken up by the case. A microphone never fails to take up and magnify the minutest mechanical disturbances.

It was thus evident that the disk did not play a prime part in this phenomenon, but that the result might be due wholly to an expansion and contraction of the air contained in the air space behind the disk.

With a new clean case and an ebonite disk the sonorous effects were feeble, but if a lens were placed close in front of the ebonite disk, so as to make a second air space in front of the disk, the sonorous effects were magnified considerably.

The ebonite disk was fitted with an extremely delicate microphone, which in this case gave good indications upon the telephone, but whether the vibrations were the results of the vibrations of the disk itself, or of the air in which the microphone was placed, was doubtful.

If the lens were removed and the disk left supported without any air cavity, either behind or in front of it, *no perceptible sound could be obtained*, proving that the effects were really due to the vibrations of the confined air, and *not to those of the disk*. It was therefore determined to dispense with the disk altogether. The disk was therefore removed, the lens remaining; the sonorous effects were *nil*.

Another case was taken under similar circumstances, i.e. *without the disk*, but the effects were very loud—60; in fact, the best results which had yet been obtained. Now the only difference between the one case or cup and the other was that the one *was blacked in the interior*, and the other was not.

Hence the former case was again taken without the disk, and though when clean it gave no effect, when its interior was blacked by camphor smoke, it gave sounds as strong as the loudest effect yet produced. It was thus evident that the sonorous effects were materially assisted by coating the sides of the containing vessel with a highly-absorbent substance, such as the carbon deposited by burning camphor. It remained to be seen how far the lens played a part in this phenomenon.

[1] Abstract of a paper by Mr. William Henry Preece, read at the Royal Society, March 10.

The lens was now removed from the front of the case, and it was replaced by a movable glass plate (1·5 millims. thick); the sounds were the same, but they gradually ceased on gradually uncovering the front opening of the case, so as to give the air room to expand.

The glass plate was replaced by a heavy rigid plate of rock-salt 13 millims. thick, and the sounds were equally loud. The plate was replaced by white note-paper. The sounds were very faint, but perceptible. It was replaced by thin cardboard, and the effect was *nil*.

Hence it is abundantly evident that these sonorous vibrations are due to the motions of the contained air, and not to those of the disk; that they are actually improved by the removal of the disk; that their production is materially assisted by lining the surface of the containing space with an absorbent substance; that they are dependent on the heat rays that pass through; and that they disappear when the rays are cut off from the air cavity by an athermanous diaphragm.

Dr. Tyndall having shown in the paper already referred to, that water vapour responded actively to these intermittent actions, a clean empty one-ounce glass flask was taken and exposed to the intermittent beams. No sound was produced.

It was then filled with water-vapour by pouring a small quantity of water into it, and warming it in a flame; fair sounds were the result.

The flask was filled with the dense smoke from burning camphor, and the sounds were intensified considerably.

Another clear one-ounce glass flask was taken. When clear no sounds were heard. When filled with tobacco-smoke fair sounds, but when filled with heavy camphor smoke very loud sounds were obtained. One side of the flask was blackened on the outside, the other side remaining clear. On exposing the clear side to the light fair sounds were obtained, but on exposing the blackened side, *no sounds were produced*. The flask was blackened *in the interior* on one side only. When the blackened side was near the source fair sounds, and when it was away from the source better sounds were heard. When the flask was cleaned all sounds disappeared. A thin glass plate was now blackened on one side and placed in front of the case. When the black surface was outside *no sounds were obtained*. When the black surface was inside good sounds were the result. When the glass was cleaned the sounds became still better. An ebonite plate was similarly treated. When the blackened surface was outside fair sounds were obtained. When the blackened surface was inside very poor sounds were the result.

This being an anomalous result, several experiments were now made to test the behaviour of opaque and transparent bodies, when used as disks, for while in the previous experiments the effect was greatest when the blackened surface faced the interior, here we find the opposite result produced, viz., the greatest effect was produced when the blackened surface was on the exterior.

Several experiments were then made, from which it appeared that transparent bodies behave in an opposite way to opaque bodies. Glass and mica can be rendered athermanous and silent by making the carbon deposit sufficiently thick. Zinc, copper, and ebonite can produce sonorous effects by a proper disposition of carbon. The effect in these latter cases may be due either to molecular pressure, in fact to a radiometer effect, though very feeble in intensity; or it may be the result of conduction through the mass of the diaphragm, that is, radiant heat is reduced to thermometric heat by absorption by the carbon deposit on the *outside* of the disk; and this heat is transmitted through the disk and radiated to the absorbent gases in the interior.

Several experiments were made which fully establish the inference that the effect is one of conduction, and that the blackened surface of an opaque body like zinc acts as though the source of heat were transferred to the outside surface of the disk.

Tubes of various sizes and dimensions were now tried to confirm Messrs. Bell and Tainter's observations on tubes. They invariably gave out satisfactory sounds when the intermittent rays were directed into the interior of the tubes, which were always considerably intensified by blackening their interiors and closing the open end with a glass plate.

It was shown that there is a time element, and that the loudness of the note emitted depends upon the rapidity with which the contained air not only absorbs the degraded energy, but upon the rapidity with which it gives up its heat to the sides of the case and the exits open to it. Though the pitch of the maximum note varied with the cavity and the amount of radiant heat transmitted, its quality never varied, notwithstanding the great diversity of materials used as diaphragms.

Since these sonorous effects are due to the expansions of absorbent gases under the influence of heat, and since wires are heated by the transference of electric currents through them, it seemed possible that if we inclosed a spiral of fine platinum wire in a dark cavity, well blacked on the inside, and sent through it by means of the wheel-break, rapid intermittent currents of electricity from a battery, heat would be radiated, the air would expand, and sounds would result. This was done, and the sounds produced were excellent. In fact, with four bichromate cells sounds more intense than any previously observed were obtained.

Furthermore it was evident that if the wheel-break were replaced by a good microphone transmitter, articulate speech should be heard. This was done, and an excellent telephone receiver was the consequence, by means of which speech was perfectly reproduced.

The explanation of these remarkable phenomena is now abundantly clear.

It is purely an effect of radiant heat, and it is essentially one due to the changes of volume in vapours and gases produced by the degradation and absorption of this heat in a confined space. The disks in Bell and Tainter's experiments must be diathermanous, and the better their character in this respect the greater the effect; remove them, and the effect is greater still. Messrs. Bell and Tainter (*Journal* of Society of Telegraph Engineers, December 8, 1880) showed that the sounds maintained their *timbre* and pitch notwithstanding variation in the substance of the disk, and M. Mercadier found that a split or cracked plate acted as well as when it was whole. These facts are consistent with the expansion of the contained air, but not with any mechanical disturbance of the disks. Moreover M. Mercadier showed that the effect was improved by lampblack, but he applied it in the wrong place.

The disks may, and perhaps do, under certain conditions, vibrate, but this vibration is feeble and quite a secondary action. The sides of the containing vessel must possess the power to reduce the incident rays to thermometric heat, and impart it to the vapour they confine, and the more their power in this respect, as when blackened by carbon, the greater the effect. The back of the disk may alone act in this respect. Cigars, chips of wood, smoke, or any absorbent surfaces placed inside a closed transparent vessel will, by first absorbing and then radiating heat-rays to the confined gas, produce sonorous vibrations.

The heat is dissipated in the energy of sonorous vibrations. In all cases, time enters as an element, and the maximum effect depends on the diathermancy of the exposed side of the cavity, on its dimensions and surfaces, and on the absorbent character of the contained gas.

THE EARTHQUAKE IN ISCHIA

THE Island of Ischia, the Pithecusa of the ancients, is some twenty miles in circumference, and appears to be the continuation of the north-western boundary of the Gulf of Naples It consists of an old volcanic mountain sloping down on all side to the sea. The southern rim of the old crater has been remove by denudation, leaving the northern as a curved serrated ridge, forming the peak of Monte Epomeo.

Situated on the southern slopes of the island are only a few and unimportant villages.

Going from east to west along the northern slope we have first the capital Ischia, then we encounter the great trachytic lava stream which issues laterally from the slope of Epomeo, and after a course of two miles entered the sea, forming a promontory. This is the so-called lava Del' Arso, of A.D. 1302. Next are encountered two very fresh-looking craters, from which lava streams have flowed. Then we come to Casamicciola, a small town of about 4000 inhabitants, to the north-west of which is the village of Lacco Ameno. At the eastern end of the island is the town of Forio.

The district in which are situated Casamicciola and Lacco is thus bounded on the north by the sea, on the south by the ridge of Monte Epomeo, on the west by a spur stretching from the latter into the sea, forming the Punta Cornacchia, and on the east are the two hills called Monte Rotaro and Montagnone, the new-looking craters already spoken of.

It is worth observing that from this side of the island the four or five historic eruptions have occurred, and all the principal thermo-mineral springs are confined mostly to this district.

It is at this very spot that the late earthquake has taken place, resulting in the total destruction of Casamicciola, with the exception of the hotels, baths, and a few well-constructed private houses. A hundred and twenty bodies have been excavated, and they are not all, besides 160 seriously wounded. At the village of Lacco thirteen houses have fallen, and five deaths are reported.

On March 4, at five and a half minutes past one p.m., a terrific shock shook the whole island, but its maximum intensity was at this point leaving Ischia and Forio almost uninjured, together with the villages on the opposite side of the mountain.

There was but a moment of premonitory trembling, when the terrific blow shook the houses about the ears of their inhabitants. The corpse of the shoemaker was found in his usual position, with the last between his knees, and we saw the corpse of a woman with the half-finished stocking in her hand and the needle in its sheath. The two cases show the suddenness of the catastrophe.

The first shock was described as a sudden blow beneath the feet, followed by a series of undulations, which appear from accounts to have radiated from a point which I shall immediately describe. This was followed shortly by faint vibrations, accompanied by loud subterranean thunder, such as was heard in the slight earthquake of last July.

On visiting the island a few hours after we were struck by the severity of the shock and by its extremely limited area. Following the methods adopted by our eminent countryman Mr. Mallet, F.R.S., in his investigations of the great Neapolitan earthquake of 1857, we have come to the conclusion that the undulations occurred in a series of closed curves radiating from a point which must have been situated about a quarter of a kilometre to the south-west of the upper town, that is in the direction of Lacco.

It is interesting to note that the seismographs at Naples and Vesuvius were not at all affected by the earthquake. This led Prof. Palmieri to conclude from the extremely local effects produced that the phenomenon was due to the excavation and removal of matter by the mineral springs and the collapse and falling in of the superincumbent ground. It seems difficult to satisfy oneself with the theory of my respected teacher and friend Prof. Palmieri for the following reasons :—

1. The collapse of earth in Cheshire in no way produces effects at all similar or equivalent to those under consideration, and yet the amount of salt in solution removed is equal to much more solid matter than is removed by the dilute mineral waters of Ischia which are also small in quantity. Landslips like that of Lyme Regis are quite incomparable in effects to the present case.

2. The waters that issued immediately after the disaster were as usual clear, and flowed at the same rate. If this explanation was tenable, then the collapse of the earth should have forced out a large body of water and vapour and have rendered the former turbid and muddy. Such however was not the case.

3. The disturbance in Ischia was coincident with the seismic movements that were felt in various parts of Europe from the 2nd to the 5th of March, and which was severe throughout Northern Italy.

We know from the following facts that Ischia cannot be reckoned amongst extinct volcanoes. The great number of fumaroles and thermo-springs that exist on its surface ; the sand on the sea-shore in some parts is so hot a few inches from the surface that the hand cannot be borne in it ; the continual seismic disturbances to which it was and is subject—all point to the conclusion that there still exists igneous matter not far from the surface.

The seismic waves of the beginning of March causing increased tension in the igneous matter through which they travelled would tend to rupture the superficial crust at its weakest point ; the Island of Ischia presents to us such suitable conditions, and the volcanic matter, vapour, or lava may by those means have endeavoured to force its way towards the surface.

The formation of a fissure, together with the blow that would be produced by the immediate falling of such, would explain the phenomena. Much the same results occur from the formation of a dyke in an active volcanic mountain ; in fact the conditions may be looked upon as analogous.

Although lava has failed to reach the surface on the present occasion, a repetition may be sufficient to produce an eruption such as has often occurred at this spot. We may look for the homologues of the present earthquake in that of A.D. 63, preceding the outburst of Vesuvius in 79, or those that disturbed Pozzuoli and its neighbourhood immediately before the formation of Monte Nuovo, but which were not felt at Naples.

The fact that the undulations produced little effect on the southern side of the island shows the extreme thinness of the earth-crust at this spot ; the weight and bulk of the superficial configuration acting as deterrent agents to the propagation of the seismic undulations to any great distance. The earthquakes in Ischia have at times been very disastrous, compelling various Greek colonies to forsake the island. There is generally a slight shock about once a year, nearly always accompanied by subterranean thunder. These have sometimes caused injuries, as on February 2, 1828, when three or four houses fell and some thirty people were killed. The details of the observations being made will be published as soon as they can be formulated.

It is an interesting fact that since writing the above, on comparing notes with Signor P. Franco, my colleague, although our observations were quite independent and unknown to each other, yet we have arrived at exactly the same conclusion in almost every detail.

H. J. JOHNSTON-LAVIS

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following notice respecting scholarships in Natural Science has been published by Merton College :—

There will be an election in June next to one (or two) Physical Science Postmasterships.

The examination will begin on Tuesday, June 28 ; it will be held in common with Magdalen College, and at the same time and place. Candidates may give in their names at either College, but all will be regarded as standing at both, unless special notice is given to the contrary. In the event of election a candidate will be requested to state which College he would prefer. The Postmasterships are of the annual value of 80*l.*, and are tenable for five years from election, provided that the holder does not accept or retain any appointment incompatible with the pursuance of the full course of University studies. After two years' residence the College may raise, by a sum not exceeding 20*l.* per annum, the Postmastership of such Postmasters as shall be recommended by the Tutors for their character, industry, and ability. Candidates for the Postmasterships, if members of the University, must not have exceeded six terms of University standing, but there is no limit of age. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Candidates will have an opportunity of giving evidence of a knowledge of Biology ; but it must be borne in mind that in such cases the examiners will look for evidence of an acquaintance with the principles of Chemistry and Physics at least equal in extent to that which is required in the Preliminary Honour Examination in the Physical Science School. A paper will be set in Algebra and Elementary Geometry (Books I.-VI.), and a Classical paper of the standard required by the University for Responsions.

Magdalen College has published the following notice respecting Natural Science Scholarships (Demyships) :—There will be an election at this College in June next to not less than seven Demyships, of which one at least will be Mathematical, one at least in Natural Science, and the rest Classical. No person will be eligible for the Demyships who will have attained the age of twenty years on October 10 next. The stipend of the Demyships is 95*l.* per annum, inclusive of all allowances : and they are tenable for five years, provided that the holder does not accept or retain any appointment which in the judgment of the electors will interfere with the completion of his University studies.

THE Oldham Lyceum and Science and Art Schools, opened by Lord Derby last Thursday, seems to be a handsome and useful building, and under Mr. Phythian's superintendence we have no doubt much good work will be done in the future as in the past. Chemical and physical laboratories and other arrangements of scientific work have been provided for.

SCIENTIFIC SERIALS

THE *American Naturalist*, March, 1881.—D. S. Jordan and Chas. H. Gilbert, observations on the salmon of the Pacific.—J. Walter Fewkes, the anatomy and development of Agalma, part 2.—A. J. Cook, on the relation of agriculture to science.—Wm. H. Holmes, glacial phenomena in the Yellowstone Pack.—E. Holterhoff, jun., a collector's notes on the breeding of some Western birds.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiv. fasc. iii.—Results of observations on the amplitude of diurnal oscillations of the magnetic needle, made in 1880, at the Brera Royal Observatory, Milan, by S. Schiaparelli.—On Prof. Cantor's new History of Mathematics, by the same.—Some observations on *verglas* and its theory, by Prof. Serpieri.—On some post-glacial fissures in the southern Alps, by Prof. Taramelli.—A physiological sign of true death, by Doctors Verga and Biffi.—On sanguineous effusion in the bottom of the eye and in the cavity of the tympanum through death by hanging, by Prof. Tamassia.

Berichte über die Verhandlungen der naturf. Gesells. zu Freiburg i. B., Band vii. Heft iv., 1880.—On the optical structure of ice, by Fr. Klocke.—On the behaviour of crystals in solution that are but a little short of saturation, by the same.—On torsion, by E. Warburg.—The forms of vibration of plucked and rubbed strings, by F. Lindemann.—Contribution to a knowledge of protozoa, by A. Gruber.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 17.—A paper by C. Greville Williams, F.R.S., was read "On the Action of Sodium upon Chinoline."

The author, after giving a historical sketch of what he had previously done upon the subject, calls attention to the fact that for a yellow oil-like dichinoline to give a red crystalline hydrochlorate is probably a unique reaction. He also states further on that the colour of this hydrochlorate is so brilliant that the finest vermillion looks brown by comparison. His most successful preparations were made from chinoline purified by conversion into a crystallised chromate. The base so prepared is almost colourless, and becomes yellow with extreme slowness as compared with a product obtained without that precaution. On treating chinoline with sodium, converting the resulting purplish fluid into hydrochlorate, separating the scarlet crystals by filtration, and fractionally precipitating with platinic chloride, he obtains several products, the most conspicuous being a salt of the formula $2(C^{18}H^{14}N^2)HCl\,.\,PtCl^4$. Sodium amalgam reacts in a similar manner, and this appears to be the best way of obtaining the scarlet hydrochlorate of dichinoline in its greatest beauty.

On recovering the chinoline unacted on from the mother liquors it had the same boiling-point as before the treatment with sodium, but on treating the recovered base again with sodium amalgam it yields a solid yellow resinous base, instead of the fluid one previously obtained. The author studies all the basic products by conversion into hydrochlorates, and fractionally precipitating with platinic chloride, and points out the remarkable similarity in the percentages of platinum obtained from the mother liquors of the scarlet hydrochlorate of dichinoline, from the scarlet salt itself, and from the hydrochlorate of the yellow solid base.

Zoological Society, March 15.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of February, and called special attention to a female Bactrian Camel (*Camelus Bactrianus*), formerly belonging to Ayoub Khan, which Col. O. H. St. John, F.Z.S., has purchased from its captors at Candahar and presented to the Society, and to a male Wild Sheep (*Ovis cycloceros*), obtained from Afghanistan, and presented to the Society by Capt. W. Cotton, F.Z.S.—Mr. A. G. More exhibited some eggs of the Red-necked Phalarope, believed to have been taken in England; and an egg of the Tree-Pipit, taken near Dublin, this bird having been considered only doubtfully Irish. Mr. More also exhibited a specimen of the Red-crested Pochard, obtained near Tralee, being the first record of the occurrence of this species in Ireland.—Mr. R. Bowdler Sharpe exhibited a specimen of the so-called Sabine's Snipe (*Gallinago Sabinii*). This bird had been shot in July last by the Hon. W. W. Palmer at Woolmer Pond, near Selborne, Hants.—Prof. F. Jeffrey Bell, F.Z.S., read the fourth of his series of observations on the characters of the Echinoidea. The present paper dealt with most of the genera of the Echinometiadæ; their systematic affinities were discussed and their relations to the Echinidæ shown to be so intimate as not to justify their separation into two distinct families.—A second paper by Prof. Bell gave the description of a new species of the genus *Mespilia*, obtained at Samoa by the Rev. S. J. Whitmee, which the author proposed to name after its discoverer, *M. Whitmei*.—Mr. W. A. Forbes read the fourth of his series of papers on the anatomy of Passerine birds. The present communication was devoted to the consideration of some points in the anatomy of the genus *Conopophaga* and of its systematic position.—A communication was read from Prof. Newton, F.R.S., in which he proposed to substitute the name *Hypositta* for *Hypherpes*, which he had formerly proposed for a genus of Passerine birds found in Madagascar.—A communication was read from Mr. M. Jacoby containing descriptions of new genera and species of phytophagous coleptera.

Physical Society, March 12.—Sir W. Thomson in the chair.—New Members: Mr. Colville Brown, Dr. J. P. Joule.—Col. Festin read a paper by Capt. Abney and himself, on the absorption spectra of organic bodies. The method of photographing the infra-red region of the spectrum gave better results for absorption than thermopile. Organic compounds were chosen as giving the larger molecules. The apparatus employed consisted of a small Gramme machine driven by a Brotherhood engine, and an electric lamp with a plevice for shifting the negative pole so as to get the crater on one side of the other carbon point. The image of the positive pole was allowed to fall on the slit of the spectroscope: the light of the arc not being used. Three prisms were used, and a camera with a back-swing to it so as to get a considerable length of spectrum in focus. Maps of the various spectra were made with six inches of the substance examined inclosed in a glass tube. Alcohols, acids, oils, and water were examined, and gave spectra of bands and lines. When hydrogen was absent in the compound there were no lines, and the authors conclude the lines to be due to hydrogen. Oxygen appeared to obliterate the space between the lines and make it a band. The authors hope by this method to detect the radicles present in a substance. They found correspondences between some lines and lines in the solar map. Dr. Coffin said that two kinds of chloroform, apparently the same, produced different physiological results: the method might distinguish between these. Sir William Thomson thought it might throw light on the ultimate constitution of matter.—Mr. Brown read a paper on the definition of work in text-books, and gave reasons for preferring that in Rankine's books.

Anthropological Institute, March 8.—F. W. Rudler, F.G.S., vice-president, in the chair.—The election of Dr. G. D. Thane was announced.—A collection of rubbings taken from door-posts and window-frames in New Zealand was exhibited. They were chiefly interesting from the proof which they afforded of the clear influence of matted and woven materials on the ornamentation of stone architecture, a parallel to the influence of wood architecture on stone architecture pointed out by Fellowes in Lycia and by Lepsius in Egypt; also from the remarkable coincidence between some of these ornamentations and the outlines on the tombstones of Mykenæ, a near approach to the triglyph in New Zealand.—A short note by Mr. S. E. Peal, on Assam pile-dwellings, was read, and was illustrated by a series of sketches by the author.—Lieut.-Col. R. G. Woodthorpe, R.E., read a paper on the wild tribes inhabiting the so-called Naga Hills on our North-Eastern frontier of India. The paper dealt only with the Angami Nagas, who, it was stated, differ from all the other hill tribes of Assam in many important particulars, such as appearance, architecture, mode of cultivation, language, and dress. In appearance they are a finer, cleaner, and better-looking race than their neighbours; they build their houses resting on the ground, and not raised on piles as all the other hill tribes of Assam (except the Khasias) do, and after a pattern not seen elsewhere. Differences in physical or topographical conditions do not account for this difference in the style of architecture, as the Angami villages are found on the same ridges as, and often not a mile from, villages constructed on the other principle. In dress the Angami differs most strikingly from all the other tribes in the kilt or short petticoat of dark cloth ornamented with rows of white cowrie

shells, the waistcloth of all other Nagas consisting only of a flap of cloth in front and behind, and often only in front. The Angamis erect tall monoliths in commemoration of the dead or of some social event. These monoliths, often of great size, are dragged up hill on sledges running on rollers. The paper was illustrated by a large collection of specimens and drawings, and also by some fine diagrams, in the preparation of which the author had been much assisted by Mr. C. Holroyd.

Royal Microscopical Society, March 9.—The president, Prof. P. Martin Duncan, F.R.S., in the chair.—Swift and Sons' new "working" microscope and fine adjustment and the "Griffith Club Portable Microscope" were exhibited.—Mr. Powell showed *Amphipleura pellicida* with the vertical illuminator, and Mr. Stephenson pointed out that the illumination was not "opaque," as supposed, but that the diatom was illuminated by transmitted light reflected back by its own under-surface.—Mr. Crisp exhibited Prof. Abbes' radiation apparatus for showing the increased amount of light emitted by a radiant in glass or balsam compared to one in air.—Mr. A. D. Michael read a paper on a supposed new species of Acarus, *Dermaleichus heteropus*, and Dr. E. Cutter's paper on a supposed Infusorian in the nasal passage in cases of catarrh was explained by Mr. Stewart and commented on by the president.—Discussions also took place on carbolic acid for mounting, and on the "Society" standard screw.

Meteorological Society, March 16.—Mr. G. J. Symons, F.R.S., president, in the chair.—Rev. A. J. C. Allen, E. Chapman, Rev. E. W. Ford, G. T. Gwilliam, H. B. Jupp, A. Ramsay, and J. Stokes were elected Fellows.—The President gave a historical sketch of various classes of hygrometers, and described about 120 different patterns; after which an exhibition of instruments was held, showing various kinds of hygrometers, and also some new instruments which have been brought out since January 1, 1880.

Victoria (Philosophical) Institute, March 21.—Mr. J. F. Bateman, F.R.S., read a paper on meteorology, in which he analysed the causes of a variation of rainfall in the United Kingdom. In the discussion special remarks were made as to the causes and effects of the almost tropical rainfall that once obtained in these islands; after which a paper on Indian rainfall, by W. P. Andrew, was read. At the close of the proceedings it was announced that Prof. Balfour, F.R.S., would read a paper on the visible universe at the next meeting.

EDINBURGH

Royal Society, March 7.—Lord Moncrieff, president, in the chair.—The President read the second part of his paper on the rise of the constitutional idea. In the half-century that elapsed after the publication of Buchanan's "De Jure Regni apud Scotos," important political changes were taking place and were shaping themselves, under the skilful hand of James VI. of Scotland, especially after his accession to the English throne, towards a despotism that would place the king alongside the arbitrary monarchs of the Continent. Charles I. however lacked the kingcraft to carry on successfully this policy of diminishing the power of the Parliament; and in 1644, in the heat of the contest between King and Commons, Samuel Rutherford published his "Lex Rex," which contains the first enunciation in the English language of the true *rationale* of the British Constitution. Passing on to the time of the Commonwealth, his lordship touched on the famous controversy on the divine right of kingship between Salmazius and Milton, a controversy which was continued by Hobbes and Harrington. Lastly, the paper discussed Algernon Sidney's work on Government, which was characterised as out of sight the best and ablest of the list.—Dr. D. J. Cunningham, in a paper on the intrinsic muscles of the mammalian foot, gave an interesting account of several of the most striking modifications that occur in the arrangement of these muscles in different animals. The typical arrangement of three layers of four muscles each was found in certain marsupials, and the deviations from this typical arrangement could be grouped in two classes—those that resulted from division, and those that resulted from fusion. The peculiar modifications in the ox, horse, ape, baboon, gorilla, and man were specially referred to, many of these deviations being of the nature of degeneration or retrograde development.—Mr. A. H. Anglin communicated a paper on the expansion of rational fractions.—Dr. A. Macfarlane, in his third paper on the algebra of relationship, showed the nature of the problems that came under the scope of his symbolic method.—Prof. Tait communicated a note on a problem in kinetics of peculiar difficulty. One of two equal masses, originally balanced on an Atwood's machine, is set oscillating through a small arc. What is the subsequent motion? The equations of motion are peculiarly intractable, but may by suitable transformation be thrown into a form from which may be derived by simple inspection the general result that the oscillating mass moves under the action of a *downward* acceleration, so that the mixed potential and kinetic energies tend to become altogether kinetic. When both masses are set oscillating, a further complication is of course introduced; and it is found that the mass that is oscillating through the greater *angle* is subject to a downward acceleration.

VIENNA

Imperial Academy of Sciences, March 17.—V. Burg in the chair.—C. Ludwig, studies made at the Physiological Institute at Leipsic during the time of 1879-80.—Dr. L. Boltzmann, enunciation of formulæ useful for determining the number of diamagnetism.—Dr. Synas Klemencic, relating to the determination of the proportion of the magnetical to the dynamical unit of the intensity of circuit.—Dr. F. Streintz, on decomposition of water on platinum-electrodes caused by the discharges of Leyden-jars.—E. Ratkay, on *Exoascus Wiesneri*.—Prof. Dr. Edm. Reitlinger and Dr. F. Woechter, on the "disgregation" of electrodes by positive electricity and explanation of the figures of Lichtenberg.—Dr. P. Weselsky and R. Benedikt, a sealed packet containing the description of some new dyeing materials.—Josef Wentze, on the flora of the Tertiary diatomeæ-slate at Sulloditz (Bohemia), central chain of mountains.—H. Schroetter, on the oxidation of Borneolacetate.—E. Stefan, on the equilibrium of a solid elastic body at a different or variable temperature.—Dr. Ernst. v. Fleischl, physiologico-optic notes.—Dr. T. Puluj, on radiant electrode-matter (third paper).

CONTENTS