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THREE CAMBRIDGE MATHEMATICAL WORKS.

The Algebra of Invariants. By J. H. Grace, M.A., and A. Young, M.A. Pp. vii+384. (Cambridge: The University Press, 1903.) Price 10*s.* net.

The Dynamical Theory of Gases. By J. H. Jeans, M.A. Pp. xvi+352. (Cambridge: The University Press.) Price 15*s.* net.

A Treatise on the Analytical Dynamics of Particles and Rigid Bodies. By E. T. Whittaker, M.A. Pp. xiii+414. (Cambridge: The University Press, 1904.) Price 12*s.* 6*d.* net.

WHATEVER opinions may be felt as to the desirability of University Presses competing with private firms in swelling the already too large flood of school geometries or issuing cram books for compulsory Greek examinations, there can only be one opinion as to the series of standard treatises on higher mathematics emanating at the present time from Cambridge. In a country which, in its lack of national interest in higher scientific research, particularly mathematical research, stands far behind most other important civilised countries, it necessarily devolves on a University Press to publish advanced mathematical works. We may take it as certain that the present volumes will be keenly read in Germany and America, and will be taken as proofs that England contains good mathematicians, though Englishmen as a nation may be unaware of their existence, with the exception of the senior wrangler of one year, who is forgotten the next.

For years Salmon's "Higher Algebra" has been the treatise which has done most to interest English students in invariants. At the present time a good deal more is wanted in order to bring our knowledge up to date. Messrs. Grace and Young have endeavoured to meet present requirements in a well defined direction. As they state in their preface, the book

"was started as an attempt to meet the need expressed by Elliott in the preface to 'The Algebra of Quantics'—'a whole book which shall present to the English reader in his own language a worthy exposition of the method of the great German masters remains a desideratum.'"

While no book, unless it were written in four languages, could satisfy the patriotic aspirations of every native of our country by appealing to him "in his own language," the production of an English book on a subject largely developed in Germany meets a distinct want.

The subject is practically started *ab initio*. The treatment does not strike us as very hard to follow, although it is difficult for a beginner at first to master the symbolical notation, especially in the definition of transvectants (chapter iii.). In chapter vi. the authors introduce Gordan's theorem, according to which the number of covariants of a binary form is always finite, and in the next chapter they employ his method of proof to obtain the complete irreducible set of covariants of the quintic. A short chapter on simultaneous systems brings us to Hilbert's theorem, with which the algebra of binary forms may be said to end. Chapters x. and xi. deal with geometrical interpretations, and in particular with apolarity. The sections dealing with ternary forms are less complete, as the authors have considered that "with the methods known up to the present the treatment of ternary forms is too tedious for a text-book."

Mr. Grace has previously been associated with the production of several mathematical text-books of a quite elementary character, and the present book bears many unmistakable traces of his experience as a writer in making a somewhat difficult subject appear relatively easy.

We say "somewhat" difficult, because the subject of Mr. Jeans's new book is incomparably harder than the "Algebra of Invariants." This difficulty arises largely from the fact that the kinetic theory of gases is closely associated with the representation of physical phenomena as they actually exist, and with all the difficulties connected with irreversibility and the existence of temperature. It is only by statistical methods that these phenomena are amenable to the equations of reversible dynamics, and with every method of attack some assumption must be made, since if any motion of a molecular system exists it is equally conceivable that the opposite motion should exist.

Even Willard Gibbs's appeal to experience quoted on p. 167 does not get over the difficulty. If we put red and blue ink together into a vessel and stir them up, it is true that if the inks differ in nothing more than colour the result is a uniform violet ink. But this is because the inks are viscous liquids the motions of which are irreversible. If they were perfect liquids perfect mixing would not take place, and the effect of stirring would merely be to produce vortex motions in which the vortex lines always contained the same particles and remained constant in strength. If we mix counters in a bag, the motions of the counters are retarded by friction; if the counters correctly represented perfectly reversible systems they would never come to rest.

Mr. Jeans in his preface considers that the discrepancy between theory and experiment in connection with the ratio of the specific heats of a gas "is of greater importance than all the others together," and he has endeavoured to emphasise the fact that when account is taken of the interaction between matter and the ether, theory and experiment harmonise as well as could be desired. But as soon as this ether is taken into account we have a simple means of obviating the irreversibility difficulty by saddling the ether with the whole responsibility. So long as physicists are contented, in solving the differential equations of wave motion in a medium, to omit the terms which represent waves converging from an infinite distance towards a centre of disturbance, so long will there be an easy way out of the puzzling contradictions arising out of Boltzmann's H-theorem.

But there is really no reason why the presence of a molecule in an indefinitely extended ether which undoubtedly possesses some energy should not bring about the convergence of waves coming in from an

infinite distance in all directions, and gradually increasing in intensity as they approach the molecule. We do not think such cases exist, but we did not expect to discover radium a few years ago.

Let us now see how Mr. Jeans attempts to deal with the difficulties here suggested. In the first seven chapters he follows fairly closely on conventional lines, and deduces the Boltzmann-Maxwell law of distribution, the minimum theorem, the law of partition of energy, and the isothermal equations according to the Boyle-Mariotte and van der Waals's laws. In chapter viii. the author throws over the principle of conservation of energy and assumes that his gas is a dissipative system in which loss of energy occurs by radiation. On this hypothesis he finds that when the rate of dissipation has become very slow probability considerations indicate a tendency to assume a definite statistical specification different from that given by the ordinary theory. It further appears that such a gas has one principal and a number of subsidiary temperatures, a notion which we believe has been previously advanced. In chapters ix. and x. Mr. Jeans considers applications of the theory of a non-conservative gas, particularly in connection with rates of dissipation of energy, and ratios of specific heats.

We thus have a definite attempt to break away from traditional methods and boldly introduce the notion of dissipation into the kinetic theory. The idea is certainly an excellent one. Whether it is free from objection is a matter which cannot be answered as the mere result of a critical examination. Often objections to theories strike the mind of a reader quite unexpectedly.

In the remaining chapters Mr. Jeans deals with "free path phenomena" such as diffusion, conduction of heat, viscosity, and the escape of gases from planetary atmospheres. In this work he is more on the ordinary lines. We notice as an important feature the sections dealing with encounters according to the law of the inverse fifth power. This series of chapters is of considerable use in affording easy access to investigations contained in a much longer form in the original papers of Boltzmann and other writers.

Turning back to the chapter on equipartition of energy, we are led to the following inference:—Mr. Jeans leaves it an open question whether the conventional law of distribution with its attendant consequences of equipartition may represent the ultimate state of a gas, but concludes that in actual gases such as we see around us where dissipation of energy occurs a different distribution holds good.

The second conclusion seems plausible. But the assumption that equipartition of energy holds *even in a conservative system* presents difficulties in connection with Stefan's law of radiation in a black cavity. According to that law the energy of the ether should vary as the fourth power of that of the molecules. It might be said that in the "conservative system" Stefan's law would not necessarily hold good, and that there would be no objection to assuming the energy of the ether to be then directly proportional to that of the molecules, or to the temperature. But the usual thermodynamic investigation—which is more certain to be valid in the case of the conservative than in that of the dissipative system—would then give a different form for the radiation pressure—apparently $f=\psi(\log\psi+\text{constant})$—and this result would have to be admitted. On the whole it appears more likely that while distributions satisfying Maxwell's law of equipartition are always theoretically possible, other distributions may exist, and may, indeed, represent a normal and *persistent* state of affairs even in *conservative* systems.

It is remarkable that physicists strain at gnats when put down to study kinetic theory or thermodynamics, and yet they swallow camels with complacency when they read the subject of Mr. Whittaker's book, "Analytical Dynamics." Some writers even go so far as to introduce pages and pages of the most unreal dynamical problems into what they call treatises on physics.

"The soluble problems" of particle dynamics" mostly represent things which have no existence. It is impossible for a particle to move on a smooth curve or surface because, in the first place, there is no such thing as a particle, and in the second place there is no such thing as a smooth curve or surface. What constitutes the chief interest of "Analytical Dynamics" is the possibility of forming clear mental pictures of its results by *imagining* bodies capable of performing the motions discussed.

Mr. Whittaker's treatment is essentially mathematical and advanced in character. He opens with sections on the displacements of rigid bodies in which Klein's parameters and Halphen's theorems on composition of screws figure near the commencement. In his chapter on equations of motion physico-philosophical discursions on force and mass are reduced to a minimum. This is as it should be, for there are plenty of people who can write about such matters, but few whose knowledge extends to the more important theorems which follow later. The Lagrangian equations are reached by § 26, which is preceded by a definition of holonomic systems. This distinction might with advantage be put into treatises in physics, for at present students of that subject are apt to assume that Lagrange's equations in their ordinary form are universally applicable, which is far from true. Passing on to chapter v., which deals, *inter alia*, with moments of inertia, our old friend the "principle of parallel axes" is treated generally for a quadratic function of coordinates, velocities and accelerations, readers being doubtless assumed to know the proof for simple cases. Chapter vii. deals with the general theory of vibrations, and the next chapter with non-holonomic and dissipative systems, the first of these two chapters consisting mainly of theory, and the second mainly of examples. The most important chapters are those which follow, dealing with the principles of Hamilton and Gauss, the integral invariants of the Hamiltonian system, and the representation of a dynamical system of equations by means of contact transformations.

Mr. Whittaker some time ago presented a valuable report to the British Association on the problem of three bodies, and he tells us that between 1750 and 1904 more than eight hundred memoirs were

published on this problem. Even at the Heidelberg congress last August further additions were made to this literature. In his chapter on the subject, which is very brief, he discusses the reduction of the equations to a system of the sixth order, thus affording a useful insight into the main features of this difficult investigation. Several other interesting chapters follow.

It will thus be seen that Mr. Whittaker's treatise collects into book form the outlines of a long series of researches for which hitherto it has been necessary to consult English, French, German, and Italian transactions. In recent years Italy has played no small part in the development of dynamics, as may be seen by the number of papers by Levi Civita and other writers which have from time to time appeared in the *Atti dei Lincei*, dealing with integrals of the equations of motion of holonomic systems, particular cases of the problem of three bodies, and allied questions.

The book is thus written mainly for the advanced mathematician. But an interesting feature is the large number of examples both in the text and at the end of the chapters. Of these a good many really contain the substance of minor papers that have been published abroad. Others are followed by the reference "Coll. Exam.," and while it may be taken for granted that Mr. Whittaker has made a judicious selection, some of the questions bearing these references may give foreign mathematicians a little insight into the unpalatable nuts which Cambridge students are expected to waste time in trying to crack for examination purposes. The antics of insects crawling on epicycloids, or the vagaries of particles moving along the intersections of ellipsoids with hyperboloids of one sheet, are of no scientific interest, and the time spent in "getting out" problems of this character might better be employed in learning something useful. Moreover, Cambridge college examiners have a habit of endowing bodies with the most inconsistent properties in the matter of perfect roughness and perfect smoothness. A perfectly rough body placed on a perfectly smooth surface forms as interesting a subject for speculation as the well-known irresistible body meeting the impenetrable obstacle. What the average college don forgets is that roughness or smoothness are matters which concern *two surfaces*, not *one body*.

In our opinion a great deal of the artificiality of the more elementary parts of dynamics might be removed by the more frequent introduction of simple problems in resisted motion. There are plenty of easy ones to be found which would be more helpful to the beginner than problems about ellipsoids rolling on perfectly smooth surfaces formed by the revolution of cissoids or witches about their axes. Those who have the ability to do more difficult work should pass on to the advanced parts of a book like Mr. Whittaker's and learn what foreign mathematicians have been doing; this is much more useful.

It remains to add that the books are neatly bound; the printing and paper are somewhat unnecessarily luxurious in quality, and—most important of all—the Cambridge printers have *not* forgotten to cut the pages with their guillotine. G. H. BRYAN.

REIN'S "JAPAN."

Japan nach Reisen und Studien. By J. J. Rein. Vol. i. Natur und Volk des Mikadoreiches. Second edition. Pp. xv+749. (Leipzig: Wilhelm Engelmann, 1905.) Price 24*s.* net, paper; 26*s.* net, cloth.

THIS is the second edition of a book first published in 1880. The author, now professor of geography in the University of Bonn, was, in 1874, commissioned by the Prussian Ministry of Commerce to go to Japan for the purpose of studying and giving an account both of the trade of Japan and the special branches of industry there carried on to so high a degree of perfection. The writer of this notice had the pleasure of making the acquaintance of Dr. Rein while in Japan, and can testify to the German thoroughness with which Dr. Rein carried out the work for which he was commissioned. The results of that work were two volumes which, from the point of view of the author, have been looked upon as the most scientific and complete of their kind. Some years after their appearance in Germany translations were published in England (Hodder and Stoughton), but both the German and English editions have for some time been out of print, and the author has done well to bring out a new edition, brought up to date in matters both of history and science. For students of Japan it is almost unnecessary to review the work of Dr. Rein, as it has long had an assured position.

The opinion of competent authorities was reflected by Prof. Chamberlain more than fifteen years ago, when, in an edition of his well known book "Things Japanese," he said:—

"At the risk of offending innumerable authors, we now venture to pick out the following works as probably the best in a general way that are accessible to English readers: (1) Dr. Rein's 'Japan,' with its sequel 'The Industries of Japan.'" No person wishing to study Japan seriously can dispense with these admirable volumes. Of the two, that on the "Industries" is the better; agriculture, cattle-raising, forestry, mines, lacquer-work, metal-work, commerce, &c., everything, in fact, has been studied with a truly German patience, and is set forth with a truly German thoroughness. The other volume is occupied with the physiography of the country, that is, its geography, fauna, flora, &c., with an account of the people, both historical and ethnographical, and with the topography of the various provinces.

It is this latter volume which is at present before us, and although it may not be so interesting, from the practical point of view, as its sequel, it is more valuable from a scientific and historical point of view. The book is essentially the same as the first edition, but the author has had the assistance of many friends in Japan in bringing it up to date, both from a scientific and a historical point of view. It is, however, unnecessary to enter into a detailed account or criticism of its contents.

The first part of the book is a very complete and interesting account of the physical geography of Japan; in fact, it is the only systematic account which has been published in a European language. When

Dr. Rein was in Japan he had, for the most part, to depend on himself for the collection of information on this part of his subject; but in the interval many ardent students of science have been trained in Japan, and they have collaborated with him in bringing the matter up to date, so we have very valuable chapters on the geological formation of the country, its physiography, hydrography, climate, flora and fauna; while very complete lists of books and papers dealing with the various departments of the subjects are given which will be useful to those who wish to study them thoroughly.

The part relating to the history of the country has had a section added to it dealing more fully with the events which have occurred during the past quarter of a century, and gives a very good outline of the developments which have taken place. It deals, however, only with what may be called the natural history or facts of the subjects involved, and does not attempt to explain the natural philosophy or dynamics. No doubt the author would say that that was beyond the scope of his work; but it is possible to make descriptions much more interesting and intelligent when the forces at work are at least indicated, and the directions and amounts of their resultants explained. The full discussion of this, however, would take us into details of historical methods about which there is still considerable difference of opinion.

Under anthropology and ethnology a considerable amount of new matter has been introduced, in which are given the results of recent investigations and speculations. An interesting sketch is given of the Japanese language and literature and of the manners and customs of the Japanese. A short account is given of the Japanese calendar and of the national festivals. The part dealing with the religious conditions of Japan is too short to allow justice to be done to it, and it does not give an adequate account of recent developments. The present war with Russia has been a revelation of the "soul of the people," a full explanation of which would require a book for itself. Still, Dr. Rein might have tried to bring this section up to date as well as the others. Its full comprehension, however, requires something more than what is usually called a scientific mind, and comparatively few men of science seem capable of entering on it with understanding. They for the most part are content to look at a people from the outside, forgetting the fact that the most powerful factors in the evolution of a nation are intellectual and spiritual.

The concluding part of the book deals with the topography of the country, and is a valuable contribution to the subject. Some useful maps are included in the book, and a very complete table of contents renders the various subjects very accessible. We venture to hope that a new edition of the second volume on the "Industries of Japan" will soon be forthcoming, for, notwithstanding all the changes which have taken place, the industrial Japan depicted by Prof. Rein still, to a very large extent, remains, and only from it can the real Japan be known.

HENRY DYER.

MAKING A PASTURE.

The Agricultural Changes required by these Times, and Laying down Land to Grass. By R. H. Elliot. Third edition. Pp. xxiii + 197. (Kelso: Rutherford, 1905.)

MR. ELLIOT and "Elliot's system" and "Elliot's mixtures" have been not a little before the agricultural public during the last ten years or so, but we have not before had the opportunity of reading at length a full account of "the system" as set out by the author.

Indeed, we doubt if we should have been very much wiser now, so formless and discursive is the book, had not the publishers been kind enough to provide a synopsis for the guidance of the reviewer.

To put the matter briefly, Mr. Elliot farms some poor high-lying land in the neighbourhood of Kelso, and has found it profitable to adopt a system of laying it down to grass for periods of four to six years, after which it will carry two crops of turnips and two of cereals, in the last of which it is laid down again to grass for another period. The essence of the system is that with the usual grass seeds, or rather with a grass mixture containing a large proportion of cocksfoot and the coarse fescues instead of rye grass, a considerable amount of chicory, burnet, sheep's parsley, kidney vetch, and other tap-rooted plants are sown, although some of these, like the burnet and the chicory, are regarded as undesirable weeds in many parts of the country. Mr. Elliot claims that the deep roots of these plants, by opening up and, on their decay, aërating the subsoil, act as the most efficient agents of cultivation and bring about a great amelioration in the texture of the soil. Further, he obtains a good turf quickly and at little cost, so that when the land comes under the plough again he can grow four crops on the accumulated fertility without the use of any manure.

It will be seen that the one point which can in any way be held to distinguish Mr. Elliot's from other systems of temporary pastures is the use of chicory, burnet, and similar plants in the grass mixtures. It is probably a sound idea to introduce these deep-rooting plants, though we should infinitely prefer the equally deep-rooting but far more valuable sainfoin and lucerne anywhere south of the Trent, yet it leaves us wondering what all the coil is about. What is there so novel or so fundamental about the scheme that the Board of Agriculture should have been expected to take up Mr. Elliot's 1250 acres and by preaching on that text revolutionise British agriculture? Mr. Elliot's system appears to have succeeded on his own somewhat special soil and climate, but there is little reason to suppose it would be equally suitable to the bulk of our farming land. Indeed, we have only Mr. Elliot's opinion that it has succeeded in his own case, for though he writes of the experiments on the Clifton on Bowmont farm, of experiments in any rigid sense we see no trace. We never read of comparative results when one part of a field was sown with Elliot's mixtures, the other with an ordinary seedsman's prescription, nor have we any balance sheet setting out the financial returns from two fields, farmed one on

Mr. Elliot's system, the other in the fashion followed by any reasonable farmer in the district. In fact, the book proves nothing more than that Mr. Elliot, by using good seed and looking carefully after his grass land, has improved his farm in his own opinion and in that of various of his visitors; otherwise the book is a farrago of irresponsible talk, of hard words for agricultural chemists and science generally, of diatribes against the Board of Agriculture and everyone else who does not see eye to eye with Mr. Elliot; it bears every mark, in fact, of the work of the man with one idea.

SOCIOLOGY.

Sociological Papers Published for the Sociological Society. Pp. xviii+292. (London: Macmillan and Co., Ltd., 1905.) Price 10*s.* 6*d.*

THESE papers, the *Transactions* of the Sociological Society, make known to the world what work the society has done during the first year of its existence, and explain the aim and scope of the work it hopes to do in the future.

The first paper recounts the history of the word sociology. After that we get to the fundamental question of eugenics, "the science which deals with all the influences that improve the inborn qualities of the race; also with those that develop them to the utmost advantage." Mr. Francis Galton, the author of this paper, would have the principles of eugenics "introduced into the national conscience, like a new religion," that so a fine race may be bred. The discussion that followed was very interesting. The view held by most medical men who have reached middle age was put without any qualification, the view that we cannot attempt to deal with "a mass of scientific questions affecting heredity," but that we must concentrate our attention on more practical questions, such as the feeding of infants. Mr. Archdall Reid, on the other hand, in a written communication, brings out with admirable lucidity the distinction between degeneracy properly so called and the defective development of the individual. These questions, both of them urgent, we must face. "In the first place we must improve the conditions under which the individual develops, and so make him a fine animal. In the second place we must endeavour to restrict as far as possible the marriage of the physically and mentally unfit." Mr. Reid might have gone on to say that the former method without the latter, the improvement of external conditions without any check upon the multiplication of the unfit, would merely hasten degeneration, as any slackening in the stringency of natural selection must inevitably do. Mr. Bateson declines to join in investigations carried on by the "actuarial" method, preferring experimental breeding with its more definite results. But is it possible to experiment with human beings?

Prof. Geddes, in his "Civics," recommends to students a geographical survey of some river basin in which is displayed the evolutionary process which, beginning with "hunting desolations" on the hill-tops, culminates in some great manufacturing city that darkens the heavens with its smoke. It is doubtful how far this method can afford definitely practical help in solving the problems of modern industrial society. Still, the historical method is capable of imparting an interest to a science which to not a few men is dismal, and certainly anything that can make our great cities interesting is to be welcomed. Dr. E. Westermarck investigates the position of woman in early civilisation, showing that she was by no means, as a rule, a slave and a nonentity, but he owns that "the condition of women or their relative independence is by no means a safe gauge of the culture of a nation." Mr. P. H. Mann follows with a paper on "Life in an Agricultural Village in England," an investigation of the economic condition of the inhabitants. He follows the method of Mr. Charles Booth and Mr. Rowntree in the study of city populations. Prof. Durkheim and Mr. Branford discuss the relation of sociology to the social sciences and to philosophy. Prof. Durkheim contends that sociology is not a mere organisation of more specialist sciences, but that it is capable of remodelling them. Historians, for instance, and political economists have already had to "reorient their studies."

In conclusion, we must congratulate the Sociological Society on its first year's work. Beyond the work which can be definitely gauged there has been the bringing together of men who hold very different views, and of men who are attacking the same great problem from different sides. F. W. H.

OUR BOOK SHELF.

First Report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum. By the Director, Andrew Balfour, M.D., B.Sc., &c. (Khartoum: Department of Education, Sudan Government, 1904.)

THE Wellcome Research Laboratories of the Gordon College, Khartoum, which were equipped by the munificence of Mr. Henry S. Wellcome, have certainly justified their existence, judging by the record of work done during the year February, 1903, to February, 1904, as detailed in the report of the director, Dr. Andrew Balfour.

The volume commences with a brief description of the laboratories, after which follows an account of the various researches that have been carried out in them.

Any medical director stationed where malaria is endemic and mosquitoes plentiful would at once direct his attention to the distribution of the latter, and institute measures to diminish their prevalence. This has been done by Dr. Balfour, and the first article is devoted to a description of his observations and administration in this respect. Of mosquitoes three species are particularly numerous, *C. fatigans*, an anophelina, *P. costalis*, and *Stegomyia fasciata*. Mosquito brigades have been organised, and anti-malarial measures conducted on the lines recommended by Ross, and there appears to be every probability that the prevalence of mosquitoes will be greatly diminished in Khartoum in the near future. Collections of mosquitoes have been received from various parts of Egypt, the Sudan, and Abyssinia, and have been examined and named by Mr. Theobald, who contributes an article descriptive of the species, many of which

are new. Experiments were made on the use of an anilin dye, chrysordine, for the extermination of mosquito larvæ and pupæ. It was found to act satisfactorily in a dilution of 1 in 30,000, but for practical purposes its use in this strength would be prohibitive on account both of cost and of its yellow colour. Biting and noxious insects other than mosquitoes is the subject of the next article, the most interesting find being *G. morsitans*, the tsetse fly which carries nagana, on the Pongo River, Bahr-el-Ghazal, and a few pages are devoted to insects and vegetable parasites injurious to crops, the most important being an aphis destructive to the dura crop described by Mr. Theobald as *Aphis sorghi* (nov. sp.). Cyanogenesis, hydrocyanic production, in the dura (*Sorghum vulgare*) is another subject briefly dealt with, and of importance, since considerable loss of horses and cattle has sometimes been occasioned thereby. The dura contains a glucoside which yields hydrocyanic acid on decomposition, the cause of which has been ascribed to abnormal growth, but may be due to the dura aphis as demonstrated by Dr. Balfour.

Lastly, the general routine work, pathological and chemical, of the laboratories is summarised, some interesting notes are given of the various diseases met with in the Sudan, and the occurrence of eosinophilia in Bilharzia disease and dracontiasis is discussed.

We congratulate Dr. Balfour on his first year's work contained in this report, which is copiously illustrated, some of the coloured plates of mosquitoes and other insects being beautifully executed.

R. T. HEWLETT.

Till the Sun Grows Cold. By Maurice Grindon. Pp. 113. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1904.) Price 2*s.* 6*d.* net.

THOUGH this story is, so far as its main incidents are concerned, of a familiar kind, it differs from others in that several of the persons described are interested in science. For instance, there is a Sir John Harpur, who "was making important alterations in his Observatory; he was an ardent Astronomer, and F.R.A.S."; Lady Harpur, again, "had a love of flowers beyond that of a botanist, although she was adept in the science"; and the hero, Ralph Hillary, at one time of his life had a workroom "in which he could follow up chemical and other researches to his heart's content." Moreover, after Ralph takes as a second wife his early sweetheart, they engage together in scientific research, and discover a substance of "extraordinary radio-activity" to which they give the name Helenium—after Ralph's sister. We cannot say that the author has been successful in blending fact and fiction together so that one can scarcely be distinguished from the other; yet this art is essential to the writer of scientific romance or romantic science.

A Short Introduction to the Theory of Electrolytic Dissociation. By J. C. Gregory. Pp. 76. (London: Longmans and Co., 1905.) Price 1*s.* 6*d.*

THIS is a useful little book for those students who, after taking a course of systematic chemistry, wish to know something of the behaviour of electrolytic solutions. The language and mode of presentation are simple, and although one might take exception to many points of detail, the book, on the whole, should prove a trustworthy guide. The headings of the four chapters into which the book is divided afford a sufficient indication of its contents:—chapter i., the condition of dissolved substances; chapter ii., ions and precipitation; chapter iii., hydrogen and hydroxyl ions; chapter iv., electrolytic and general considerations.

LETTERS TO THE EDITOR.

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

Electromagnetics in a Moving Dielectric.

SOME time ago, when considering the assumption that the ether inside a body is quite stationary when a body is moved, and that in the application to Maxwell's ethereal equations this involves the use of a fixed time differentiation for the ether, and a moving one for the matter, I argued that the same applied not only to the electric polarisation, as done by Lorentz and by Larmor, but also to the magnetic polarisation. I told the late Prof. FitzGerald that to make the extension seemed to be a sort of categorical imperative. For it involves no assumption as to how the magnetic polarisation is produced. At the time I made the application to plane waves only. Since then I have extended it to the general case. The principal interest at present lies in the mechanical activity, fundamentally involved in the question of the pressure of radiation, and electromagnetic moving forces in general. The results confirm the desirability of applying similar reasoning to the magnetic and to the electric polarisation, in so far as they are relatively simple, and cast light upon the subject.

Thus, let $\mathbf{M}=V\mathbf{DB}$ be the complete *quasi*-momentum per unit volume, and $\mathbf{M}_0=V\mathbf{D}_0\mathbf{B}_0$ the ethereal part. Then if the velocity of the matter is $\mathbf{u}$, and of the ether $\mathbf{q}$, the motional activity (in the absence of free electrification, or variation of the electrical constants in space) comes to

$$\{\mathbf{u}(d/dt)+\nabla(\mathbf{u}.\mathbf{u}\}(\mathbf{M}-\mathbf{M}_0)+\{\mathbf{q}(d/dt)+\nabla(\mathbf{q}.\mathbf{q})\}\mathbf{M}_0\,; \qquad (1)$$

or, in a more developed form,

$$\mathbf{u}\{d/dt+\mathbf{u}\nabla+\nabla\mathbf{u}+\nabla_u.\mathbf{u}\}(\mathbf{M}-\mathbf{M}_0)+\mathbf{q}\{d/dt+\mathbf{q}\nabla+\nabla\mathbf{q}+\nabla_q.\mathbf{q}\}\mathbf{M}_0. \qquad (2)$$

Here the factor of $\mathbf{u}$ is the moving force on the matter, and that of $\mathbf{q}$ the force on the ether. It will be seen that in the material part we simply deduct that part of the complete $\mathbf{M}$ which does not move with the matter. This makes a great simplification of ideas. To avoid misconception, the ∇ in (1) acts upon all that follows, whereas in (2) the first ∇ acts on the $\mathbf{M}$'s, but the second and third on the velocities only, as may be seen on comparison with (1).

It is necessary, however, to point out distinctly the data involved in the above, as the simplification comes about in a special way. Divide the displacement $\mathbf{D}$ into $\mathbf{D}_0=c_0\mathbf{E}$ in the ether, and $\mathbf{D}_1=c_1\mathbf{E}_1$ in the matter, where $\mathbf{E}_1=\mathbf{E}+\mathbf{e}$, and $\mathbf{e}=V(\mathbf{u}-\mathbf{q})\mathbf{B}_0$. Similarly, divide the induction $\mathbf{B}$ into $\mathbf{B}_0=\mu_0\mathbf{H}$ and $\mathbf{B}_1=\mu_1\mathbf{H}_1$, where $\mathbf{H}_1=\mathbf{H}+\mathbf{h}$, and $\mathbf{h}=V\mathbf{D}_0(\mathbf{u}-\mathbf{q})$. The electric energy is $U_0+U_1=\frac{1}{2}\mathbf{ED}_0+\frac{1}{2}\mathbf{E}_1\mathbf{D}_1$, and the magnetic energy is $T_0+T_1=\frac{1}{2}\mathbf{HB}_0+\frac{1}{2}\mathbf{H}_1\mathbf{B}_1$. Also, let there be four æolotropic pressures, of Maxwellian type, say P_0, P_1 electric, and Q_0, Q_1 magnetic. *E.g.* $P_1=U_1-\mathbf{E}_1.\mathbf{D}_1$, meaning a tension U_1 parallel to $\mathbf{E}_1$ combined with equal lateral pressure. The rest are similar. Finally, the two circuital equations are

$$V\nabla(\mathbf{H}-\mathbf{h}_0-\mathbf{h}_1)=\dot{\mathbf{D}}, \qquad -V\nabla(\mathbf{E}-\mathbf{e}_0-\mathbf{e}_1)=\dot{\mathbf{B}}, \qquad (3)$$

where the motional electric and magnetic forces are defined by $\mathbf{h}_0=V\mathbf{D}_0\mathbf{q}$, $\mathbf{h}_1=V\mathbf{D}_1\mathbf{u}$, $\mathbf{e}_0=V\mathbf{q}\mathbf{B}_0$, $\mathbf{e}_1=V\mathbf{u}\mathbf{B}_1$. This completes the data, and from them may be derived the equation of activity

$$-\nabla\{V\mathbf{EH}+\mathbf{q}(U_0+T_0+P_0+Q_0)+\mathbf{u}(U_1+T_1+P_1+Q_1)\}$$
$$=\dot{U}+\dot{T}+(U_0/c_0)\dot{c}_0+(U_1/c_1)\dot{c}_1+(T_0/\mu_0)\dot{\mu}_0+(T_1/\mu_1)\dot{\mu}_1+\mathbf{F}_0\mathbf{q}+\mathbf{F}_1\mathbf{u}, \qquad (4)$$

where $\mathbf{F}_0$ and $\mathbf{F}_1$ are the forces displayed in (2). The meaning is that the left side of (4) is the convergence of the flux of energy made up of the Poynting flux, the convective flux, and the activity of the pressures, whilst the right side shows the result in increasing the stored energy *and* in work done upon the matter and ether, either, both or neither, according to the size of the two velocities.

The terms involving $\dot{c}$, &c., in (4) represent residual activity which may be of different sorts. The commonest is when the constants vary in space, especially at a boundary. For example, $\dot{c}_1=-\mathbf{u}\nabla.c_1$ if c_1 does not vary

in the moving matter. This means a moving force $-(U_1/c_1)\nabla c_1$. But if there is compression, c_1 probably always varies intrinsically as well.

It will be found that the omission of the auxiliary **h** has the result of complicating instead of simplifying the force formulæ. Similarly the omission of **e** complicates them. Now the use of **e** is founded upon the idea that the electric polarisation is produced by a separation of ions under the action of **E**, for $\mathbf{E}_1$ is the moving force on a moving unit electric charge. Analogously $\mathbf{h}_1$ is the moving force on a moving unit magnetic charge or magneton. If there are really no such things, the interpretation must be made equivalent in other terms. But the categorical imperative is not easily to be overcome.

The application to plane waves I described in a recent letter (NATURE, March 9) will be found to harmonise with the above in the special case.

But a correction is needed. In the estimation of the moving force on "glass" receiving radiation, the assumption was made that the electric and magnetic energies in the transmitted wave were equal. So the result is strictly limited by that condition. The conditions $E=wB$ and $U=T$ are not coextensive in general, though satisfied together in Lorentz's case. When U not $=T$, we have instead of (8), p. 439,

$$p_1v-p_2v-p_3w=w(T_3-U_3),$$

and the rate of loss of electromagnetic energy is

$$2\mu H_1H_2u+(w-u)(T_3-U_3).$$

Now this is zero when $e=0$, or the polarisation is proportional to the electric force. The question is raised how to discriminate, according to the data stated above, between cases of loss of energy and no loss. To answer this question, let **e** and **h** in the above be unstated in form; else the same. Then, instead of (4), the activity equation will be

$$-\nabla\mathbf{W}=\dot{\mathrm{U}}+\dot{\mathrm{T}}+\{\tfrac{1}{2}\mathrm{E}^2(\partial c_0/\partial t)+\ldots\}+(\mathbf{f}_0\mathbf{q}+\mathbf{f}_1\mathbf{u})-(e\mathbf{J}_1+h\mathbf{G}_1), \quad (5)$$

where **W** is as in (4), whilst $\mathbf{f}_0$ and $\mathbf{f}_1$ are the forces derived from the stresses specified (not the same as $\mathbf{F}_0$ and $\mathbf{F}_1$), and $\mathbf{J}_1$, $\mathbf{G}_1$ are the electric and magnetic polarisation currents, thus, $\mathbf{J}_1=\dot{\mathbf{D}}_1+\mathrm{V}\nabla\mathbf{h}_1$, &c. It follows that it is upon **e** and **h** that the loss of energy depends in plane waves, when **u** and **q** are constant. For the stresses reduce to longitudinal pressures, so that by line integration along a tube of energy flux we get

$$\Sigma(e\mathbf{J}_1+h\mathbf{G}_1)=\Sigma(\dot{\mathrm{U}}+\dot{\mathrm{T}}). \quad (6)$$

Thus, when a pulse enters moving glass from stationary ether, the rate of loss of energy is $\Sigma(-e\mathbf{J}_1)$. If e is zero, so is the loss, as in the special case above. There is also agreement with the calculated loss in the other case. That the moving force on the glass should be controlled by **e** is remarkable, for it is merely the small difference between the electric force on a fixed and a moving unit charge. The theory is not final, of course. If the electromagnetics of the ether and matter could be made very simple, it would be a fine thing; but it does not seem probable. OLIVER HEAVISIDE.

April 5.

The Dynamical Theory of Gases.

IN a letter to NATURE (April 13) Lord Rayleigh makes a criticism on my suggested explanation of the well known difficulty connected with the specific heats of a gas. He considers a gas bounded by a perfectly reflecting enclosure, and says "the only effect of the appeal to the æther is to bring in an infinitude of new modes of vibration, each of which, according to the law (of equipartition), should have its full share of the total energy."

The apparent difficulty was before my mind when writing my book. Indeed, as Lord Rayleigh remarks, something of the kind had already been indicated by Maxwell. (I think the passage to which Lord Rayleigh refers will be found in the "Coll. Works," ii., p. 433:—"Boltzmann has suggested that we are to look for the explanation in the mutual action between the molecules and the æthereal medium which surrounds them. I am afraid, however, that if we call in the help of this medium, we shall only increase the calculated specific heat, which is already too great.") It seemed to me, however, that the difficulty was fully met by the numerical results arrived at in chapter ix. of my book.

Suppose, to make the point at issue as definite as possible, we take a sample of air from the atmosphere, say at 15° C. Almost all the energy of this gas will be assignable to five degrees of freedom—so far as we know, three of translation and two of rotation. Let us surround this gas by an imaginary perfectly reflecting boundary. The total energy of matter and æther inside this enclosure will remain unaltered through all time, but this total energy may be divided conveniently into two parts:—

(1) The energy of the five degrees of freedom, say A.

(2) The energy of the remaining degrees of freedom of the matter plus the energy of the æther, say B.

As Lord Rayleigh insists, the system is now a conservative system, so that according to the law of equipartition, the total energy A+B is, *in the final state of the gas*, divided in the ratio

$$\mathrm{A}:\mathrm{B}=5:\infty \quad . \quad . \quad . \quad . \quad . \quad (1)$$

whereas observation seems to suggest that the ratio ought to retain its initial value

$$\mathrm{A}:\mathrm{B}=5:0 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This I fully admit, but a further point, which I tried to bring out in the chapter already mentioned, is that the transition from the ratio (2) to the ratio (1) is very slow—if my calculations are accurate, millions of years would hardly suffice for any perceptible change—so that, although (1) may be the true final ratio, it is quite impossible to obtain experimental evidence of it.

If the sample of gas were initially at a much higher temperature than we have supposed, the transition would undoubtedly be much more rapid; but even here we could not hope for experimental verification. For the assumed boundary, impervious to all forms of energy and itself possessing none, cannot be realised in practice, and as soon as the energy of the enclosed æther becomes appreciable, the imperfections of our apparatus would become of paramount importance in determining the sequence of events. J. H. JEANS.

Growth of a Wave-group when the Group-velocity is Negative.

THE following may be of interest in connection with the recent discussion on the flow of energy in such cases.

Let the energy of an element of a linearly arranged mechanical system be

$$\tfrac{1}{2}\{(d^2y/dxdt)^2+y^2\}dx/2.$$

Such a system can be approximately realised by taking a bicycle chain, loading it so that the radius of gyration of each link has the same large value, and suspending it by equal threads attached to each link so that the chain is horizontal and the axes of the links vertical. By the principle of least action we immediately find the equation of motion to be $d^4y/dx^2dt^2=y$. A simple harmonic wave is given by $y=\sin(pt-x/p)$. The group velocity is $-p^2$, and is negative. Let such a system, extending from $x=0$ to $x=\infty$, be at rest in its position of equilibrium at time $t=0$, and then let the point $x=0$ be moved so that its position at any subsequent time is given by $y=1-\cos t$.

By application of the usual method *viâ* Fourier's integral, the motion of the system is found to be given by either of the equivalent formulæ

$$y=\Sigma(-1)^n(t/x)^{n+1}\mathrm{J}_{2n+2}2\sqrt{(tx)},$$

or

$$y=1-\cos(t+x)-1+\Sigma(-1)^n(x/t)^n\mathrm{J}_{2n}2\sqrt{(tx)},$$

where the J's are Bessel's functions and the summations extend from $n=0$ to $n=\infty$. There are some doubtful

points in the reasoning, however, and the proof consists in showing (1) that y satisfies the differential equation, (2) from the second formula that $y=1-\cos t$ when $x=0$, (3) from the first formula that y and dy/dt are both zero when $t=0$, (4) from the first formula that when t is finite y is small for all large values of x. If, now, x is finite and t great, the second formula reduces to $y=-\cos(t+x)$, so that the motion now consists entirely of waves proceeding *towards* the source of the disturbance—a most remarkable result. If in the formulæ for y we change the sign of x, the J functions are replaced by I functions. The resulting value of y does not satisfy (4), and cannot be accepted as a solution of the problem.

H. C. POCKLINGTON.

The Transposition of Zoological Names.

AMONG the many radical changes in zoological nomenclature proposed of late years, none appear to me more open to objection than those where names which have long been in general use for particular species or groups are transferred to others on the ground that they were originally applied to the latter. One of the earliest of such transpositions was suggested by Prof. Newton, of Cambridge, who urged that Strix is not the proper generic designation of the barn-owl, and that while this species should be called *Aluco flammeus*, the tawny owl should take the generic title Strix, as *S. aluco*. I find, however, that this emendation is not accepted in the British Museum "Hand-list of Birds," where the barn-owl figures under its familiar title of *Strix flammea*. Uniformity is not, therefore, attained by this proposal.

Another instance occurs in the case of the walrus, which was long known as *Trichechus rosmarus*, until systematists discovered that the generic title refers properly to the manati, to which animal they transferred the name. Again, the *Simia satyrus* of Linnæus is now stated to be the chimpanzi, and not the orang-utan, and consequently Simia is made to stand for the latter instead of for the former. As a fourth example of this transference of a familiar generic name may be cited the case of the marmosets of the genus Hapale, to which it is now proposed to apply the title Chrysothrix, despite its practically immemorial use as the designation of the titi monkeys.

As an example of the transference of a species name, it will suffice to take the case of the African antelope commonly known as the white oryx (*Oryx leucoryx*). This name, it is stated, properly belongs to the Arabian Beatrix oryx, to which it is accordingly proposed that it should be transferred, after being so long used for the former animal.

Personally, I am very strongly of opinion that such transpositions should not on any account be permitted, and that when a species or genus has been known by a particular name for a period of, say, fifty years, this should, *ipso facto*, give such an indefeasible title to that name (altogether irrespective of its original application) as to bar its transference to any other group or species. It may, indeed, be deemed advisable that, as in the case of the walrus, the old name should not be retained in the generally accepted sense, but, if so, it should be altogether discarded, and not transferred. The practice of transferring names must, if persisted in, inevitably lead to much unnecessary confusion without the slightest compensating advantage. Indeed, it will render such works as Darwin's "Origin of Species" and Wallace's "Geographical Distribution of Animals," which are certain to live as biological classics, absolutely misleading to the next generation unless special explanatory glossaries are supplied.

Advanced systematists urge that those who refuse to follow their lead in this and other kindred emendations in nomenclature are not only old-fashioned and behind the times, but that they are absolutely doing their best to hinder the progress of zoological science. This, however, is but the opinion of a comparatively small (and, shall we say, somewhat prejudiced?) section. What we really want is the opinion of all those interested in zoology and natural history, namely, professional zoologists, palæontologists, geologists, physiologists, anatomists, zoogeographers, amateur naturalists, and sportsmen. If the general consensus of opinion of all these were on the side of the proposed changes, and of others of a similar type, then, and then only, I venture to think, could they be regarded as obligatory.

It may be added that the use of combinations, which Mr. Stebbing has felicitously designated "comicalities in nomenclature," of the type of *Anser anser* and *asinus asinus* (or, still worse, *Asinus asinus asinus*, which is a possible contingency), is rapidly tending to discredit the common sense of scientific zoologists among matter-of-fact men of the world.

R. LYDEKKER.

A little known Property of the Gyroscope.

To my surprise I have found that the property of the gyroscope which I am about to describe, although perfectly elementary, appears to be little known to either physicists or astronomers. Neither is it mentioned in the text-books so far as I am aware. That it has a very important bearing on the mechanism of the solar system has been shown in some of my earlier papers, but the laws which govern the rotation and the simple facts themselves seem to be so little understood that I have thought it worth while to explain them more fully in this place.

If a gyroscope is mounted on gimbals so that it may shift its plane of rotation freely about an axis passing through the plane of the revolving disc, we shall find it is possessed of certain curious properties. To most persons the notable characteristic of a gyroscope is the resistance it offers to any force tending to change the plane of its rotation. This is true of it only, however, in case certain conditions are complied with. If these conditions are neglected, it will change its plane with the greatest facility.

If the wheel is properly balanced and mounted as above described, and we set it spinning, it will continue to rotate in one plane without change until it stops. Suppose that while it is spinning we set it upon a table, and cause the stand supporting it to revolve slowly about its vertical axis. Instantly the wheel will adjust itself so as to revolve in a plane parallel to the surface of the table.

Furthermore, the direction of rotation of the wheel upon its axis will be the same as the direction of rotation of the stand. If we turn the stand in the opposite direction the wheel will at once shift its plane, and turn over, so as again to rotate in the same direction as the stand.

Another way of showing the experiment is to hold the stand supporting the gyroscope at arm's length. The observer then slowly revolves upon his heels, first in one direction and then in the other. Each time the observer shifts his own direction of motion the gyroscope will shift its plane, and always in such a manner that its direction of rotation shall be parallel and in the same direction as its revolution in its orbit.

It is a well known fact that according to the nebular hypothesis all the planets should have rotated in a direction opposite to that of their revolution in their orbits, just as Neptune does at the present time. This is because by Kepler's laws the inner edge of a revolving ring must necessarily move faster than the outer edge. The fact that Neptune is the only planet that even approximately fulfils this condition has always been a source of trouble to the adherents of the nebular hypothesis. No one has ever even attempted to explain the anomalous rotation of Uranus, in a plane practically perpendicular to the plane of its orbit.

The interesting property of rotating bodies illustrated above in the case of the gyroscope, and fully explained by its theory, now at once makes the matter perfectly clear. In the case of the planetary bodies, the force rotating the stand of the gyroscope is supplied by the annual tide raised upon the planets by the sun. In former times, when the planets were large diffuse bodies, this tidal force was of considerable importance. Neptune, however, is so remote from the sun that the tidal influence upon it has always been small. The plane of its rotation, therefore, has been but slightly shifted from that of its orbit—about 35°. Uranus being nearer the sun has had its plane shifted nearly half-way over, or through 82°. The plane of rotation of Saturn has been shifted through 153°, while that of Jupiter has suffered a nearly complete reversal, and the planet now revolves approximately in the plane of its

orbit. The deviation amounts to but 3°, and its plane of rotation has therefore shifted through 177°.

The explanation of the retrograde rotation of Phœbe is now also clear. Phœbe, the first-born of Saturn's numerous retinue, came into being while the planet itself still retained its original plane of rotation, that is, while it was still revolving in a retrograde direction. Before Iapetus, Saturn's second satellite, reckoning from without inwards, was created, the mighty tides acting upon the planet in its then diffuse condition had shifted its plane of rotation more than 90°. Two forces then acted on the plane of the orbit of the new satellite, one from the sun tending to bring the orbit into the plane of the orbit of Saturn, the other from Saturn tending to bring the orbit of the satellite into the plane of the equator of its primary. At first both forces tended to produce the same result, namely, to diminish the angle of inclination of the plane of the orbit of the satellite. They are now pulling in opposite directions, as is the case with our own moon, the inclination of the orbit of Iapetus, 19°, being less than that of the equatorial plane of its primary.

The inner satellites of Saturn are more powerfully affected by the equatorial expansion of the planet than by the action of the sun, the planes of their orbits, 27°, coinciding nearly with the plane of the planet's equator.

WILLIAM H. PICKERING.

Harvard Observatory, Cambridge, Mass., U.S.A.

Have Chemical Compounds a Definite Critical Temperature and Pressure of Decomposition?

So far nobody seems to have considered the question whether to every chemical compound there exists a definite critical temperature and pressure of decomposition. Yet I think the following considerations show that such constants probably do exist. Suppose we place a given compound (say $CaCO_3$) in a closed cylinder and subject it to a continually increasing temperature, keeping the pressure constant by means of a weighted piston. Then at a certain definite temperature range the compound will begin to decompose. Suppose, now, we increase the pressure sufficiently; then the decomposition ceases, and the substance can now bear a higher temperature than before without decomposition.

Proceeding in this way, it is, I think, obvious from the *finite* nature of the mass of the atoms, and from the limited intensity of the forces holding them together in the molecule, that ultimately at some definite finite temperature the external forces tending to drive the atoms apart will become equal to the maximum internal forces that the atoms can exert on each other in the molecule. It therefore follows that above a certain definite temperature, depending upon the nature of the molecule, no pressure, however great, can prevent the substance from completely decomposing. This temperature and pressure, above which a compound is incapable of existing, we will call the critical temperature and pressure of decomposition of the compound. The critical temperature and pressure of decomposition would therefore be completely analogous to the critical temperature of liquefaction of a compound—only in the latter case we are dealing with the temperature whereat a certain molecular condition of existence disappears, and in the former case with the temperature whereat a certain atomic condition of existence disappears.

Since atoms are a very much more finely divided form of matter than molecules, it is clear that the critical temperature of decomposition of a compound must be a very much sharper and clear-cut constant than its critical temperature of liquefaction. The critical temperature and pressure of even very unstable compounds is usually very high, provided there exist but a few atoms in the molecule. For example, $AuCl_3$, ozone, and the oxides of nitrogen, although very unstable at ordinary temperatures, seem capable of existing at very high temperatures. In general, the greater the number of atoms contained in the molecule the lower the critical temperature of decomposition, as is evident from the general observation that the more complex a compound is the easier it is to decompose. Many of the very complex carbon compounds—for example, the proteids—have, on account of their complexity, critical temperatures of decomposition which lie very close to the normal temperature of the earth's surface.

If, now, by some means we proceed to add on atoms to such a molecule so as to make it more and more complex, we would steadily lower its critical temperature of decomposition, and by adding on a suitable kind and number of atoms we could reduce the critical temperature and pressure of the compound until they coincided with the normal temperatures and pressures which hold upon the earth's surface. Such a compound would be possessed of an extraordinary sensitiveness to external influences on account of the sharpness of the constants called above the critical temperature and pressure of the compound. The slightest increase of temperature or decrease of pressure would serve to throw it into a condition of rapid chemical decomposition, whereas a slight increase of pressure and decrease of temperature would cause it to cease to decompose. Even did we maintain the external temperature and pressure exactly at the critical temperature and pressure of the compound, nevertheless the external impulses which are continuously pervading all space in the neighbourhood of the solar system, beating intermittently upon the sensitive substance, would be sufficient to throw it into a series of rapidly alternating states of decomposition and repose.

I suggest that the temperature range of animal life is probably nothing more or less than the range of the critical temperatures of decomposition of a series of certain very complex carbon compounds which are grouped together under the name "protoplasm," the external pressure of the atmosphere coinciding roughly with their critical pressures of decomposition. In fact, I suggest that just as a tuning-fork is set into motion by vibrations of a certain definite frequency and by no others, so living matter is so constructed as to respond continuously to the incessant minute fluctuations in the external conditions which hold upon the earth, the state of response being what is known as life. The temperature of animal life keeps remarkably constant, as it should do on our supposition, a temperature too high exceeding the critical temperature of decomposition of living matter and so destroying its structure, while a temperature too low causes it to cease to decompose, and the living matter becomes inactive.

GEOFFREY MARTIN.

University of Kiel, April 4.

[THE writer of the above will see his "suggestion" discussed in Lockyer's "Inorganic Evolution," book iii.—ED. NATURE.]

Experiment on Pressure due to Waves.

I HAVE seen both in the *Physikalische Zeitschrift* (January) and in the *Physical Review* (February) an account of an experiment by Prof. R. W. Wood to demonstrate the pressure due to waves, and which he suggests as a lecture demonstration of the effect observed by Lebedeff and by Nichols and Hull. The same experiment is quoted by Prof. Poynting in his address on this subject to the Physical Society of London (*Phil. Mag.*, April). I venture to suggest that the experiment, which consists in setting a small windmill in motion by means of Leyden jar discharges maintained by a transformer, will bear a different explanation. It was shown long ago (1793) by Kinnersley, of Philadelphia, in his "Electrical Thermometer," that a jar discharge produces in air a violent explosive effect, which we should now explain by the repulsion between constituents of the current in opposite phase to one another. The repulsive force may be very great. I think it is this explosive effect that Prof. Wood shows in the experiment, and not the pressure due to reflection of a continuous train of waves. I do not think that the suggestion is new, but it appears to me that the same cause may account for the disruption which occurs when lightning strikes a building, an instance of which is recorded in NATURE of April 13 (p. 565) in the displacement of some of the blocks of the small pyramid.

SIDNEY SKINNER.

South-Western Polytechnic, Chelsea, April 15.

TANTALUM.

THE application of electricity to chemical problems has again borne fruit in the isolation and preparation of tantalum. Dr. Werner von Bolton, of the firm of Siemens and Halske, published the results of his very interesting research upon the preparation of tantalum in the *Zeitschrift für Elektrochemie* (January 20). Although the existence of tantalum was pointed out by Hatchett in 1801, it does not appear up to the present to have been prepared in the pure condition. Moissan, indeed, in 1902 prepared the metal by reducing tantalic oxide (Ta_2O_5) in the electric furnace. But the metal was extremely hard and brittle, a property which Dr. Bolton now shows only belongs to the impure product; Moissan's metal probably contained some carbide. Dr. Bolton has succeeded in obtaining the metal by an electrical and by a chemical method.

The Electrolytic Method.

As is well known, Nernst found that when a thin rod of magnesia (MgO) is heated to whiteness it becomes able to conduct the electric current, the magnesia being split up into its components, magnesium and oxygen; the magnesium, however, immediately re-combines with oxygen, the process of electrolysis therefore becoming continuous. Other metallic oxides, such as zirconium, ytterbium, thorium, calcium, and aluminium, &c., likewise behave in a similar manner. If, now, a rod of magnesium is strongly heated in vacuum and the electric current passed through it, the oxygen given off is so dilute that re-combination does not take place, and the rod becomes powdered. Dr. Bolton, working along somewhat similar lines, found that the coloured or lower oxides of vanadium, niobium (columbium), and tantalum will conduct the electric current without the necessity of being heated to very high temperatures. Strange to say, the colourless or higher oxides have not this property.

In order to prepare tantalum in this manner a filament of the brown tantalum tetroxide (Ta_2O_4) was prepared and fixed into an evacuated globe, which was connected with a vacuum pump, so that if oxygen was given off, on heating, it could be pumped out. On passing a current through this filament, at first the two ends of the filament became white hot, and then gradually the incandescence travelled along the filament until the whole of it became incandescent. A large quantity of oxygen was given out, and the filament, which at the commencement was brown, became metallic grey. The tantalum so obtained showed on analysis a purity of 99 per cent.

The Chemical Method.

Details as to how the chemical method is carried out are not given. Dr. Bolton simply says that the metal can be obtained by fusing a mixture of potassium tantalum fluoride with potassium by means of the electric arc furnace in a vacuum. This method is a modification of that used by Berzelius in 1824.

Properties of the Metal.

One of the most remarkable properties of the metal is its extreme ductility combined with extraordinary hardness. The red-hot metal can readily be rolled into sheets and foil, and easily drawn into wire. When the sheet is again heated and hammered it becomes so extremely hard that it was found impossible, by means of a diamond drill, to bore a hole through a sheet 1 mm. thick. The drill, rotating 5000 times to the minute, was worked day and night for three days, and at the end of the time had only made a depression 0.25 mm. deep, while the diamond of the drill was very much worn. This property may very probably lead to its being used for drills in place of the diamond.

The metal melts between 2250° and 2300°. The atomic heat agrees with the law of Dulong and Petit, being 6.64. The specific gravity is 14.08. When two electrodes of tantalum are placed in a bath of dilute sulphuric acid, the tantalum becomes passive, and even with an E.M.F. of 220 volts at the terminals no current passes. When placed opposite an electrode of platinum only one phase of an alternating current passes; it may thus be used for rectifying an alternating current in the same manner that aluminium can.

In the form of wire, sheet or ingots, the metal is unacted upon by sulphuric, hydrochloric, or nitric acid, and even by aqua regia. Hydrofluoric acid reacts very slowly, unless the metal is in contact with platinum, for example, in a platinum dish, when it dissolves readily with evolution of hydrogen. Fused alkalis have no action upon it.

FIG. 1.—View of Tantalum Lamp. Half-size linear.

When made the kathode in an acid electrolyte it absorbs hydrogen, which is only partially given up, even when the metal is fused. The metal may be heated to red heat in the air without taking fire. At 400° it turns slightly yellow, at a low red heat it turns blue, and finally becomes coated with a white protective coating of the pentoxide. It absorbs nitrogen at a white heat, and unites with sulphur when melted with it under fused potassium chloride. Tantalum apparently forms no amalgam with mercury, although it produces alloys with most other metals. When united with 1 per cent. of carbon it becomes hard and brittle, and can no longer be drawn into wire.

As already stated, the original idea in working with tantalum was to find a new material to be used for incandescent electric lamps. The first experiments were tried with the oxides of vanadium and niobium (columbium); the coloured or lower oxides of these metals were found to conduct the current and to give up their oxygen when thus heated in vacuum. Vanadium so obtained was found to melt at 1680° and niobium at 1950°; but owing to these comparatively low melting points they could not satisfactorily be employed for electric lighting purposes. Tantalum, however, which melts between 2250° and 2300°, has been successfully employed for this purpose by Messrs. Siemens and Halske.

Filaments of the metallic tantalum are fused into a globe, which is then evacuated in the usual manner. The first lamp was made with the usual bow-shaped filament, and required 0.58 ampere with a pressure of 9 volts, giving 3 candle-power. It was then found that in order to produce a 22 candle-power lamp suitable to being placed on a 110-volt circuit more than 20 inches length of filament was required. The difficulty presented was to get this great length of filament conveniently into the ordinary sized globe. The illustration (taken from the *Electrical Magazine* for March) shows how the difficulty was got over. The central support is a rod of glass, having a number of wires radiating from it to act as supports. This

lamp gives 22 candle-power with an energy consumption of 1·7 watt per candle-power, or about half that required by the ordinary incandescent lamp. The weight of a single filament is 0·022 gram, so that 1 kilogram of metal would be sufficient for 45,000 such lamps.

Whether it will be possible to obtain sufficient mineral to produce tantalum on a really large scale remains to be seen, because if it is possible there should be hardly an end to the usefulness of this metal, which possesses the properties ductility and hardness in such an extraordinary degree, leaving entirely out of question its employment in electric lamps.

F. MOLLWO PERKIN.

PRIMITIVE WATER-SUPPLY.[1]

THE mighty earthworks that still crown so many of our hills fill the archæologist alike with wonder and despair—wonder that prehistoric man, with the most primitive tools, was equal to the task of raising them, and despair that so little can ever be known about them, despite the most laborious and costly excavation. Plenty of books, however, of the kind now under notice would do much to solve the mystery and increase our admiration for Neolithic man, for it is to the period before bronze was known in Britain that the authors assign the stupendous works of Cissbury and Chanctonbury on the South Downs.

This is an open-air book that gives life to the dry bones of archæology, and reads like the record of a well-spent holiday. A keen eye for country is one of the qualifications possessed by one or both the authors, and evidence of ramparts long since levelled is wrung from the very daisies as they grow. The construction of dew-ponds by the early inhabitants of Britain has often been glibly asserted, but few, if any, have furnished such clear and circumstantial evidence as the authors of this short treatise. The water-supply for the occupants of our huge prehistoric "camps" has always been somewhat of a mystery, and it has been suggested that they were only temporary refuges, when the country was "up," so that a permanent supply was not regarded as a necessity. But the watering of men and animals on the scale indicated by the areas enclosed would be a formidable task even for a day, and another explanation must be sought. The late General Pitt-Rivers, for example, held that the water-level of the combes was higher then than now, and streams would have been plentiful on the slopes; but, feeling the inadequacy of this view, he also had recourse to the dew-pond theory. To those familiar with the process, this might seem an obvious expedient, but the interesting account given of the formation of such reservoirs might make us chary of crediting prehistoric man with such scientific methods.

An exposed position innocent of springs was selected, and straw or some other non-conductor of heat spread over the hollowed surface. This was next covered with a thick layer of well puddled clay, which was closely strewn with stones. The pond would gradually fill, and provide a constant supply of pure water, due to condensation during the night of the warm, moist air from the ground on the surface of the cold clay. Evaporation during the day is less rapid than this condensation, and the only danger is that the straw should be sodden by leakage. It is for this reason that springs or drainage from higher ground are avoided, as running water would cut into the clay crust.

Some ponds of this kind, no doubt of very early and perhaps of Neolithic date, may still be seen in working order: others are of modern construction; but to and from the ancient dew-ponds (or their sites) can sometimes be traced the hillside tracks along which the herds were driven, one leading from the camp, or cattle-enclosure hard by, to the watering-place, another leading back, to avoid confusion on the road. These and other details as to guard-houses and posts of observation are brought to our notice in the description of selected strongholds in Sussex and Dorset; and verification, if, indeed, such is demanded, must be sought on the spot by any who have doubts or rival theories.

FIG. 1.—Cattle-ways leading down to Dew-pond at the North of Cissbury Ring. From Hubbards "Neolithic Dew-ponds and Cattle-ways."

The banks, that enclosed pasture-areas sometimes of vast extent, were no doubt stockaded against man and beast, and may be compared with the base-court defences of the Norman burh; but the excavator of Wansdyke had an alternative theory that such banks were sometimes erected for driving game. Incidentally, the authors discountenance the view that the "camps," not to mention the outworks, were ever efficiently manned. Their extent would necessitate for this duty a vast number of fighting men within call.

[1] "Neolithic Dew-ponds and Cattle-ways." By A. J. Hubbard and G. Hubbard. Pp. x+69; illustrated. (London: Longmans, Green and Co., 1905.) Price 3*s*. 6*d*. net.

Possibly, in a few instances, the ridges on the hill-slopes may be due to outcropping strata, and others might suggest terrace-cultivation; but there seems ample evidence for the view taken that Neolithic cattle-tracks have survived to this day around certain of our most imposing "camps."

Failing large-scale maps, a sketch-plan of the earthworks noticed would have made the description even more illuminating; but the only matters of complaint are that the book is all too short, and that the paper selected to throw up the detail of the photographs is as chalky as the Downs they illustrate so pleasantly.

HENRY BENEDICT MEDLICOTT, F.R.S.

ON April 6 there passed away one of the few survivors amongst the small body of men who laid the foundations of Indian geology. Despite much excellent work, chiefly by non-professional men, very little was really known of the geology of India, and especially of Peninsular India, before the middle of the nineteenth century, and as one instance amongst many, the Vindhyans, now believed to be Archæan, were still classed with Gondwana Permo-Carboniferous strata, and both were regarded as of Jurassic age. A comparison of Dr. Carter's "Summary of the Geology of India between the Ganges, the Indus and Cape Comorin," published in 1853, with the "Manual of the Geology of India," issued in 1879, will show the great improvement that took place in the meantime in our knowledge of the country.

In this change none had a larger share than Henry Benedict Medlicott. Born in Loughrea, county Galway, he was the second of three sons of the Rev. Samuel Medlicott, rector of Loughrea, and of Charlotte, the daughter of Colonel H. B. Dolphin, C.B. All three sons were men of great intellectual capacity and of marked originality. The eldest, J. G. Medlicott, became a member of the Geological Survey of India before his brother joined; he was subsequently in the Indian Educational Service, and died in 1866. The third brother, Samuel, was a clergyman, who has also been dead several years. The subject of the present memoir was educated at Trinity College, Dublin, and, after taking his degree, was for a short time on the staff, first of the Irish, then of the English Geological Survey. In the spring of 1853 he joined the Geological Survey of India under the late Dr. Thomas Oldham, but was almost immediately appointed professor of geology at the Roorkee College of Civil Engineering, an appointment which he held until 1862, when, on some additions being made to the staff, he re-joined the Geological Survey of India, and was made deputy superintendent for Bengal.

But during his tenure of the Roorkee post he spent part of the year surveying for the Geological Survey, and in his first season's work he and his brother made a primary step towards the elucidation of Indian geological history by separating the ancient Vindhyans north of the Son and Nerbudda Rivers from the Indian Coal-measures and their allies to the southward. In subsequent years, whilst his brother mapped the last named strata, he surveyed the older Vindhyans and their associates, and to him we owe our first recognition of the Bijawur and other ancient rocks between the old gneissic formation and the Vindhyans. In other years he explored the Himalayas, and the ranges at their base, between the Ganges and the Ravi, and he drew up the description of the older unfossiliferous beds of the mountains, and of the Tertiary and other strata fringing their base, which was published in the third volume of the Indian *Memoirs*. This contains a sketch of the history of the Himalayas which has been generally accepted ever since.

After returning to the survey in 1862 (he always protested that he really had remained a member of the staff throughout), he examined in successive years the greater part of northern India. Various tracts of the Himalayas from the Punjab to Assam, the Assam valley and the hill ranges south of it, and, in the Peninsula, Rajputana, Nimar, the Nerbudda valley and Satpura ranges, Bundelkhand, South Rewah, Chhatisgarh and Sambalpur, Chota Nagpore, Hazaribagh, and Behar were visited and reported upon in turn.

Dr. Oldham retired in 1876, and Mr. Medlicott succeeded him as superintendent, a title subsequently changed to director of the survey. The first work undertaken by him as superintendent was a general account of Indian geology. This had long been urgent, and would probably have been written by Dr. Oldham but for failing health. The "Manual of the Geology of India" was published in 1879, and a very large portion, including the account of the Azoic rocks from gneiss to Vindhyans (which between them cover the greater part of the Indian peninsula), and of the geology of the Himalayas and sub-Himalayas, in fact, nearly half the entire work, was written by Mr. Medlicott himself. In many ways a great impulse was given to survey work by the new superintendent. As regards publication alone, the volumes of the *Records* from 1877 are doubled in bulk when compared with previous issues, and these volumes, containing accounts of recent geological observations, both economical and scientific, represent the actual field work of the survey to a larger extent than the longer memoirs and palæontologia.

Throughout his career as head of the survey Mr. Medlicott adopted a most liberal policy of publication. He allowed his staff to report on their own work freely, and whilst assisting them in every way, both in the field and in the study, he never took any of the credit of their work. Not only did he welcome reports from the geologists of the survey, but he published, whenever possible, contributions from independent observers. In this manner he secured the valuable assistance of the late General McMahon, the whole of whose most important observations on the physical history of the Himalayas appeared in the *Records* of the Geological Survey of India.

Modest and retiring, he was nevertheless a man of high courage and independence. One trait of this was shown in the Indian Mutiny, when, with one companion, despite the mutiny of the guard that should have accompanied them, he saved the lives of a Christian family who had fallen into the hands of the rebels, a most gallant action, the account of which is due to Colonel Baird Smith, the head of Roorkee College and the commanding officer. After retiring from the Indian Survey in 1887, he lived very quietly at Clifton, devoting himself to philosophical problems. He published a couple of short pamphlets on "Agnosticism and Faith" in 1888, and on "The Evolution of Mind in Man," but a larger work on which he was engaged is, it must be feared, incomplete. A strain caused by bicycling led to serious heart symptoms some years ago, and although a partial recovery was made, a relapse about a year since reduced him so much that it was not surprising to hear that he passed quietly away on April 6, whilst seated in his study.

Mr. Medlicott became a Fellow of the Geological Society as long since as 1856, and in 1888, on his retirement from India, he received the Wollaston

medal. He was elected a Fellow of the Royal Society in 1877. He received the military medal for his services in the Mutiny. He was also a Fellow of Calcutta University, and from 1879 to 1881 he was president of the Asiatic Society of Bengal.

W. T. B.

NOTES.

THE report on the natural history collections made in the Antarctic regions by the *Discovery* Expedition, to be published by the trustees of the British Museum, and edited by Prof. E. Ray Lankester, F.R.S., promises to be of particular interest and importance. The working out of the collections has been entrusted to nearly fifty naturalists, each of whom will deal with material in which he is specially interested. Inquiries concerning the zoological and botanical collections should be addressed to Mr. F. Jeffrey Bell, British Museum (Natural History), Cromwell Road, London, S.W.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed before the institution during the past session:—Telford gold medals to Lord Brassey, K.C.B., and Mr. C. S. R. Palmer; a George Stephenson gold medal to Mr. Lyonel E. Clark; a Watt gold medal to Mr. J. F. C. Snell; Telford premiums to Messrs. L. F. Vernon-Harcourt, R. W. Allen, and Wm. Marriott; a Crampton prize to Mr. A. Wood-Hill, and the Manby premium to Mr. E. D. Pain. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session. Sir Alexander Binnie has been elected president of the institution in succession to Sir Guilford Molesworth, K.C.I.E.

MR. W. E. COOKE, Government astronomer for Western Australia, writes to us from the observatory at Perth to direct attention to an unusual seismic disturbance in that place. During March 5 there were three marked earthquakes in the space of a few hours, and these reached their maxima at 16h. 25·8m., 19h. 0·1m., and 13h. 42·6m. The times are given in Greenwich civil time. Each maximum was preceded by tremors from fifteen to twenty minutes earlier, and by a large wave from ten to fifteen minutes before the maximum. It is noteworthy that the transit circle was displaced considerably in both level and azimuth. Another earth tremor, the greatest yet registered on the Milne seismograph at Perth, occurred on March 19. There were no preliminary tremors; the disturbance proper commenced abruptly, and reached a maximum in 19·6m.

THE workers at the Port Erin Biological Station during this spring vacation include Prof. B. Moore, Dr. H. E. Roaf, and Mr. B. Whitley (all from the biochemical department of the University of Liverpool), Mr. J. A. Dell and Mr. E. Standing (from the University of Leeds), Prof. Herdman, Mr. W. Dakin, and Mr. W. A. Gunn (from the University of Liverpool), and Mr. Chadwick, the curator. Prof. Moore and his party are investigating the changes produced in the growth of embryos by alterations in the constitution of the sea-water and other conditions of the environment. The other workers are engaged on various lines of zoological research. The fish-hatching is now going on rapidly, and more than three millions of plaice fry have already been turned into the sea this month. The parent plaice in the spawning pond were evidently about a fortnight earlier in reproducing this season than last, as the first fertilised eggs were obtained on February 14, and in large quantity, as against March 3 in 1904.

IT is proposed to send out a special series of telegraphic time signals beginning at 11.55 p.m., United States Eastern Standard Time (mean time of the 75th meridian west from Greenwich), on May 3, and ending at midnight, according to the plan followed daily at noon. These special time signals will be sent out by request of the American Railway Association, with the approval of the Secretary of the Navy, in honour of the International Railway Congress, which is to meet in the capital of the United States on the following day. It is hoped that the principal observatories of the world will make efforts to receive and time these signals accurately, and reports of such observations may be made at once, without expense, through the courtesy of the various telegraph and cable companies. This was done in the case of the New Year's Eve time signals from the United States Naval Observatory, which are reported to have reached the Toronto Observatory in 0·00s.; Lick Observatory, 0·05s.; City of Mexico, 0·11s.; Manila, 0·37s.; Greenwich, 1·33s.; Sydney, Australia, 2·25s.; Wellington, N.Z., 4·00s.; and Cordoba, Argentina, 7·7s. From the rapidity and accuracy with which these time signals are transmitted over connecting land lines, as a result of long experience in transmitting the daily noon signals, it seems very probable, if the telegraph companies will take especial care in their transmission and not interpose any secondary clocks or human relays, that they may serve to give fairly accurate determinations of longitude at any telegraph station on the American continent where they can be noted exactly and compared with accurate local time.

IT was decided in the Chancery Division of the High Court on April 19 that the public has not the right of free access to Stonehenge. The question of free access was raised by an action in which the Attorney-General claimed an order against Sir Edmund Antrobus to remove the fencing which now encloses Stonehenge, and an injunction to restrain him from erecting any such fencing. The claim was based on two grounds:—(1) that Stonehenge is a national monument of great interest and is subject to a trust for its free user by the public; (2) that there are public roads running up to and through Stonehenge, and that those roads have been blocked by the defendant's fencing. Mr. Justice Farwell, who heard the action, decided that both these claims were untenable; and he therefore dismissed the action, with costs. In concluding this judgment, his Lordship is reported by the *Times* to have remarked:—"I hold that the access to the circle was incident only to the permission to visit and inspect the stones, and was, therefore, permissive only, and, further, that the tracks to the circle are not thoroughfares, but lead only to the circle, where the public have no right without permission, and, therefore, are not public ways. The action accordingly fails, and ought never to have been brought. It is plain that the vicinity of the camp and the consequent increase of visitors compelled the defendant to protect the stones if they were to be preserved; and he has done nothing more than is necessary for such protection. I desire to give the relators credit for wishing only to preserve this unique relic of a former age for the benefit of the public, but I fail to appreciate their method of attaining this. The first claim to dispossess the defendant of his property is simply extravagant, so much so that, although not technically abandoned, no serious argument was addressed to me in support of it. The rest of the claim—for rights of way over the network of tracks shown on the plaintiff's plan—if successful would defeat the relators' object. If these ways were left unfenced and heavy traffic passed through the circle, there

would be great risk of injury, and even without such traffic there is great risk from the increased numbers of passers-by. As Sir Norman Lockyer (whose interesting application of the orientation theory to Stonehenge has recently appeared) says in one of his articles:—'The real destructive agent has been man himself—savages could not have played more havoc with the monument than the English who have visited it at different times for different purposes.' I feel no confidence that the majority of tourists have improved, nay, rather—'Aetas parentum, pejor avis, tulit Nos nequiores.' It is only fair to the defendant to say that he is not acting capriciously, but on expert advice for the preservation of the stones. If, on the other hand, the roads are all fenced off, the general appearance would be ruined, and no human being would be in any way the better. It is not immaterial to remark that this is not the action of the district or the county council to preserve rights of way, but is brought on the relation of strangers on the score of the public interest in Stonehenge."

THE death is announced of Prof. A. A. Wright, professor of geology and zoology at Oberlin College since 1874.

THE Rome correspondent of the *Daily Chronicle* reports that Vesuvius is again in full eruption, and that earthquake shocks are frequent in the Vesuvian communes.

THE French Government, says the *British Medical Journal*, has granted a subvention of 4000*l*. in aid of the International Congress on Tuberculosis, which is to be held in Paris next October.

DR. L. F. BARKER, professor of medicine at the Rush Medical School, Chicago, has been appointed to the chair of medicine in Johns Hopkins University, Baltimore, in succession to Prof. Osler.

A DINNER will be given at the Hotel Cecil on May 10, under the presidency of Mr. Chamberlain, and with the support of the present Secretary of State for the Colonies, in aid of the funds of the London School of Tropical Medicine.

WE learn from the *Times* that the twenty-fifth anniversary of the return of the *Vega* from Arctic regions after accomplishing the north-east passage under Baron Nordenskjöld was celebrated at Stockholm on April 24. The King of Sweden and the Crown Prince and the other members of the Royal Family were present at the commemorative meeting, as well as Admiral Palander, Minister of Marine, who commanded the expedition.

A DISTINCT earthquake shock was felt shortly after 1.30 a.m. on April 23 over a large area in the north of England, including parts of Yorkshire, Derbyshire, Nottinghamshire, and Lincolnshire. The shock is reported to have been unmistakable, and to have lasted several seconds. There is a want of agreement in the reports as to whether the movement was from west to east, or *vice versâ*, and it is not clear if one or two shocks occurred. A heavy rumbling sound is said to have been heard at Sheffield, Selby, Worksop, and other places.

ON Tuesday next, May 2, Prof. L. C. Miall will deliver the first of three lectures on the "Study of Extinct Animals," on Thursday, May 4, Sir James Dewar will commence a course of three lectures on "Flame," and on Saturday, May 6, Prof. Marshall Ward will begin a course of two lectures on "Moulds and Mouldiness." The Friday evening discourse on May 5 will be delivered by Prof. H. E. Armstrong, the subject being "Problems Underlying Nutrition," on May 12 by Prof. E. Fox Nicholls on "The Pressure due to Radiation," and on May 19 by Sir Charles Eliot on "The Native Races of the British East Africa Protectorate."

THE annual meeting and conversazione of the Selborne Society will be held by kind permission in the theatre and halls of the Civil Service Commission, Burlington Gardens, on the evening of May 3. Lord Avebury will give the annual address, Mrs. Dukinfield Scott will show her kammatograph pictures of opening flowers, Mr. Fred Enock will describe the work of a wood-boring wasp with the help of some moving slides, Mr. Oliver G. Pike will contribute a short lecture, while Mr. Percival Westell has promised to give an account of the actions of a young cuckoo, and to show photographs in illustration of them. There will also be many exhibits, including microscopes lent by members of the Royal Microscopical Society and the Quekett Club. All particulars may be obtained from the honorary secretary, Mr. Wilfred Mark Webb, 20 Hanover Square, W.

A LARGE portion of the second part of the first volume of the *Proceedings of the Manchester Field Club* is taken up by the beautifully illustrated article on protective resemblances in insects, by Mr. M. L. Sykes, which was summarised in NATURE of March 30. In addition to a number of shorter articles, mostly the reproductions of addresses delivered at meetings of the club, the volume contains the reports for the years 1900 and 1901, together with lists of officers and council.

THE first article in the *Irish Naturalist* for April is devoted to an illustrated description of the Patterson Museum in the new People's Palace at Belfast. The greater portion of this natural history exhibition is contained in a lofty chamber 75 feet in length by 25 feet in width. The work of planning the cases and obtaining specimens with which to fill them was entrusted by the managers of the palace to Mr. R. Patterson, who seems to have carried out his task with conspicuous success. Specimens were contributed by a large number of donors, and Mr. Patterson himself has consented to act as honorary curator.

FROM the Bergen Museum we have received copies of the *Aarsberetning* and the *Aarbog* for 1904. The former contains photographs of three exhibits added during the year to the vertebrate series. Of these, the groups of snowy owls and of sea-eagles appear unexceptionable, but we cannot congratulate the authorities on the plan of placing a red deer mounted on a quadrangular wooden stand in front of a background formed by a picture of a fir-plantation bordering a church. In the *Aarbog* the most important communication is one by Mr. R. Høye dealing with the methods of curing salt and kippered fish, and describing the mycetozoa frequently developed during or after the process.

WE have received a bound copy of the second volume of "Marine Investigations in South Africa," issued at Cape Town by the Department of Agriculture of Cape Colony. Although the title-page is dated 1904, the whole of the eleven papers contained in the volume were published during 1902 and 1903. The subjects include Crustacea, by the Rev. T. R. R. Stebbing; Mollusca (two papers), by Mr. G. B. Sowerby; fishes (three papers), by Dr. Gilchrist; deep-sea fishes, by Mr. Boulenger; corals, by Mr. Gardiner; sponges (two papers), by Mr. Kirkpatrick; and ocean currents. Several of the articles have been noticed in our columns as they were issued.

To the April number of the *Journal of Anatomy and Physiology* Dr. A. Keith contributes a thoughtful article on the nature of the mammalian diaphragm and pleural cavity. The pleural cavity he considers to have been formed by a hernia-like outgrowth from the general body-cavity, the diaphragm thus being formed by a portion of the original outer wall of that cavity. Considerable interest also attaches to a paper by Dr. A. A. Gray on the membranous labyrinth of the internal ear of man and the seal, in the course of which it is shown that seals possess in this region large otoliths comparable to those of fishes. Although the precise function of these structures is at present unknown, it would appear from their occurrence in the two groups that they are correlated with an aquatic existence.

In the second of a series of articles on Canadian life, published in the April number of the *Empire Review*, Mr. A. P. Silver, of Halifax, gives a graphic description of the wild, or "feral," horses inhabiting in large droves the storm-swept Sable Island. This island, which lies about eighty miles to the eastward of Nova Scotia, consists of an accumulation of loose sand, forming a pair of ridges united at the two ends and enclosing a shallow lake; tracts of grass are to be met with in places, as well as pools of fresh water. The droves of wild horses, or ponies, and herds of seals appear to be the chief mammalian inhabitants of the island. It is generally supposed that the original stock was landed from a Spanish wreck early in the sixteenth century, although some writers make the introduction much later. Five-and-twenty years ago the number of ponies was estimated at between 500 and 600; at the present day there are less than 200, divided into five troops. Not more than two-thirds of these are pure-bred, the remainder being the offspring of mares crossed with introduced stallions. The introduction of these foreign stallions (which is to be regretted by the naturalist) has been a matter of great difficulty, as the strangers were attacked and wounded by the leaders of the droves. The author comments on the striking likeness of these wild ponies to the horses of the Parthenon frieze and to the now exterminated tarpan of Tartary. They also seem to resemble the wild horses of Mexico, although their coat is doubtless longer. These resemblances seem to point to reversion to the primitive type of the species. All colours save grey characterise the pure-bred stock; but chestnut, with a dark streak on the back and on the withers, is the most common tint, after which come bays and browns.

Prof. H. F. Osborn has been good enough to send us a collection of papers published by himself during the past year, some of which have been already noticed in our columns. Among the latter is one on a re-classification of reptiles, from the *American Naturalist* of February, 1904, in which it is proposed to divide the class into the brigades Diapsida and Synapsida. This plan is further elaborated in part viii. of the first volume of the *Memoirs* of the American Museum, which is well illustrated, and gives the leading characteristics of a number of the chief groups. The budget also includes three papers from the *Bulletin* of the American Museum, one dealing with sauropod dinosaurs, the second with new Oligocene representatives of the horse line, and the third with armadillos from the Bridger Eocene. An interesting feature recorded in the first of these is the discovery that in some at least of the sauropod dinosaurs the first digit of the fore-foot was alone furnished with a claw, or, at all events, with a claw of large size. The discovery of what are regarded as ancestral armadillos (apparently furnished with a leathery skin) in the Bridger Eocene is of much interest from a distributional point of view. It is noteworthy that these animals were described under the name of Metacheiromys, under the impression that they were allied to the aye-aye (Chiromys).

In a communication published in the *American Journal of Science* for April, 1904, Prof. Osborn summarises the palæontological evidence in favour of the theory that mammalian teeth are derived from a primitive tritubercular type, and comes to the conclusion that it strongly supports the theory. Reference may also be made to the preface to vol. ii. of the *Bulletins* of the American Museum (1898–1903), in which Prof. Osborn gives an interesting account of the explorations and researches carried out by the department of vertebrate palæontology during that period. Special endeavours have been devoted to collecting the dinosaurian remains from the Upper Jurassic of Wyoming and Colorado.

A catalogue of second-hand books in various branches of botany, offered for sale by Mr. F. L. Dames, Berlin, has been received; the sections best represented are the diatoms and desmids, floras, and the works on anatomy and physiology.

An abridged report on the experiments with seedling and other canes in the Leeward Isles in 1903–4, forming No. 33 of the pamphlet series of publications of the Imperial Department of Agriculture for the West Indies, shows a certain amount of divergence from the results of previous years in the list of canes arranged according to sugar production; Dr. F. Watts, the officer in charge, attributes it to the dryness of the season. In Antigua, Sealy Seedling, a cane of great vegetative vigour, appears first on the list, while B 208, which still retains its character of producing the purest juice, drops to the fourth place. A system of comparing the plants according to the number of stations in which they figure among the first seven promises to determine those most suitable for general planting.

A flora of the Calcutta district, where the district extends sixty miles south and forty miles in other directions, has been compiled by Dr. Prain, and is published as vol. iii., No. 2, of the *Records of the Botanical Survey of India* under the title of the "Vegetation of the Districts of Hughli-Howrah and the 24-Pergunnahs." The larger part of the district is alluvial rice-country, but a dry area occurs in the north-west, and the West Sunderbuns in the south comprise swamp forest and muddy creeks. The flora is not confined to wild plants, but includes crops and trees or shrubs of cultivation. The list of crops, with the original home of each, brings out very clearly the varied sources from which they are derived; as compared with fifty native plants, twenty-five are traced to the Mediterranean area, and about twelve each to Africa and America, besides other Asiatic species.

Before vacating the post of Government mycologist in Ceylon, Mr. J. B. Carruthers placed on record in the *Circulars* (vol. ii., Nos. 28 and 29) of the Royal Botanic Gardens his observations on two cankers, caused by species of Nectria, on tea bushes and rubber trees respectively. The tea canker which has been known in India for some years was found over a large area of the tea districts, more especially at the high elevations and on some of the finest tea plantations; the fungus spreads in the soft tissues under the bark, but produces cracks where the spores are formed. The Nectria on the Para rubber trees is more

insidious, as there is generally little or no evidence of the disease until the bark is peeled. The same remedy, that of cutting out and around the diseased areas, is recommended in both cases.

THE *Transactions of the Leicester Literary and Philosophical Society* (vol. ix., part i.) contain useful notes on the excursions made by the several sections. The society seems to have gone far afield in its studies. Thus Mr. Fox Strangways conducted a highly interesting excursion to Whitby, and Dr. B. Stracey contributes a sketch of the igneous rocks of Morven and the Inner Hebrides.

MR. G. K. GILBERT has submitted to the trustees of the Carnegie Institution ("Year Book" No. 3, Washington) a plan for the investigation of subterranean temperature-gradient by means of a deep boring in plutonic rock. It is proposed that the boring be carried to a depth of 6000 feet, and that a site be selected in the Lithonia district of Georgia. Here a fairly uniform and massive granite extends about three miles in one direction and ten miles in another. It is regarded as of early Palæozoic or older age.

IN an article on the pre-Glacial valleys of Northumberland and Durham (*Quart. Journ. Geol. Soc.*, February), Dr. D. Woolacott points out that while borings have proved buried valleys in the lower reaches, the higher parts of the ancient valleys belong to the present drainage. The Tyne and Tees were the major rivers, and the land stood at a higher elevation than now. The greatest recorded thickness of drift is 233 feet, and the maximum depth below sea-level is 141 feet. The author discusses the character of the uplift, the distribution of the drift, and its subsequent erosion.

THE Nile flood in relation to the variations of atmospheric pressure in north-east Africa has been the subject of investigation by Captain H. G. Lyons, Director-General Survey Department of Egypt, and the important results of the inquiry were recently communicated to the Royal Society. The paper itself is too lengthy to allow of even a brief abstract being made in this place, but a *résumé* of the conclusions at which Captain Lyons has arrived may be given here instead. The curve of the Nile flood on the average varies inversely as the mean barometric pressure of the summer months, high and low pressures accompanying low and high floods respectively. The pressure variations are similar over wide areas from Beirut to Mauritius, and from Cairo to Hong Kong, and are generally of the Indian type of curve of the Lockyers or Bigelow's "direct" type. Sometimes the pressure at Beirut and Cairo is in disagreement with that of the rest of the area, approaching the "Cordoba" type of pressure of the Lockyers or the "indirect" type of Bigelow. Considering monthly means of atmospheric pressure, this relation is more clearly shown, and pressure above or below the normal in months of the rainy season of Abyssinia coincides closely with deficiency or excess of rainfall. From 1869 to 1903, an accurate prediction of the flood from month to month could have been made in six years out of seven. Using the conclusions derived from the above discussion for the condition of the Nile flow during the present year, Captain Lyons writes:—"With weak summer rains and high pressure conditions in September and the first part of October, no large amount of water can have been stored up in the soil of Abyssinia, so that the springs will run off early, and a very low stage may be expected in 1905."

THE next meeting of the American Institute of Mining Engineers will be held at Washington in May. Special attention will be devoted to the discussion of papers relating to the genesis of ore deposits.

THE gas turbine has been regarded as the logical successor of the steam turbine, and numerous devices have been suggested to convert the energy of the confined products of combustion into mechanical power. In a paper in the current issue of the *Engineering Magazine* Dr. C. E. Lucke examines the thermodynamic principles involved in such devices, and shows, as the result of experiments conducted at Columbia University, that this conversion is not effected by free expansion in simple nozzles. In short, the pure gas turbine, provided with the simple nozzles used by steam turbines, is a failure commercially, and cannot be otherwise until some method has been found to make results by free expansion more nearly equal to those obtained in cylinders.

IN the *Engineering and Mining Journal* Mr. J. B. Jaquet gives particulars of a severe explosion of rock that occurred in the New Hillgrove Mine, New South Wales, on December 15, 1904. The shock was felt throughout the country for a mile or two around, and the area affected was more than 300 feet long and 100 feet high. These sudden outbursts have long been a source of anxiety to the miners of Hillgrove, and there is evidence to show that they are increasing in violence as greater depths are reached. Explosive rocks have been described as occurring in many parts of the world. In the Derbyshire lead mines, for example, slickensided rocks were described by Mr. A. Strahan as being liable to burst on being scratched with a pick. It has been suggested that the bursts are due to molecular strain, to occluded gases, or to a compression of the slates upon their being intruded by a mass of granite. Mr. Jaquet believes that the Hillgrove bursts are due to the walls being in a condition of strain and to the fact that the slate will not bend; it only breaks and disintegrates into a number of fragments.

ON account of their resistance to the action of sea-water and of their mechanical properties when heated, a number of special brasses have during the past few years been applied in naval construction. In view of this, a paper published by M. L. Guillet in the *Bulletin de la Société d'Encouragement* becomes of some general interest; it deals in detail with the changes in the mechanical properties and in the microstructure of typical brasses which are caused by the addition of lead, tin, aluminium, and manganese. The influence of aluminium is particularly noteworthy. On adding from 0·5 per cent. to 5·0 per cent. of this metal to a brass containing 60 per cent. of copper and 40 per cent. of zinc, a deep golden colour is produced, whilst after adding more than 5 per cent. of aluminium the alloy becomes superbly rose-coloured. This effect is at its maximum at 7 per cent., and with 10 per cent. of aluminium the colour has become a silvery white. Corresponding with these variations of colour, striking changes in the internal structure of the alloy may be traced. It may be added that aluminium brasses have been applied in France in the construction of submarines, but they have not as yet given complete satisfaction.

THE March number of the *Gazzetta* contains an interesting paper by Nicola Pappadá on the coagulation of dilute solutions of silicic acid under the influence of various substances. Organic compounds such as glucose, saccharose,

the alcohols, &c., do not produce coagulation, and the phenomenon seems to be initiated solely by the presence of the positive ion of an electrolyte. The negative ion apparently is quite without influence on the rate of coagulation; equivalent quantities, for instance, of sodium chloride, sodium nitrate, and sodium sulphate cause coagulation to occur at exactly the same rate. The nature of the positive ion, on the other hand, exercises great influence on coagulation; in the case of the alkali metals the rate depends on the atomic weight, there being a regular sequence in the order lithium, sodium, potassium, rubidium, cæsium, the metal of greatest atomic weight bringing about coagulation most rapidly. Traces of acids and of acid salts, however, inhibit coagulation, an abnormal behaviour of the hydrogen ion being thus indicated, whilst alkalis always increase the rate of formation of a coagulum.

MESSRS. BURGOYNE, BURBIDGES AND CO. have recently sent us a new edition of their price list of pure chemicals and reagents manufactured by them. Part ii. of the catalogue contains a list of chemical and physical apparatus for laboratory or lecture purposes.

WE have received the May issue of the *Stonyhurst Magazine*, an excellent example of an illustrated college magazine. The "science notes," which are entirely astronomical, are illustrated by drawings made at Stonyhurst Observatory of the great sun-spot of February. There is also a collection of notes on the bird-life of the college district.

THE Cambridge University Press has published the first supplement of the second volume of "The Fauna and Geography of the Maldive and Laccadive Archipelagoes, being the Account of the Work carried on and of the Collections made by an Expedition during the Years 1899 and 1900," which is being edited by Mr. J. Stanley Gardiner. An index is in course of preparation, and will be published shortly.

PROF. J. J. THOMSON'S work on "Electricity and Matter," containing six lectures delivered by the author at the University of Yale in 1903, has been translated into Italian by Prof. G. Faè, and published as one of the Hoepli manuals. In the opening paragraph of a short introduction to the work, Prof. Faè quotes the remark made by Sir Oliver Lodge in our columns that the volume is "Altogether a fascinating and most readable book for students of physics and chemistry."

WE have received from Messrs. Taylor, Taylor and Hobson, Ltd., of Leicester, a very neatly got up catalogue of their photographic lenses. These, as is well known, are of many varieties, and the particular features are that they are composed of three thin glasses, uncemented, and accurately adjusted to produce with full aperture sharp definition evenly throughout the plate. The principles of the action of a lens are clearly described and illustrated by Mr. William Taylor, and an interesting series of illustrations is given showing the manipulation of the glass in their works from the rough blocks to the finished lenses.

THE 1905 issue of the "Statesman's Year-book" has now been published by Messrs. Macmillan and Co., Ltd. The statistical and other information in the new issue has been brought up to the latest available date, in some cases to the end of 1904. Much alteration has been involved by the Anglo-French Convention of 1904 and by the administrative re-arrangement of French West African possessions. The space devoted to Germany as a whole, especially education, has been increased; Bulgarian statistics have been much extended; the Philippine Islands have been treated more fully; and numerous other sections have been largely re-written and thoroughly revised. Two interesting tables are included, one showing the losses sustained by the Russian and Japanese forces in the present war, and the other showing the penetrative power of the projectiles used. As usual, the maps and diagrams are numerous, well executed, and of great value—among them may be mentioned one showing the new naval distribution scheme, and one illustrating the British meat imports from abroad. The "Statesman's Year-book" is likely long to retain the high place it has held for many years among books of reference.

THE annual report of the Board of Scientific Advice for India for the year 1903–4 has been received. With the exception of that part of the report relating to the work of the Survey of India, it is based upon the departmental reports for the year under consideration. The information included is arranged under the following headings:—trigonometrical survey, topographical survey, forest survey, cadastral and traverse survey, geographical surveys and reconnaissances, total outturn, geodetic, marine survey, astronomical work, meteorology, geology, zoological survey, veterinary science, botanical survey, applied botany, and chemistry. It is worthy of note that the report contains no list of names of the men of science constituting the Board of Scientific Advice, nor are there reports of any meetings of the Board. The portion of the report relating to the work of the Survey of India is based on the report of that department for 1902–3 published in 1904, and certain other items embodying information of later date than the period covered by any of the other reports. The publication as a whole may be described as a *résumé* of individual departmental reports; it contains scarcely anything in the way of recommendations for the future guidance of departmental work, and little that is to be identified as the special function of a Board of Scientific Advice.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 1. Vesta 6° S. of β Leonis.
,, 2. 9h. 38m. Minimum of Algol (β Persei).
,, 2. 6h. Epoch of Aquarid meteoric shower (Radiant 338°–2°).
,, 3. 18h. Jupiter in conjunction with the Sun.
,, 6. 5h. 28m. to 6h. 30m. Moon occults α Tauri (Aldebaran).
,, 8. 8h. Mars in opposition to the Sun.
,, 12. 8h. 46m. to 9h. 53m. Moon occults A Leonis (mag. 4·6).
,, 15. Venus. Illuminated portion of disc = 0·100; of Mars = 0·997.
,, 17. 10h. Mars in conjunction with Moon, Mars 5° 10′ S.
,, 20. 23h. Mercury at greatest W. elongation, 25° 26′.
,, 22. 11h. 20m. Minimum of Algol (β Persei).
,, 24. Saturn. Outer major axis of outer ring = 39″·50; minor axis of outer ring = 5″·88.
,, 25. 13h. Saturn in conjunction with Moon, Saturn 1° 39′ S.

ELEMENTS AND EPHEMERIS FOR COMET 1905 *a* (GIACOBINI).—A set of elements and an ephemeris (April 6–30) for comet 1905 *a* have been communicated, by General Bassot, of the Nizza Observatory, to No. 4010 of the *Astronomische Nachrichten*. These were computed from observations made at Nice on March 26, 28, and 30, and the elements agree closely with two other sets computed at Harvard and Paris respectively, and published in the same journal. The elements and an extract from the ephemeris are here given:—

Elements.

T = 1905 April 4·141 (Paris M.T.)

$\left.\begin{array}{l} \Omega = 358^\circ\ 18'\cdot0 \\ \S = 157\ \ 7'\cdot1 \\ i = 40\ 24'\cdot8 \end{array}\right\}$ 1905·0

$\log q = 0\cdot04836$

Ephemeris 12h. (M.T. Paris).

1905	α	δ	log Δ	Brightness
	h. m. s.	° ′		
April 26 ...	8 9 33 ...	+43 1·0 ...	9·9079 ...	0·70
27 ...	8 15 24 ...	+43 38·8		
28 ...	8 21 17 ...	+44 14·3		
29 ...	8 27 13 ...	+44 47·3		
30 ...	8 33 11 ...	+45 17·5 ...	9·9247 ...	0·61

Brightness at time of discovery = 1·0.

An observation by Dr. Palisa at Vienna on April 8 gave a correction of +2s. and +0′·2.

CHANGES ON MARS.—A telegram from Mr. Lowell, published in No. 4010 of the *Astronomische Nachrichten*, announces that colour changes similar to those previously reported are again taking place in some of the Martian features. The Mare Erythræum, just above Syrtis, has again changed from a blue-green to a chocolate-brown colour. This change was first observed by Mr. Lampland on April 4, and the Martian season now corresponds to our February.

In a communication to No. 4, vol. xiii., of *Popular Astronomy*, Prof. W. H. Pickering observes that ice will probably begin to form at *both* poles of Mars during the present month, the north pole being turned towards the earth at an angle of 10°–13°. This opposition is particularly favourable for observations of the green colour over a greater part of the planet's surface, as Mars will be more favourably situated than during the preceding or the following opposition. Its apparent diameter will be from 13″ to 17″, and the poles should appear either of a pure white, a light yellow, or a vivid green colour, the first named being due to hoar-frost or snow, the second to clouds, and the last named, in part at least, to vegetation.

PHOTOGRAPHY OF PLANETARY NEBULÆ.—In No. 356 of the *Observatory* Mr. W. S. Franks suggests that special attention should be paid to the photography of planetary nebulæ by those observatories which possess *long-focus* cameras. Whilst using the late Dr. Roberts's 98-inch "Starfield" reflector, Mr. Franks attempted to photograph these interesting objects both with and without a secondary magnifier, but in the first case the images obtained were indistinguishable from those of the surrounding stars, whilst in the latter the definition was very unsatisfactory.

One point which is strongly in favour of anyone entering this field of research is the fact that the light emitted by these objects is of a highly actinic character necessitating only short exposures.

RADIAL VELOCITIES OF "STANDARD-VELOCITY STARS."—No. 3, vol. i., of the *Mitteilungen* of the Nicholas Observatory, Pulkowa, contains a number of results obtained by Prof. Belopolsky for the values of the radial velocities of the "standard-velocity" stars. Each of the values was obtained from the measurement of about fifteen iron lines on a single plate, and the date, time, and hour-angle is given in each case. The stars dealt with in the present publication are α Arietis, α Persei, ε Pegasi, and β Geminorum, and taking the mean of the several values given in each case the following respective velocities are obtained:—−12·30 km., −2·14 km., +5·72 km. (one plate) and +4·21 km.

MAGNITUDE EQUATION IN THE RIGHT ASCENSIONS OF THE EROS STARS.—In *Bulletin* No. 72 of the Lick Observatory Prof. R. H. Tucker discusses the magnitude equation which enters into the observations of the right ascensions of the Eros stars as observed at various stations engaged in the work. Comparing the equations in the first and second Eros lists, it is found that there is no marked similarity between the two sets observed at the same station; different instruments, and probably in some cases different observers, having been employed. At Lick the effect of magnitude has been measured by screen observations at three different epochs for the same observer and instrument. For clock stars the correction obtained was 0·007 second per magnitude, and, assuming it to vary with declination, this would give 0·010 second and 0·008 second per magnitude for the first and second lists respectively. Confirmation of this, in general, is found in the Königsberg results obtained with a clock-driven micrometer in which it is assumed that the magnitude equation is eliminated. Other tables given show the variation of the error with varying magnitudes.

MEMOIRS ON MARINE BIOLOGY.

THE study of marine life by the sea-side is not only a delightful occupation in itself, but is now considered as an almost essential part of the training of every young biologist. It is also one of the most fruitful fields of inquiry for the elucidation of the fundamental problems of biology. Several marine stations have now been erected on our coasts, in which a naturalist may gain a practical knowledge of the rich fauna and flora of the sea, and where he may apply those modern and often expensive methods of experiment and research which can only be carried out in a well equipped laboratory.

Among the most successful of these institutions is that of the Liverpool Marine Biology Committee, established first on Puffin Island in 1887, and subsequently moved to its present quarters at Port Erin. It is chiefly due, we believe, to the efforts and enthusiasm of Prof. W. H. Herdman that this laboratory was founded. To help the student to make good use of its resources, Prof. Herdman is now editing a series of small practical monographs known as the L.M.B.C. *Memoirs*. Much valuable time may be wasted, many serious errors may be committed, and many precious opportunities may be lost in the practical study of marine biology through the want of proper guidance, or through the ignorance of the literature of the subject. Well stocked libraries are rarely to be found near at hand, and, moreover, it often happens that the commonest animals and plants are just those which have been least completely described in readily accessible works. It is with a view to remedy these defects that the memoirs are being published. As the editor tells us in his preface, the series deals with those types which have hitherto not been adequately described in English text-books and laboratory manuals.

Some thirty volumes are promised. They range over almost the whole of marine life—from the diatom to the sea-weed, from the sponge to the porpoise. Twelve volumes have already appeared. These are:—(1) Ascidia, by the editor; (2) Cardium, by J. Johnstone; (3) Echinus, by H. C. Chadwick; (4) Codium, by R. J. H. Gibson and Helen Auld; (5) Alcyonium, by S. J. Hickson; (6) Lepeophtheirus and Lernæa, by Andrew Scott; (7) Lineus, by R. C. Punnett; (8) Pleuronectes, by F. C. Cole and J. Johnstone; (9) Chondrus, by O. V. Darbishire; (10) Patella, by J. R. A. Davis and H. J. Fleure; (11) Arenicola, by J. H. Ashworth; (12) Gammarus, by M. Cussans. Not only is a detailed and accurate account given of the structure of each type, but its habits, life-history, and embryology are also dealt with, and its "economic" aspects are not forgotten.

On the whole, the various monographs seem to us most trustworthy, and reflect great credit on the work of the authors, who, indeed, are for the most part specialists thoroughly familiar with the types they describe. Yet it must be confessed that the volumes differ considerably in merit and attractiveness. Some of them contain little that is either new or original. Among the most interesting of those already published we may mention the excellent volume on the plaice, Pleuronectes, by Messrs. Cole and Johnstone, which has already been reviewed in NATURE, also the memoir on Arenicola by Mr. Ashworth. Both these seem to us models of what such monographs should be—clear and practical descriptions of the anatomy and life-history of the animals concerned, with some discussion of the general problems suggested, and good illustrations. Naturally enough the embryology is in most cases very briefly described, and often the accounts provided are chiefly derived from the works of other authors. We question, indeed, whether it is really worth while reproducing in such monographs figures illustrating the development which can be found in almost any text-book.

While both a table of contents at the beginning, and an index at the end, may not always be necessary, yet it is a pity that many of the monographs should be published with neither. In some cases, also, the figures are scarcely clear enough; but considering the very moderate price at which they are issued, the L.M.B.C. *Memoirs* are excellently printed and illustrated. They will doubtless fully justify the hope of the editor, and will prove most useful to students of marine biology, who will await with eagerness the appearance of the remaining volumes.

THE PHYSICAL HISTORY OF THE VICTORIA FALLS.[1]

WHEN Dr. Livingstone discovered the Victoria Falls in 1855, he sought to explain their origin by calling in volcanic agency, and stated that they were "simply caused by a crack made in the hard basaltic rock from the right to the left bank of the Zambezi, and then prolonged from the left bank away through 30 or 40 miles of hills." All subsequent travellers support the same idea; but in his article Mr. Molyneux, in the *Geographical Journal*, claims that, as at Niagara, the combination of cañon, gorge, chasm, and falls is due to erosion and the constant reducing action of the Zambezi River (Fig. 1).

In explaining his theory, the author first refers to present-day conditions of the river, and divides it into three portions; the coastal, stretching 360 miles up as far as the Kebrabasa Range—a portion of the mountain axis of South Africa—through which it runs in a gorge 35 to 40 miles in length. The middle reach is 600 miles long, in low-lying country, and is divided from the upper regions of the river by the high Victoria Falls, 1000 miles from the coast.

The geology of the country around the falls is then sketched briefly. During what was probably the Tertiary period, South Central Africa was subject to vigorous volcanic action, the concrete forms of which can now be seen in the denuded and exposed lava-flows of the Limpopo and Zambezi valleys. In the vicinity of the falls, the Batoka country, the basalt is interbedded with the soft forest sandstones, but the Zambezi River, in draining the ancient lake regions of Central Africa, has eaten into the overlying sediments until it has reached the hard and almost level igneous sheet in which the falls occur. This sheet extends from the end of the cañon, 40 miles east of the falls, to beyond the Gonye Falls, 120 miles north-west.

On reaching the top of this sheet, the erosive action of the river was checked; but conditions were more favourable in the middle regions of the river, which had no protective covering, and where the rocks are unresisting sandstones and Coal-measures. A difference of level between the two regions came into existence—defined by the eastern edge or fringe of the basalt sheet.

It may be understood that the eastern edge would be thin, and the backward erosion of the Zambezi from its middle reaches would quickly break into it. But as the thickness of the basalt increased as the river receded westwards, the cutting action became slower, until the rate of deepening of the middle reach and Kebrabasa gorge far outstripped the slower process of forming the Grand Cañon of the Victoria Falls. The difference between the river bed where running on the basalt sheet and the altitude of the central reach became more exaggerated as time passed. Including the height of the falls (400 feet), this difference is now about 1000 feet.

Of the process by which the river cut back this Grand Cañon and shaped the falls as they are seen to-day, the author states that, as is common to all rocks of this nature, it is full of cracks and fissures due to contraction, generally assuming a columnar form. These columns can be seen at low water along the lip of the falls, more or

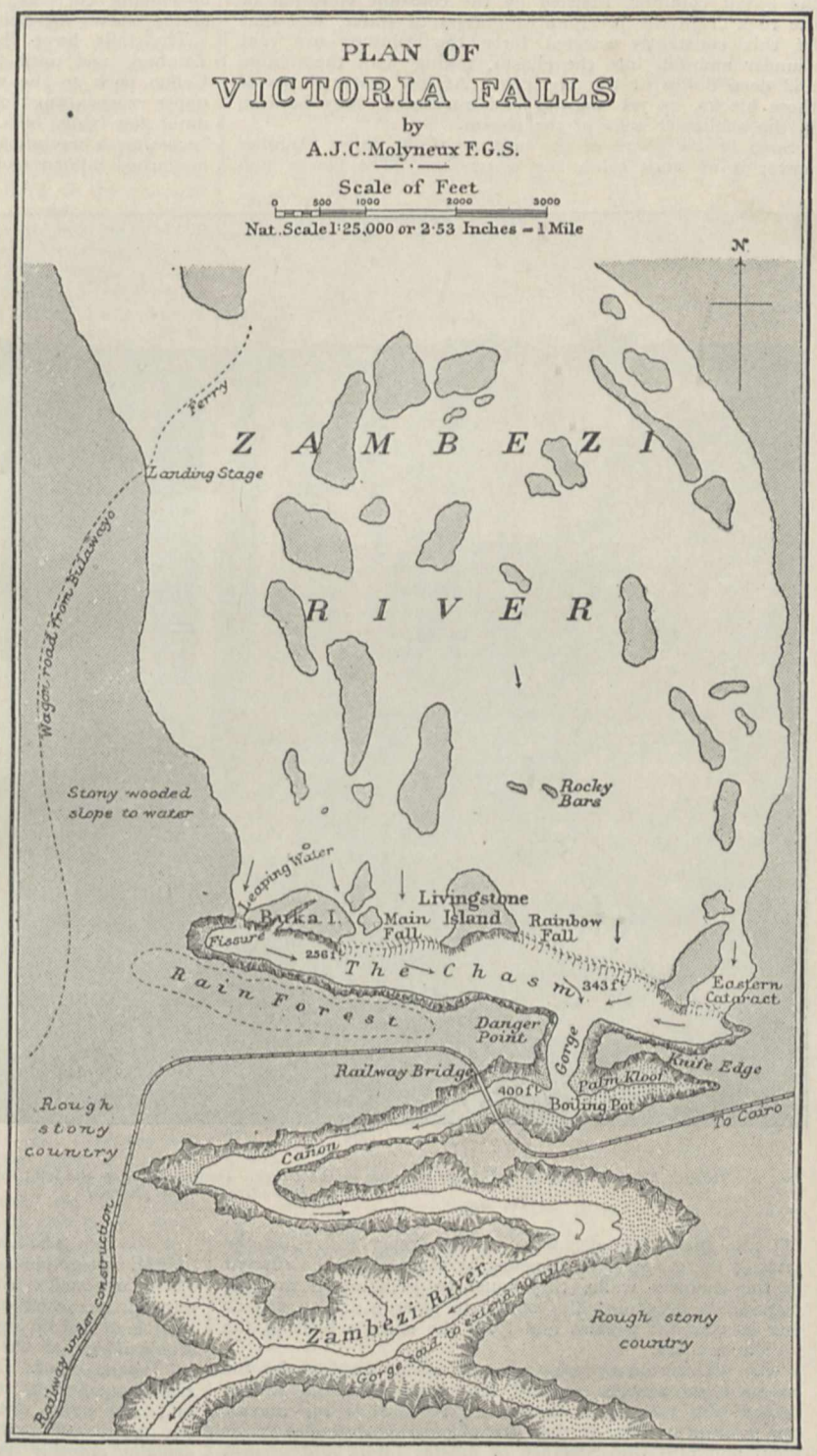

FIG. 1.—Plan of Victoria Falls. From the *Geographical Journal*.

[1] Abstract of a paper by Mr. A. J. C. Molyneux in the *Geographical Journal* for January.

less truncated as the verge is reached, and bearing little evidence of attrition (Fig. 2). Mr. Molyneux is of opinion that the cutting back of the falls is due to the perpetual hammering action of the vast bodies of water falling into, and down upon, the cracks between the basalt columns, assisted by the constant vibration of the rock from the precipitated masses of water, and that by this constantly exerted force the columns are rent asunder and fall into the chasm, taking with them huge and deep flakes of the precipice. At low water heaps of these blocks, as yet angular and unreduced, may be seen in the shallower ends of the chasm.

Such is one phase of the erosion of the falls. Another power is at work below the water line. The blocks that fall into the chasm disappear in the deeper waters at the jaws of the gorge—yet, impelled by the rush of the current in the confined walls, they must be grinding down and perpetually deepening the cañon, to emerge at the eastern end as rounded pebbles and form the shingle beds of the middle reaches.

The extraordinary zig-zags or acute angles in the cañon have always aroused comment, and the author thinks that two main causes are responsible for them—the position of islands that probably studded the river (as now) and also the existence of master joints and fissures in the basalt. On Boaruka Island this action is exemplified in a striking manner, for a stream can be seen falling down a crevice, that forms, peculiarly enough, another acute angle with the chasm.

Granted that the falls are due to the action of moving water, such parts as are protected by islands must be free from such erosion. To-day there are three important islands on the lip of the chasm, and more than fourteen large ones in 4 miles of river above the falls. In the channels between, there must be more prolonged submission to moving currents, by which the cataracts at the ends of the chasm are being deepened into sloping by-washes.

The falls have checked the deepening of the Upper Zambezi, and until they chisel the groove of the Grand Cañon back to the western edge of the basalt sheet, the upper reaches must continue to run at a high altitude and amid low-lying hills. This has prevented the Zambezi becoming a navigable river throughout, and has also had a marked influence on the geography of South Africa.

Photo. by Pedrotti, Bulawayo.

FIG. 2.—View of Victoria Falls seen through the jaws of the Gorge. Danger Point on the left; the promontory of the "knife edge" on the right. From the *Geographical Journal*.

SEISMOLOGICAL NOTES.

THE attraction of the moon has always been felt by earthquake workers, whatever may be its effect on earthquakes themselves. The latest contributions to this aspect of seismology are two papers in No. 18 of the *Publications* of the Earthquake Investigation Committee in Japan. Prof. Omori deals with the lunar daily distribution, finding maxima of frequency between 0h. and 5h., and again between 12h. and 13h., reckoning from the upper culmination. Dr. Imamura, dealing with the synodic monthly variation in frequency, finds that this shows an increase at the syzygies and quadratures; the former is attributed to the combined effects of the attraction of the sun and the moon, while the latter is explained by the fact that the time of high water at Tokio then coincides with that of the diurnal maximum of barometric

pressure. In spite of the ingenuity of this explanation, its validity seems doubtful, for the stresses involved can at most be only a subsidiary cause of earthquakes, and consequently any effect due to them would naturally be looked for at the time when they vary most rapidly in amount rather than at that of their maximum.

The same publication contains a paper, of some importance in this connection, on daily periodic changes of level in artesian wells, by K. Honda. It is the account of a record, obtained by a self-registering instrument, of the daily changes in level of two artesian wells, 380 metres and 300 metres depth, in Tokio and Yokohama. Each of them showed a periodic change of level which is directly correlated with the tides in the neighbouring sea, and also a variation due to changes in barometric pressure, of such amount as to show that one-third of the changes in the first case, and one-fourth in the second, are absorbed by the rocks overlying the water-bearing stratum.

The catalogue of earthquakes felt in Austria during the year 1903, forming No. 26 of the *Mitteilungen* of the Austrian Earthquake Commission, is the last of the series which will be published under the auspices of the Academy of Sciences. In the introduction to the catalogue it is announced that from the beginning of 1904 the task of collecting and publishing the records of all earthquakes, whether of local or distant origin, observed in Austria, was taken over by the Zentralanstalt für Meteorologie und Geodynamik. The Earthquake Commission, having published the earthquake registers up to the end of 1903, will in future confine itself to the encouragement and publication of purely scientific investigations.

After the collapse of the campanile of St. Mark's, in 1902, there was a popular demand, inspired by the idea that the detonation was likely to precipitate the destruction of other historic buildings in Venice, for the cessation of the usual mid-day gun. The idea was, of course, unfounded, but to allay the alarm Prof. Vicentini was requested to instal one of his microseismographs, and his report has now been published. The instrument was attached to the wall of the ducal palace which faces the lagoon and is directly exposed to the sound waves of the cannon; it indicated a vertical displacement, in consequence of the report, of 0·012 mm. to 0·014 mm., and a horizontal displacement of 0·007 mm. to 0·012 mm., being about one-half of those produced by a person jumping on the floor of the room in which the instrument was installed, and one-fifteenth of the displacement caused by a high wind. From these figures it is evident that the sound waves of a cannon can have no appreciable effect on a building, though plaster may be detached where this has become loosened and separated from the wall by an air space.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"The Colour-physiology of the Higher Crustacea," Part iii. By F. **Keeble** and Dr. F. W. **Gamble**. Communicated by Prof. Sydney J. Hickson, F.R.S.

(1) The chromatophores of Hippolyte and Crangon are multicellular structures. Their branches show differentiation into a firmer ectoplasm and a more fluid mobile endoplasm in which the pigment occurs. (2) The formation of the pigments in the larval and post-larval chromatophores is described. (3) In addition to pigments, fat, in the form of colourless globules, occurs in the chromatophores of Hippolyte. This fat lies in special cells of the chromatophore, and exhibits a mobility similar to that of the pigments of the chromatophore. (4) If fed and kept in the dark, or if starved and kept in the light, Hippolyte loses little of its chromatophoric fat. Depletion of fat occurs, however, in starved, dark-kept animals. These, when exposed to sunlight for five or six hours, show fat in their chromatophores. These results show that the colourless chromatophoric fat is a reserve food material, and point to the conclusion that in the accumulation of this reserve fat light plays an important part. (5) At the time of settling on the weeds of the sea-shore, *Hippolyte varians* is a colourless or faintly brown-striped animal. At this stage it is extremely sensitive to the light conditions of its environment, assuming the colour of its surroundings within twenty-four hours. If the environment be changed, sympathetic change of colour takes place in three days. Half- and full-grown Hippolyte are less susceptible. With them sympathetic colour-change occupies a week or more.

March 30.—"On the Distribution of Velocity in a Viscous Fluid over the Cross-section of a Pipe, and on the Action at the Critical Velocity." By J. **Morrow**. Communicated by Prof. H. S. Hele-Shaw, F.R.S.

Summary and Conclusion.—(1) The experiments provide a partial confirmation of the theoretically obtained law of velocity distribution, but show that this distribution can only be obtained under very special conditions, of which absolute freedom from obstructions and end effects are important; and hence (2) When the flow is direct and stream-lines exist, the velocity distribution is not necessarily exactly that which may be described as characteristic of "normal" flow. (3) At the critical velocity the irrotational straight line motion ceases and is followed by one in which the paths of the particles of fluid are eddying and turbulent. The law of distribution of mean linear velocity parallel to the axis simultaneously changes from the parabolic (or approximately parabolic) to that typical of eddying motion. (4) The critical velocity in question (being that at which eddying motion ceases to be transformed into direct motion, and not that at which a highly unstable stream-line motion is suddenly disturbed) is not accompanied by a sudden change in the velocity parallel to the axis at any point in the cross-section. On the other hand, as the total flux increases, the experiments show a gradual transition from one state to the other, due to the change which has occurred in the law of velocity distribution. (5) The observations have little bearing on the upper limit of stream-line flow, as observed by colour bands. They indicate, however, that the unstable direct motion would follow an approximately parabolic law of velocity distribution (as represented by the equation obtained for stream-line motion), and that at the higher critical velocity this distribution would suddenly change to that represented by the equation given for eddying motion. In this case, then, instead of a gradual change of velocity, there would actually be sudden and large changes in the velocity parallel to the axis at different points in the cross-section of the pipe. (6) The "Pitot law" ($v=\sqrt{2gh}$) is at least approximately true at exceedingly low velocities.

April 6.—"The Influence of Cobra-venom on the Proteid Metabolism." By Dr. J. **Scott**. Communicated by Sir Thomas R. Fraser, F.R.S.

Conclusions.—(1) Practically no change in rate of proteid metabolism was induced by the administration of cobra-venom, in spite of well marked local reaction. (2) A slight decrease in the proportion of urea nitrogen, quite insignificant compared with that produced by diphtheria toxin and various drugs, was observed. (3) A slight rise in the proportion of ammonia nitrogen occurred. (4) There was a slight rise in the proportion of nitrogen in purin bodies. (5) The nitrogen in other compounds showed no constant change. (6) The P_2O_5 excreted showed no constant change, but in two experiments there was a slight rise. The change produced in the proteid metabolism is, therefore, small, and such as it is, being in the directions of decreased elaboration of urea and increase in the proportion of nitrogen excreted as ammonia, it seems to indicate a slight toxic action on the hepatic metabolism rather than a general action on the proteid changes, and tends to confirm the view that the poison acts chiefly upon the nervous system.

Entomological Society, April 5.—Mr. F. Merrifield, president, in the chair.—Specimens of a melanic Grammoptera, discovered by Mr. J. C. T. Poole at Enfield, and apparently quite distinct from any member of the genus taken in Britain: H. St. J. **Donisthorpe**. Mr. Gahan, to whom the species had been referred, considered it to be a form of *G. ruficornis*.—A specimen of *Megalopus melipoma*, Bates, an insect which so much resembles a bee that Bates had said they were indistinguishable in

nature: M. **Jacoby.**—Specimens of *Papilio macleayana* and *Hypocysta metirius* captured in Queensland, illustrating the use of "directive" markings in the Rhopalocera in influencing their enemies to attack non-vital parts: A. **Bacot.**—An example of *Ceratopterus stahli*, Wast., a beetle from Australia possessing notable powers of crepitation: G. J. **Arrow.**—A series of *Erebia alecto* (*glacialis*), var. *nicholli*, Obth., taken at about 8000 feet at Campiglio, South Tyrol, with specimens of *Dasydia tenebraria*, var. *wockearia*, caught in the company of the Erebias in the same localities; when upon the wing the two species were not dissimilar: A. H. **Jones** and H. **Rowland-Brown.** Mr. Jones also exhibited examples of *Erebia melas* from the Parnassus Mountains, Greece, for comparison, and fine forms of butterflies found at Mendel, near Botzen.—A series of *Morpho adonis* from British Guiana, with the very rare dimorphic black and white female: W. J. **Kaye.**—The social web and pupal shells of *Eucheira socialis*, Westw., together with specimens of the perfect insect, being the actual nest from Mexico described and figured by Westwood in the *Transactions* for 1836: Dr. F. A. **Dixey.** After Dr. Dixey had read a note upon the habits of this and similar species, the Rev. W. T. Holland, of Pittsburg, Pa., U.S.A., gave his personal experiences of social silk-cocoon spinning species also from Mexico.—A note recently received from Mr. S. A. Neave giving further interesting evidence of the superstitious dread of larvæ with terrifying eye-like markings entertained by South African natives: Prof. E. B. **Poulton.**—Experiments to ascertain the vitality of pupæ subjected to submersion: F. **Merrifield.**—*Pseudacraea poggei* and *Limnas chrysippus*; the numerical proportion of mimic to model: H. A. **Byatt.**—A monograph on the genus Ogyris: G. **Bethune-Baker.**

Geological Society, April 5.—Dr. J. E. Marr, F.R.S. president, in the chair.—On the divisions and correlation of the upper portion of the Coal-measures, with special reference to their development in the midland counties of England: R. **Kidston.** The following classification of the Coal-measures is proposed by the author:—

Proposed names		Names previously used
(4) Radstockian Series	=	Upper Coal-measures.
(3) Staffordian Series	=	Transition Series.
(2) Westphalian Series	=	Middle Coal-measures.
(1) Lanarkian Series	=	Lower Coal-measures (including the Millstone Grit).

—On the age and relations of the phosphatic chalk of Taplow: H. J. O. **White** and L. **Treacher.** The rocks at the locality of Taplow are described in detail, and the following classification is adopted:—(E) Upper White Chalk (visible), 16 feet; (D) Upper Brown Chalk, or rich phosphatic band, about 8 feet; (C) Middle White Chalk, about 16 feet; (B) Lower Brown Chalk, or rich phosphatic band, about 4 feet; (A) Lower White Chalk (visible), 17 feet. Fossil-lists are given from each of the above divisions, and the authors conclude that the Lower White Chalk belongs to the zone of *Micraster cor-anguinum*, and the succeeding beds to that of *Marsupites testudinarius*; while the lower phosphate-band represents the lower part of the Uintacrinus-band, and the upper one that of the Marsupites-band of that zone.

Physical Society, April 14.—Dr. R. T. Glazebrook, F.R.S., past-president, in the chair.—Ellipsoidal lenses: R. J. **Sowter.** The paper extends the treatment of thin ellipsoidal or astigmatic lenses, and gives a simple solution for complex problems of the following types:—"To determine the astigmatic pencil, after refraction of an astigmatic pencil by an ellipsoidal lens." And "to find the ellipsoidal lens equivalent to two cylindrical lenses placed a definite distance apart, with their axes inclined at any angle." The method of treatment can be applied to crossed ellipsoidal lenses, in contact, or separated, and is applicable in general to astigmatic pencils.—Determination of the moment of inertia of the magnets used in the measurement of the horizontal component of the earth's field: Dr. W. **Watson.** One of the constants required when determining the horizontal component of the earth's magnetic field by the ordinary method is the moment of inertia of the magnet which is used in the vibration experiment. It is usual to determine the moment of inertia of the cylindrical brass bar supplied with each instrument by calculation, then by measuring the period of the magnet alone, and when loaded with this bar to calculate the moment of inertia of the magnet. This method presupposes that the density of the inertia-bar is uniform throughout. It is not easy to secure a bar of which the density is uniform throughout, and further it is difficult to test whether such uniformity has been secured. The author thinks that more trustworthy and uniform results would be obtained by determining once for all, with very great care, the moment of inertia of a standard bar and then determining the moment of inertia of the bars supplied with the different magnetometers, by comparing them with the standard bar experimentally. In the paper is described an instrument suitable for comparing the moment of inertia of bars, together with some experiments made with a view to determine the moment of inertia of a standard bar, and an investigation of the influence of the air upon the period.—Exhibition of a series of lecture experiments illustrating the properties of the gaseous ions produced by radium and other sources: Dr. W. **Watson.**

Royal Astronomical Society, April 14.—Mr. W. H. Maw, president, in the chair.—Spherical aberration of object glasses: A. E. **Conrady.** The paper dealt with the difference of phase at the focus caused by the spherical aberration. Two different rigorous solutions, by which such differences could be conveniently computed, were deduced and discussed. The paper also dealt with the relation between these differences of phase and spherical aberration in the geometrical sense.—(1) A suggested arrangement for the mounting of a cœlostat; (2) point distributions on a sphere, with remarks on the determination of the apex of the sun's motion: H. C. **Plummer.**—The four-prism spectrograph attached to the Newall telescope of the Cambridge Observatory, with remarks on the general design of spectrographs for equatorials of large aperture, considered from the point of view of "tremor-discs": H. F. **Newall.**

Royal Meteorological Society, April 19.—Mr. Richard Bentley, president, in the chair.—An account of the observations at Crinan in 1904, and description of a new meteorograph for use with kites: W. H. **Dines.** These observations, which are carried out under the direction of a joint committee of the Royal Meteorological Society and of the British Association, are made with meteorographs attached to kites with the object of ascertaining the conditions prevailing in the upper atmosphere. During last summer the kites were flown from the deck of H.M.S. *Seahorse*, which was placed at the disposal of the committee by the Admiralty. Mr. Dines designed a new and inexpensive meteorograph, which he now fully described. The weather conditions of last summer were somewhat unusual, there being a decided preponderance of east and south-east winds. Near the summit of Ben Nevis the air was often dry, and was on several occasions warmer than the air at the same level at Crinan. As a rule, however, the temperature on Ben Nevis is generally much lower than the temperature in the free air at the same level. On several occasions temperature inversions were observed at levels between 3000 feet and 7000 feet. A fact previously noticed was again observed, viz. the decrease of strength of easterly winds with elevation.—Rate of fall of rain at Seathwaite: Dr. H. R. **Mill.** This is a discussion of the records from a Negretti and Zambra self-recording rain gauge during a period of eighteen months. Seathwaite, which is in Borrowdale, Cumberland, is in almost the wettest spot of the British Isles, the average yearly rainfall being about 137 inches. Dr. Mill's results seem to show that the rainfall at Seathwaite in an average year indicates a tendency to be greater during the hours of darkness than in daylight, that rather less than half the time during which rain is falling it continues without intermission for at least six hours at a time, and that rather more than half the total amount of rain is deposited in such long showers.

DUBLIN.

Royal Dublin Society, March 21.—Sir Howard Grubb, F.R.S., in the chair.—(*a*) The temperature of healthy dairy cattle, (*b*) the temperature of tuberculous cattle, not clinically affected: Prof. G. H. **Wooldridge.** The author made 520 observations on 63 healthy dairy cattle which were subsequently submitted to the tuberculin test, and failing to react were considered free from the disease. His conclusions are that the temperature may vary between 100°·4 F. and 100°·8 F., with an average mean temperature of 101°·4 F. Feeding caused an average rise of 0°·3 F. above the temperature of the same cattle at the same time on other days, but not feeding. In the afternoon, between 4 and 5 o'clock, the average temperature was 0°·5 higher than at 8 a.m. Pregnant cows had an average temperature 0°·3 F. higher than the average of the other cattle in the same building. Tuberculous cattle numbering 74, apparently perfectly healthy, but subsequently reacting to tuberculin, were the subjects of 505 observations. These animals had a much wider range of variations. The average was 101°·7 F. The lowest observed was 100°·4 F. and the highest 104°·3 F. The widest range of an individual was from 100°·7 F. to 104°·3 F., with an average of 102°·2 F. (temperature taken 15 times). Out of 137 apparently healthy dairy cattle, 74 (54 per cent.) reacted to tuberculin, thus emphasising the advisability of using that agent in attempts to obtain a dairy free from tuberculosis. —On the petrological examination of macadam: Prof. J. **Joly,** F.R.S. Various specimens of macadam used on Scottish roads have been examined. The general results of the investigation are to elucidate the characteristics of these macadams, as well as apparent abnormalities of behaviour, and to demonstrate the value of petrological methods in such cases.—On the construction of fume-chambers with effective ventilation: Prof. W. N. **Hartley,** F.R.S. The results of a series of experiments on ventilation and of practical experience with fume-chambers have shown the conditions which are necessary for the removal of noxious fumes from a chemical laboratory with the greatest efficiency and the least possible trouble and expense. Measurements were made daily over a period of six months of the gas burnt, the air extracted, the difference between inside and outside temperatures, the barometric pressure, the direction of the wind and its strength. The direction and dimensions of the flues, and the relation of the passage of air up the flues to the cubic contents of the chambers, are stated. The average quantity of air exhausted per minute was 354 cubic feet per chamber of 51 cubic feet, and on an average the air of each chamber is completely changed every nine seconds. The small height of the flues, being 25 feet, renders such a means of ventilation as that described readily adaptable to small out-buildings, such as school laboratories. Details are given as to the construction of flues with a descending draught as fitted to a lecture table and fume-chamber in a lecture room.—On the structure of water-jets and the effect of sound upon them, part ii.: Philip E. **Belas.**

EDINBURGH.

Royal Society, February 20.—Sir John Murray in the chair.—On the graptolite-bearing rocks of the South Orkney Islands: Dr. J. Harvey **Pirie.** The presence of Silurian sedimentary rocks in these isolated islands indicates a former much greater extension of land in the area lying to the south-east of Cape Horn. The fossils Pleurograptus and Discinocaris indicate their age as corresponding to the Caradoc or Lower Llandovery, and the structure of the rocks suggests that they belong to the same series as the Silurian rocks of the Argentine.—Palæontology of the Upper Old Red Sandstone of the Moray Firth area: Dr. R. H. **Traquair.** The fossils discussed in this paper, which embodied the research of the past fourteen years, were almost entirely fish remains, other remains, in the shape of badly preserved plants and certain tracks, probably of invertebrate animals, being rare. Twenty-one species of fish were recorded, of which only seven were known from the Upper Old Red of this region when the author took up the subject. The character of the fish remains suggested the division of the strata of the Moray Firth Upper Old Red into three zones, these being, in ascending order, the Nairn, Alves, and Rosebrae beds. Reference was made to the affinity of the Rosebrae fish-fauna with that of Dura Den, the yellow sandstones of which locality constitute the highest member of the Upper Old Red of Fifeshire. Dr. Traquair specially desired to acknowledge his great indebtedness to Mr. W. Taylor, of Lhanbryde, without whose assistance in furnishing material the paper could not have been prepared.—The constitution of complex salts, i., derivatives of the sesquioxides: A. T. **Cameron.** Retger's method of investigating isomorphous mixtures was applied to the blue chromoxalates of ammonium and potassium, and showed that they had no definite composition, there being, therefore, no conclusive reason for doubling the formulæ of these and similar compounds. The striking analogy between the so-called double fluorides, chlorides, cyanides, &c., and the complex derivatives of dibasic acids was pointed out. It was shown that to almost all such compounds, whether derived from monobasic or dibasic acids, simple constitutions can be assigned by supposing the hydroxyl radicals of the metallic hydroxide to be replaced by complex groups.—Theorems relating to a generalisation of Bessel's function, ii.: Rev. F. H. **Jackson.**

March 6.—Lord M'Laren in the chair.—A study of three vegetarian diets: Drs. Noël **Paton** and J. C. **Dunlop.** Of the three diets described, one was a totally insufficient diet of bananas, a second was a fairly typical vegetarian diet showing the difficulty of avoiding an excess of sugary food, and the third was the far from economical diet of a vegetarian glutton. These were compared with the diets of the labouring classes in cities as illustrated by the author's own investigations in Edinburgh, and those of Rowntree, Alswater, and Lumsden respectively in York, New York, and Dublin, and as regards rural districts by Wilson Fox's report. It was shown that these normal diets more nearly approached the physiological standard than the vegetarian diets studied.—A further contribution to the fresh-water plankton of the Scottish lochs: W. and G. S. **West.** The thirty-six lochs studied were in the north-west Highlands. There was an abundance of Desmids, a fact attributed to the geological character of the country. The Protococcoideæ were not abundant, in marked contrast to what occurs in Continental Europe. Diatoms were very abundant, and did not disappear in May and June. Myxophyceæ, again, were relatively few. The Swedish lakes alone approached the Scottish in the richness of the plankton. The Danish plankton was relatively much poorer in Chlorophyceæ, especially Conjugates. This was to be attributed principally to the fact that the geological formations are mostly of Tertiary age. —On the Sarcodina of Loch Ness: Dr. E. **Penard.** Of a list of nearly fifty species of Rhizopods and Heliozoa obtained at depths of upwards of 250 feet, several were of interest on account of their rarity, some being found for the first time in Europe, others being previously known only from the Lake of Geneva. The majority of the Rhizopoda had probably been derived from the shallow margins of the lake or from the neighbouring peat bogs; but some half dozen species or varieties were regarded as peculiar to the abyssal portions of large lakes.—The Rhizopods and Heliozoa of Loch Ness: J. **Murray.** In this paper the list of species given in the previous paper by Penard was supplemented by a number of species observed by the Lake Survey, bringing the list of Loch Ness Sarcodina up to sixty-six species. The difficulty of accounting for the transmission of peculiar abyssal forms from one deep lake to another was met by the suggestion that the abyssal forms originate separately in each lake and are probably not good permanent species, but modified forms due to the direct action of the environment on the growing individual.

PARIS.

Academy of Sciences, April 17.—M. Troost in the chair. —Second note on the principle of cellular flotation in ships: M. **Bertin.**—Mixed treatment by arsenious acid and trypan red of infection due to Trypanosoma: A. **Laveran.** Fresh experiments on monkeys confirm the favourable results previously obtained on rats and dogs.—Observations on the new comet Giacobini (1905, March 26) made at Toulouse Observatory: F. **Rossard.**—On the

differential equation $y''+\lambda A(x)y=0$: Max **Mason.**—On the relation which exists between the velocity of combustion of powders and the pressure: R. **Liouville.**—Optical properties of iono-plastic iron: L. **Houllevigue.**—On the theory and imitation of the motion of sails: A. **Bazin.**—On the use of the centrifugal method in the analysis of cocoa and chocolate: F. **Bordas** and M. **Touplain.** It is necessary, to avoid some practically impossible filtrations, to use an apparatus capable of nearly 2000 revolutions a minute.—New method for a quick analysis of milk: F. **Bordas** and M. **Touplain.** By centrifugal means one avoids much filtration as well as the protracted desiccation of the casein.—An apparatus for giving warning of the presence of luminous gas and afterdamp: MM. **Hanger** and **Peschoux.**—The crystalloluminescence of arsenious acid: M. **Guinchant.** This appears to be due to a chemical phenomenon corresponding with the reversible reaction

$$As_2O_3+6HCl \rightleftarrows 3H_2O+2AsCl_3.$$

—On the emission spectrum of the high tension electric arc: J. **de Rowalski** and P. **Joye.**—On a simple method for the study of oscillating sparks: G. A. **Hemsalech.** The method depends on the fact that a current of air directed on such a spark can separate out the oscillations.—Apparatus and methods in the medical applications of statical electricity: L. **Benoist.** An attempt to systematise the usage based on the consideration of electric density.—On the mode of formation of some monosubstituted derivatives of urethane: F. **Bodroux.** When small quantities of ethyl carbonate are dropped into an ether solution of the magnesium derivative of an aromatic primary amine, a lively reaction takes place. If aniline be used, phenylurethane is formed.—On the mineralogical analysis of arable earths: J. **Dumont.** The author describes methods for quantitatively determining the proportions of sand, mica, felspar, quartz, &c.—On some Crustacea resulting from the expedition of the *Princess Alice*: H. **Coutière.** By the use of a net with a large aperture a considerably more valuable collection was made.—On the excitation of nerves by a minimum of energy, and its application to electrodiagnosis: M. **Cluzet.** By experiments made on the nerves of human beings, it has been found through the application of a formula that the duration of minimum excitation may be 0·00020 second.—Physiology of the spleen: MM. **Charrin** and **Moussu.** The experiments made tended to elucidate the much discussed question as to the functional relationship between the liver and the spleen.—The action of intestinal fluid on enteric secretion: A. **Frouin.** Many facts seem to prove that this exciting action is not due to secretin.—Researches on animal lactase: H. **Bierry.** The experiments show that lactase is not contained in the pancreatic juice of suckling puppies.—On the production of alcohol and acetone by muscles: F. **Maignan.** The author replies in the affirmative to the question as to whether these substances, which are normally present in muscle tissue, arise by alcoholic fermentation of glucose by the agency of protoplasm. But while the acetone continues to be formed, the alcohol is sooner or later destroyed again.

DIARY OF SOCIETIES.

THURSDAY, APRIL 27.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Discussion*: Mr. B. J. Arnold's Address to the Joint Meeting at St. Louis on the Problem of the Alternate Current Motor applied to Traction.—*Paper*: The Alternate Current Series Motor: F. Creedy.

FRIDAY, APRIL 28.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

MONDAY, MAY 1.

ROYAL INSTITUTION, at 5.—Annual Meeting.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—(1) The Study of the Action of Hydrogen Peroxide on a Photographic Plate in the Dark; (2) On the Influence of the Length of the Time of Development on the Degree of Darkening of the Photographic Plate: Prof. Chiri Otsuki.

VICTORIA INSTITUTE, at 4.30.—The Influence of Physiological Discovery on Thought: Dr. E. P. Frost.

TUESDAY, MAY 2.

ZOOLOGICAL SOCIETY, at 8.30.—On *Leucosolenia contorta*, Bowerbank, *Ascandra contorta*, Haeckel, and *Ascetta spinosa*, Lendenfeld: Prof E. A. Minchin.—Some Notes upon the Anatomy of the Ferret-Badger (*Helictis personata*): F. E. Beddard, F.R.S.—Contributions to the Osteology of Birds, Part vii., Eurylæmidæ, with Remarks on the Systematic Position of the Group: W. P. Pycraft.

ROYAL INSTITUTION, at 5.—The Study of Extinct Animals: Prof. L. C. Miall, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Monumental Treatment of Bronze: J. Starkie Gardner.

WEDNESDAY, MAY 3.

ENTOMOLOGICAL SOCIETY, at 8.—The Structure and Life-history of *Psycheda sexpunctata*, Curtis: J. A. Dell.

SOCIETY OF PUBLIC ANALYSTS, at 8.

SOCIETY OF ARTS, at 8.—Recent Excavations in Rome: Mrs. Burton-Brown.

THURSDAY, MAY 4.

ROYAL INSTITUTION, at 5.—Flame: Sir James Dewar, F.R.S.

CHEMICAL SOCIETY, at 8.—The Synthesis of Substances Allied to Adrenaline: H. D. Dakin.—Methylation of *p*-Aminobenzoic Acid by Means of Methyl Sulphate: J. Johnston.—Some Notes on Sodium Alum: J. N. Wadmore.—Camphoryl-ψ-Semicarbazide: M. O. Forster and H. E. Fierz.

RÖNTGEN SOCIETY, at 5, (1) to Medical Members only. Forty-two Cases of Ureteral Calculus Diagnosis by X-Rays proved by Operation on the Passage of the Calculi; (2) at 8.15 p.m., to the General Meeting. Measurement and Technique in Therapeutic Dosage: Dr. C. Lester Leonard, Philadelphia.

LINNEAN SOCIETY, at 8.—Œcology: its Present Position and Probable Development: A. G. Tansley.—The Flora of Gough Island: R. N. Brown.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 7.30.—Annual General Meeting.—At 8.—Card-Indexing and Filing: J. C. Osborne.

FRIDAY, MAY 5.

ROYAL INSTITUTION, at 9.—Problems underlying Nutrition: Prof. H. Armstrong, F.R.S.

SATURDAY, MAY 6.

ROYAL INSTITUTION, at 3.—Moulds and Mouldiness: Prof. Marshall Ward, F.R.S.

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