THURSDAY, APRIL 28, 1904.

HETERŒCIOUS RUST-FUNGI.

Die Wirtswechselnden Rost-pilze. By H. Klebahn. Pp. 426 + preface, appendix, bibliography, and two indexes. (Berlin: Bornträger, 1904.) Price 20 marks.

IN 1864–65 De Bary startled the biological world with his discovery of the heterœcism of the Uredineæ—with his proofs that the long suspected and often re-iterated connection between the peculiar yellow fungus known as Æcidium, growing on the barberry, and the well-known rust-fungus, Puccinia, which devastates wheat and other cereals, is true in fact, and that the winter-spores of the latter germinate in spring and develop spores which infect the young barberry leaves, whereon are then developed the quite different spores of the Æcidium, which in their turn re-infect the wheat.

Investigations along the same experimental lines, and supported by the same irresistible logic, soon showed that many other Uredineæ, or rust-fungi, are capable of a similar change of life as they pass from one host-plant to another, among which were the Gymnosporangia of junipers, which develop the very different Rœstelia on Pomaceæ (hawthorns, pears, &c.), and the even more remarkable cases of Coleosporium on Senecio, which infects pines and develops thereon the curious æcidial forms known as pine blisters, or Peridermium.

The list of heterœcious Uredineæ, or rust-fungi, which thus change their hosts and develop a different kind of fungus on each host now numbers 160, including a few cases only where the phenomenon is not yet proved with absolute certainty by the experimental infections, and Klebahn has set himself the task of bringing together all the salient biological features of these remarkable plants, the economic importance of which to mankind is sufficiently indicated by the fact that the ravages of these parasites on our cereals and fodder plants, to say nothing of plants grown for pleasure, amount to many millions sterling every year, and that entire planting enterprises have been ruined by them.

But the subject of heterœcism has equally important bearings on the scientific philosophy of plant life, closely bound up as it is with the large questions of parasitism, and the nature and origin of species.

Klebahn's book is divided into two parts. The first 204 pages are concerned with the general aspects and discussions of the whole subject, the rest of the work with the special description and biology of each species in succession.

A mere enumeration of the headings suffices to show how interesting and important are the themes discussed in part i. Beginning with definitions and the history of the whole question of heterœcism, and a summary of the principal types of rust-fungi concerned, the author passes, in section iv., to an account of the means of distribution, and the conditions of germination and infection of the various kinds of spores produced by these remarkable fungi.

Certain controversial questions are then examined and answered. Klebahn emphatically declares (p. 43) that no evidence of value exists to show that the host which bears teleutospores can be infected by sporidia. He also examines the question of the necessity of heterœcism, and concludes that for some forms it is indispensable, though there are many which are known to be able to do without it. Some of the latter have a perennial mycelium, the classical example being De Bary's *Æcidium elatinum*, which induces the witches' brooms on silver firs.

By far the most exciting part of Klebahn's general exposition is that which deals with the wheat-rust problem and Eriksson's mycoplasma hypothesis. The wheat-rusts are held to be heterœcious, but able to dispense with the change of hosts. The wintering of uredo-spores is not regarded as sufficient to explain the infection of plants in the spring. But if the æcidium form is absent, and no uredo-spores have survived the winter, how is it the cereal shows infection next spring?

Klebahn insists on the importance of the world-wide distribution, in vast quantities, of the rust and of wheat culture, and that the wind can carry the spores, *as it can far heavier particles such as grains of dust*, hundreds of miles at a stretch, and Marshall Ward's experiments with the uredo-spores of *Puccinia dispersa* prove that such spores may retain their germinating power for sixty-one days.

Eriksson has entirely failed to grasp the significance of these facts, and his hypothesis of a latent and undiscoverable mycoplasm is not only superfluous, but has entirely broken down under the criticism of Marshall Ward's investigations, which show that the so-called incipient mycelia proceeding from "mycoplasm" are nothing but the normal haustoria of the fungus.

Section ix. deals with the distribution of rust-fungi and their passage into new regions. Section x. with methods, not only of culture and infection, but also—far too briefly—with the details of microscopic preparation. Section xi. is devoted to the problems of geographical areas of distribution, and contains much interesting information about the rusts of various countries.

In section xii. Klebahn illustrates, with ingenious diagram tables, the vagaries of these parasites in their choice of host-plants, and then passes to the discussion of the second of the two great burning questions of the rust problem, viz. the phenomenon of specialisation of parasitism, with which Eriksson's name must always be honourably associated.

Put shortly, the matter stands thus. Although a given species of rust-fungus is found on two host-species A and B, and although no trace of difference can be discovered with the microscope in the two cases, nevertheless the fungus on A will not infect B, nor will that on B infect A. This has been so abundantly and thoroughly proved by the researches of Eriksson, Klebahn, Marshall Ward and others that there can be no doubt as to the facts. The explanation appears to be that the fungus on A is so closely adapted to the physiological peculiarities of its host A that it cannot suddenly alter its habits when placed on another host B to which it is not yet attuned, and consequently fails to infect B. But, as Marshall Ward showed, the host B may be merely a closely related variety of A, whence we must infer that the differences of food-material and so forth may be very small, and it is not surprising that occasionally a spore from A may succeed in infecting B, possibly when the latter is "off its guard," as it were, and short of its supplies of resistant materials or unduly lavish of its stores of attractive substances, or possibly because the spore in question happens to be better equipped than usual with the necessary solvents or poisons needed to break down the normal resistance of B. Be this as it may, once the fungus of A has gained a hold on B, it can now go on infecting B by means of its spores—it has now adapted itself to B.

But Marshall Ward showed that, while the fungus on A may fail to infect B, it may be readily able to infect a third related variety of host-plant C, and after adapting itself to C it may then pass easily to B; thus C becomes a bridging form from A to B.

Klebahn in sections xiv. and xv. discusses these matters, and the gradations of specific variation and their bearing on the theory of descent at great length, and concludes,

"The manifold characters of the existing biological species and races appear to have come into being owing to the alternating extensions and restrictions of the area of nutritive plants. These changes, and especially the restrictions of area, have been influenced by adaptation and selection, but many observations indicate that internal developmental tendencies, as yet entirely unexplained, have also played a part in determining the direction of the evolution."

Not much is gained by the latter phrase, but it at least shows the lines along which the thoughts of modern pathologists are tending.

Section xvi. deals with the question of the origin of heterœcism. Klebahn appears to doubt whether the increase of virulence said to be exhibited by Æcidium spores from barberry, as contrasted with uredo-spores grown on the wheat itself, can be maintained, and inclines to the belief that an advantageous utilisation of the periodic phenomena of vegetation is rather the key to the problem.

The author then proceeds to the discussion of predisposition, and accepts Marshall Ward's researches showing that anatomical peculiarities on the part of the host-plant do not explain it, concluding that in part chemical constitution, in part forces or factors of unknown nature in the protoplasm, are at the bottom of the question.

The concluding section of this part concerns the spermogonia, and views as to the alleged sexuality of the rust-fungi. The view is maintained that the spermatia are now functionless, and the author doubts the sexual character ascribed by Sappin-Trouffy and Dangeard to certain nuclear fusions in the development of teleutospores.

Part ii. is essentially a work of reference for investigators, and deals very thoroughly with all the special points in the biology of the various species of heterœcious Uredineæ raised by the Tulasnes, De Bary, Dietel, Fischer, Magnus, Eriksson and Henning, Marshall Ward and other workers, including—by no means the least important—the author himself.

A very complete account is given of Eriksson's work on the rusts of the cereals, and of that of Marshall Ward on the brome rusts, and it is probably not too much to say that a more thorough and masterly work on the subject has never yet been produced.

That Klebahn's work will have a wide influence in furthering investigation into these extraordinary and important parasites cannot be doubted.

A STUDY OF RABIES.

Rabies: its Place among Germ-diseases and its Origin in the Animal Kingdom. By David Sime, M.D. Pp. xii+290. (Cambridge: University Press, 1903.) Price 10*s*. 6*d*. net.

THE admiration with which we must regard Pasteur's studies on rabies is increased by the fact that the actual microbe which causes the disease is unknown. Pasteur, nevertheless, by a logical application of the facts known concerning other pathogenic microbes, triumphed over this difficulty, and presented the world with a method of preventive inoculation against hydrophobia. He owed this achievement to the rigid and laborious series of experiments with which he was scrupulously careful to control his theories.

It is strange that Dr. Sime, with this example constantly before his eyes, should have been absolutely blind to its lesson. Anyone who seriously proposes to add to our knowledge of rabies must follow Pasteur's methods. No advance is likely to be made by the most ingenious reasoning unsupported by practical demonstration; we have no use at all nowadays for armchair pathology. Dr. Sime's work is beautifully printed and written in excellent English; it bears evidence of very wide reading and of careful though fanciful thought. But it is wordy to an exasperating degree, and the perpetual use of inverted commas and italics becomes almost a nightmare. There is no evidence from first to last that the writer has attempted to substantiate any one of the remarkable views which he sets forth by a single practical experiment.

There is room in the English language for a good monograph on rabies, but instead of giving a plain and straightforward account of what is at present known about the disease, which it is probable that Dr. Sime would have been competent to do, he presents us with a "study" of rabies from a number of theoretical standpoints, at times embroidered with excursions into transcendental bacteriology. It must suffice here to give a few examples only of the strange views supported by the author. The discussion as to the order of germ-diseases to which rabies belongs is based on a classification with which we are unfamiliar. Dr. Sime sharply divides infective diseases into two groups—those which protect against future attacks and those which do not; for these he employs the singularly unhappy names "prophylactic" and "preventive" respectively. Why a disease which does not protect should be called "preventive" is not explained, nor does it much matter; every degree of protection can be traced amongst infective diseases, and no such sharp distinction exists as that set forth by Dr. Sime. We learn that the rabies microbe is strictly "preventive," and in the course of the argument much stress is laid upon a misleading analogy between the rabies virus and alcohol—a mistake which might have been avoided had the author's studies included Ehrlich's work on the fundamental differences between such a poison as alcohol and the bacterial toxins which contain a haptophore atom-group.

A chapter is devoted to proving the "multiform structure" of the rabies microbe, illustrated by diagrams as fanciful as the speculations upon which they are based. In a chapter on rabies of the sympathetic system, the virulent character of the saliva in paralytic rabies is explained on the theory that the salivary glands are invaded through the sympathetic nerves. Inasmuch as stimulation of the sympathetic checks the secretion of the submaxillary gland, while stimulation of the chorda tympani excites it, we fail to follow the line of reasoning. In any case Dr. Sime should have put his views to the test by laboratory experiment. But perhaps the high-water mark of irresponsible speculation is reached in the chapter on the relation of bacterial agency to secreting organs, in which the novel view is propounded that not only poisonous secretions in animals and plants, but even digestive secretions owe their existence to a bacterial commensalism in the tissues. As regards the origin of rabies in the animal kingdom, Dr. Sime doubts its primitive canine source, and is inclined to trace it to the "intensifying" division of animals, and in particular to the rabbit, which, exhausted by being hunted, contracts the disease in some unexplained manner from the soil, especially when its ears are frost-bitten. We fear that we must regard this book as an example of the unscientific use of the imagination, and we should not have devoted so much space to it had it not been issued by the Cambridge University Press.

MINING AND QUARRYING.

The Elements of Mining and Quarrying. By Sir C. Le Neve Foster, D.Sc., F.R.S. Pp. xviii+321. (London: Charles Griffin and Co., Ltd., 1903.) Price 7*s*. 6*d*. net.

ONE of the most difficult tasks in the field of technical literature is the preparation of a thoroughly good elementary text-book of an industrial art, and the difficulty is especially conspicuous when the subject dealt with is mining, with its incursions into mathematics, physics, chemistry, geology, mineralogy, civil engineering, mechanical engineering, electrical engineering, law, and sanitary science. It is not astonishing that the task has not hitherto been attempted. In French and German there are several useful works of the kind; but in English, elementary text-books have dealt exclusively with but one branch of the subject, the best example being the rudimentary treatise written a generation ago for Weale's series by the late Sir Warington Smyth.

In 321 pages the late Sir C. Le Neve Foster has covered the whole range of mining and quarrying. With an intimate knowledge of his subject, he combines great clearness of style and a thorough grasp of the beginner's needs. Superfluous detail is carefully avoided, and the arrangement of the matter is eminently logical. Each of the sixteen divisions of the subject is concisely expressed by a single word:—(1) occurrence, (2) discovery, (3) boring, (4) excavation, (5) support, (6) exploitation, (7) haulage, (8) hoisting, (9) drainage, (10) ventilation, (11) lighting, (12) access, (13) dressing, (14) legislation, (15) health, and (16) accidents. These easily remembered headings serve as pigeon-holes in which a student may file his notes upon any mine or quarry he visits. Into this comprehensive system, subjects from widely different fields of science and technology are combined by the author, with the result that his text-book forms, without undue burden of references, a thoroughly trustworthy guide for the beginner in mining, and in many respects for the experienced miner, who is apt too often to specialise in one branch of mining and to ignore the progress made in other branches. The beginner is wisely urged to deal with the subject broadly, and not to confine himself to the narrower sphere of the coal-miner or of the seeker for ores. After mastering the general principles of his art he can specialise later.

This has always been the method of teaching adopted at the Royal School of Mines. Half a century ago Sir C. Le Neve Foster's predecessor in the chair of mining expressed the view that he would never dissociate entirely the art of working collieries from that of working metalliferous mines, since both had much in common, and the one might often profitably borrow an idea from the other. He thought, however, that in the various districts where schools in the future might be established it would be needful to devote more attention to one department than to another, and according to the opportunities of the teacher to select special portions for fuller and more practical instruction. The success of the broad treatment adopted at the Royal School of Mines is clearly shown by the large number of associates of that institution that are occupying positions of eminence in the divergent fields of coal, ore, and precious stone mining in all parts of the world, and by the fact that at the provincial educational institutions of more recent formation the specialised mining instruction is, almost without exception, in the hands of old students of the parent school.

One of the original features of Sir C. Le Neve Foster's book is that he insists that from the very outset the student should seek to acquire some information concerning the laws regulating mining and concerning the diseases and accidents incidental to the miner's calling. This new departure deserves warm commendation. Mining differs from most other occupations by being regulated by special statutes, and with an uncongenial branch of the subject like law the student needs special help. The labour question, too, is of so much importance and often so much more difficult to solve than the extraction of mineral from the ground, that the student cannot fail to be grateful for guidance in the task which in his future career he may have to face, of collecting workmen in inaccessible districts, of housing them, and of looking after them generally.

The work contains 281 illustrations, some being drawings to scale and others reproductions of photographs, showing in a striking manner the operations of mining and quarrying. All are excellent, and, like the letterpress, are exceptionally well printed. A very full and accurate index greatly adds to the value of the book.

B. H. B.

SOME BOOKS ON QUATERNIONS.

Étude sur les Quantités mathématiques. Grandeurs dirigées, Quaternions. By Prof. Claro Cornelio Dassen, D. es Sc. Pp. vi+133. (Paris: A. Hermann, 1903.) Price 5 francs.

Introduction to Quaternions. By the late Profs. Philip Kelland, F.R.S., and P. G. Tait. Prepared by C. G. Knott, D.Sc. Pp. vii+208. (London: Macmillan and Co., Ltd., 1904.) Price 7*s.* 6*d.*

Bibliography of Quaternions and Allied Systems of Mathematics. Drawn up for the International Association for Promoting the Study of Quaternions, &c. By Alexander Macfarlane, D.Sc., LL.D., F.R.S.E., General Secretary of the Association. Pp. 86. (Dublin: University Press, 1904.)

IT may perhaps be rather an exaggerated statement, but it is none the less to a great extent true, that mathematicians tend to divide themselves into two classes, quaternionists and non-quaternionists, and that these two classes frequently become involved in polemical controversies. But at the present time the notion of vector quantities is of frequent occurrence in physics, and it is important that everyone should have an opportunity of understanding the laws and nature of vector operations. It is not unfrequently stated that forces are vectors, because they are directed quantities, and *therefore* they are compounded by the parallelogram law. But the moment of inertia of a body about a line is also a directed quantity in the sense that its magnitude depends on the direction of the line, although moments of inertia, as every mathematician knows, are *not* compounded by the parallelogram law. Clearly dogmatic statements about vectors are dangerous for teaching purposes.

Dr. Dassen's book deals with a much wider field than the study of quaternions proper. The first part treats of "the concept of quantity," *i.e.* the fundamental laws of algebra. The second part is divided into three chapters, which treat of directed quantities in space of one, two and three dimensions respectively, so that it is only in this last chapter that the particular system of algebra associated with the name of Sir W. R. Hamilton is discussed.

Prof. Knott's edition of Kelland and Tait's book is a typical English text-book of a kind such as writers of other nationalities rarely produce. By this we imply that it is full of worked illustrative examples, and at the end of each chapter is a copious collection of examples for exercise. The first five chapters, extending up to p. 89, would form an excellent course for a student whose time is short.

The chapter on dynamical applications is an important innovation which might well be extended in the interest of science students by the addition of more elementary examples. Chapter vi., dealing as it does with "cones and their sections," possesses little interest for the modern student. It would have been more useful thirty years ago, when it was the fashion not to teach the calculus until the student had learnt by heart a series of propositions for the parabola, a second series for the ellipse, and a third series (scarcely ever properly understood) for the hyperbola. Nowadays more suitable illustrations may be obtained from physical problems without wasting time over these elaborate discussions about conics. On the other hand, chapter vii., dealing with central *surfaces* of the second order, is less detailed in its treatment, and consequently likely to be more helpful.

Dr. Macfarlane is to be congratulated on the very complete list of papers which he has succeeded in drawing up for the association of which he is secretary. These papers, we notice, cover different systems of multiple algebras, discussions on the geometric representation of complex magnitude, and nearly every book, pamphlet or paper on mathematics or physics in which quaternions or allied systems of mathematics play any part whatever, such, for example, as Clerk Maxwell's "Matter and Motion" or Minchin's "Statics." The only improvement that can be suggested is a classification of the papers by which those merely containing references to quaternions should be separated from those which treat of a substantial portion of the general theory of algebras of vector quantities.

OUR BOOK SHELF.

A Manual of Zoology. By Richard Hertwig. Translated and edited by J. S. Kingsley. Pp. xi+704. (London: G. Bell and Sons, 1903.) Price 12*s.* 6*d.* net.

THE English student of zoology has now the choice of a large number of excellent text-books, varying in style, in thoroughness, in wealth of illustration, but sufficient for the purposes of his education up to the time when his more advanced studies require him to turn his attention to the writings of foreign authors in their original language. To add to the list, the translation of a foreign text-book requires some special justification. It must provide something, some special treatment of a subject or some philosophical speculation which has not been provided by those who, with a knowledge of the needs of our own students, have written text-books for their guidance. The great reputation of Prof. Hertwig would lead us to expect a text-book from his pen that would justify its translation into the language of any country where zoology is seriously studied, and in some respects we are not disappointed.

The book opens with a definition of general terms and a short history of the development of the science from the time of Aristotle to the present day, which are admirably concise and clear. The pages dealing with general morphology and physiology are also decidedly excellent, better, perhaps, than are the corresponding parts of any other modern text-book. In the portion dealing with special zoology, however, there are many features which detract from its general merits. We might point out, for example, that the description given of the important group Protracheata is insufficient, and the statement that the animals included in it are viviparous is erroneous. The classification of the Pelecypoda adopted in the text is old-fashioned and by no means the best.

The statement on p. 206 that in Ciliata there is *a* micronucleus is misleading. It should be one or more micronuclei. These and many other general statements are unsatisfactory. The book, moreover, is disfigured by numerous misprints. Such a misprint as Afrid*a* (p. 644) may not be of much consequence, but the misprints in the names of animals, such as My*l*ilidæ (p. 367), Che*l*efer (p. 450), Mac*h*rocheiroptera (p. 638), Strongylocentr*a*tus (p. 345), Saxica*r*a (p. 367), and a great many others cannot but mislead the elementary student of zoology.

A Guide to the Antiquities of the Bronze Age in the Department of British and Mediaeval Antiquities, British Museum. Pp. xii+159; 148 figures, 10 plates. (London: British Museum, 1904.) Price 1*s*.

THE members of the staff of the British Museum who are responsible for the "Guide to the Antiquities of the Bronze Age," which has just been published, are to be congratulated on having provided the public with a most excellent little manual which is not merely a guide to the collections in our National Museum, but is at the same time a convenient text-book on the Bronze age. There had long been a lack of authoritative handbooks on archæology in English, and in this respect we were at a disadvantage compared with certain other countries in Europe. Thanks to the energy and knowledge of Mr. C. H. Read and his colleagues and to the liberality of the trustees, we are now provided with two well written, precise, and copiously illustrated shilling books which supply this deficiency for the Stone and Bronze ages, and we are glad to note that a volume on the Iron age is in course of preparation.

In the closely packed twenty-six pages of the introduction we have a succinct account of the evidence for a Bronze age and its relative chronology; the existence of an antecedent Copper age is discussed, and it is admitted that some countries do possess a distinct Copper age. The author leans to the view that bronze was first discovered in China in the fifth millennium B.C. The Aryans are treated to a brief discussion, and the position is taken "that the Aryan language was forced upon the aboriginal inhabitants of Europe towards the end of the Neolithic period by a stalwart race with short skulls and fair hair, who radiated from some point in south-east Europe . . . the new comers are sometimes known as the Alpine race."

The bulk of the little book is taken up not with a mere catalogue of objects, but with an instructive guide to the objects in the collection, and for the further elucidation of the culture of the Bronze age descriptions and illustrations are given of hut-circles, brochs, and a barrow. A considerable amount of space is taken up with objects from various countries on the Continent, and by this means the finds in our own islands can be placed in their relative position in the cultural history of Europe. The numerous illustrations in this book are carefully chosen and well executed, and the book can be highly recommended to curators, students, and the general public.

The Care of Animals. By N. S. Mayo, M.S., D.V.S. (Rural Science Series). Pp. xvi+459. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s*. net.

THE agricultural reader who possesses Prof. Jordan's admirable text-book "The Feeding of Animals" will welcome this addition to the "animals" section of the Rural Science Series. The writer, Dr. N. S. Mayo, professor of veterinary science in the Kansas State College, indicates his standpoint in the following two sentences taken from the preface. "The day of the 'horse-doctor' book is passing. Prevention, sanitation, careful handling are more important than mere medication."

The first section of the volume, treating of the general care of animals, is a little disappointing. There is much common sense, but there is also a suspicion of padding. The illustrations of farm live-stock in chapter i. have no particular point, and one feels that a dozen pages of illustration and letterpress transferred from the first three chapters to the chapter on veterinary obstetrics would have been an advantage. When the writer comes to his own subject, the care of sick animals, there is a great improvement, and 400 pages are filled with just the kind of information that the stock-owner wishes to have. The chapters on the indications of disease and the nursing of sick animals are excellent. The descriptions of ailments, though quite free from medical terms, are pointed and so clear that even in the absence of professional assistance the farmer is likely to be able to recognise many of the diseases. The advice given is plain but guarded. The writer does not forget that there are medicines which may do harm, and he has given special prominence to the use of simple remedies; he urges the owner of valuable stock to take no risks, and when in doubt to consult a skilled veterinarian. For those unable to do this there is a short chapter on common drugs, doses and recipes. The book is likely to be popular in the British colonies, and its usefulness for the colonist would be increased if the sections on drugs and recipes were extended. In its present form, however, this addition to our agricultural text-books deserves popularity. To the stock-owner whose province it is to "nurse" rather than to "treat" the sick animal Prof. Mayo's volume will be most useful, and should be most welcome.

A Text-book of Ceramic Calculations, with Examples. By W. Jackson, A.R.C.S. Pp. xviii+67. (London: Longmans, Green and Co., 1904.) Price 3*s*. 6*d*. net.

THIS little book is designed to supply students in classes in pottery and porcelain manufacture with a collection of problems and examples to illustrate the application of mathematical and chemical methods to the solution of the problems with which the potter is constantly confronted in his work. The preliminary lists of chemical substances—with their formulæ, atomic or molecular weights, and specific gravities—and of minerals important from the potter's point of view should prove useful. The heading on pp. 12–14, "List of Elements," is unfortunate, seeing that the substances tabulated are mostly compounds. More exercises for the student to work out might have been supplied with advantage, for instance, to chapter ix. one problem only seems to be given.

Botany Rambles. Part i. In the Spring. Pp. iv+120. (London: Horace Marshall and Son, 1904.) Price 10*d*.

THE anonymous writer of this book for children gives the following excellent advice to the youngster beginning to read the little volume: "If you have not time to read this little book and go out as well, then don't read it, but go out instead." The information provided is given in clear, simple language, and is of a kind that a sympathetic adult taking a child for a ramble would strive to make the young botanist find out for himself. The photographs of trees in the book are very good.

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.*]

The Complex Nature of Thorium.

With regard to several letters on thorium and its complex nature that appeared in Nature of March 24 and 31, April 7 and 14, and in which my name is mentioned, I take the liberty of adding a few remarks, having had ten years' experience in working with thorium.

In 1897, at a meeting of the British Association in Toronto (Canada), I read a paper in which I pointed out that spectrum evidence proves the complex nature of thorium.

In 1898 (Chem. Soc. *Trans.*, p. 953) I isolated from some thorium fractions an earth with an atomic weight of 225·8 (tetrad). Knowing the difficulties of the separation of rare earths (I have been engaged in this kind of work since 1878), and not wishing to publish a premature conclusion, I did not declare this to be a novel constituent of thorium, but said that foreign earths were present, in spite of the fact that the reaction used ought to have separated them.

In 1901 I published another short paper (*Proc.* Chem. Soc., March 21, 1901, pp. 67–68), in which I said that "my experiments may be regarded as proving the complex nature of thorium." Thorium was split up into Thα and Thβ. With Thβ I obtained so low an atomic weight as $R^{iv}=220$. The fractions Thα gave by the analysis of the oxalate, though it was prepared by pouring the thorium salt solution into an excess of oxalic acid, in order to avoid the formation of a basic salt, the high atomic weight $R^{iv}=236·3$. But I stated expressly, and I feel obliged to repeat it, that these fractions show a great tendency to form basic salts. Assuming these to be normal, a higher atomic weight than the true one is obtained. This is true especially in regard to the oxalate.

The splitting up of thorium into Thα and Thβ was, of course, not so sensational an event as the announcement from America of the splitting up of thorium into "carolinium" and "berzelium." Bohuslav Brauner.

Bohemian University, Prague, April 18.

Radio-activity and the Law of Conservation of Mass.

Mr. Soddy in the Wilde lecture on the "Evolution of Matter as Revealed by the Radio-active Elements" (*Proc* Manchester Phil. Soc., vol. xlviii., part ii., p. 29) gives two methods of deducing the average life of a radium atom. The results become concordant if we assume that the complete disintegration of an atom of radium involves the emission of four α particles. Now the atomic mass of radium is 225, and that of an α particle about 2; the question therefore arises as to what has become of the rest of the mass.

There appear to be three possible answers to this question. In the first place Mr. Soddy's estimate may be wrong by a factor of ten, although it is hardly likely that the data are uncertain to this extent; secondly, the various stages of the disintegration may involve the liberation of non-radio-active by-products which would necessarily be incapable of detection by the methods of investigation employed; and, finally, there may be a decrease in the total mass of the system owing to the decrease in the velocities of some of the constituent electrons.

A priori the second hypothesis appears to have the balance of probability in its favour, as it agrees best with our present ideas; but I think the third solution should not be dismissed too hastily. In discussing the matter recently with Mr. G. A. Schott, I found that he also had been led to consider the tenability of this view in connection with some theoretical work on the structure of the atom which will probably soon be published. O. W. Richardson.

Trinity College, Cambridge, April 19.

The Atomic Weight of Radium.

In the *Philosophical Magazine* for April, 1903, Runge and Precht work out the atomic weight of radium from its spectrum to be 258, instead of the 225 found by Madame Curie. I should like to point out that the spectrum data of radium support the value given by Madame Curie, if handled according to Section v. of "The Cause of the Structure of Spectra" (*Phil. Mag.*, September, 1901). There is an important question of principle involved in the distinction between the two methods of using the spectrum of an element for determining its place in the periodic classification.

The method adopted by Runge and Precht is founded on a slight alteration of the approximate empirical law discovered by Rydberg, that, when similar elements have corresponding pairs or triplets of lines in their spectra, the difference of the frequencies of vibration of the two lines in a pair belonging to any one element is proportional to the square of its atomic weight. Runge and Precht alter this law by substituting the words "some power of its atomic weight" for "the square of its atomic weight." Thus in the alkaline earth family they give the power as 1/0·5997. The frequency differences of corresponding pairs of lines in Mg, Ca, Sr and Ba, namely, 91·7, 223, 801 and 1691 being denoted by x, the logarithms of the atomic weights M of these elements are given by the formula $\log M=0·2005+0·5997 \log x$. As x for radium is 4858·5, the value 258 is found by Runge and Precht for the atomic weight of radium. But the frequency differences are connected with one another by numerical relations, and not directly by their atomic weights.

The clearest instance of this purely numerical relationship is shown by the spectra of Zn, Cd, and Hg. A characteristic set of corresponding frequency differences for these elements is 386·4 for Zn, 1159·4 for Cd, and 4633·3 for Hg. The number for Zn multiplied by 3 gives 1159 2, which is indistinguishable from the value for Cd, and 12 times the number for Zn gives 4636 8, which is within 1 part in 1000 of the value for Hg.

In the paper mentioned I have shown how this numerical series, 1, 3, 12, appears elsewhere in the frequency differences for other families of elements, with a fourth member, namely, 28. Now these numbers are the first four terms of the series the general term of which is $1-3n/2+7n^2/2$. This series, and not atomic weights, controls the relations between the frequency differences for the spectra of allied elements.

Perhaps the most striking evidence in support of this assertion is afforded by some characteristic frequency differences discovered by Runge and Paschen in the complicated spectra of O, S, and Se. These are for O 3·7 and 2·08, for S 18·15 and 11·13, and for Se 103·7 and 44 07. Of these six numbers four are the first four terms of the series the general term of which is $3·7(1-3n/2+7n^2/2)$, namely, 3·7, 11·1, 44·4, and 103·6. The numerical law applies, then, to the non-metals as well as to the metals. The distinction between a purely numerical and an atomic weight relation between the frequency differences of allied spectra is fundamental, the one implying a kinematical, the other a dynamical, origin for the structure of spectra.

As to the bearing of these considerations on the determination of the atomic weight of radium from its spectrum we can represent the differences given above for the alkaline earth elements by the formula 63·8(1, 3, 12, 26)+31·6, in which 26 for Ba takes the place of 28 in the standard series. There are other instances in which a serial number like 12 or 28 is reduced by 2 or 4, a phenomenon probably of kinematic origin. For the next three elements of this family with higher atomic weights than Ba, the frequency differences corresponding to those just given should be the values of $63·8(1-3n/2+7n^2/2)+31·6$, given when $n=4$, 5 and 6. The coefficients of 63·8 are 51, 81 and 118. Now the 4858·5 of Runge and Precht for radium is $63·8\times75·7+31·6$. Thus the 75·7 of radium corresponds to the 81 of the regular series in the same way that the 26 of Ba does to the 28 of the regular series. So the numerical law for the frequency differences places radium two main rows lower than Ba in the table of elements, and gives to it, therefore, an atomic weight exceeding that of Ba, namely, 137, by about 90. The spectrum evidence confirms then the determination 225 made by Madame Curie.

As quite a number of investigators are working at relations between spectrum data and atomic weight, it seems important to make generally known the fact that mathematical series, like that of Balmer's law or that given above, are the main feature in the laws of spectra. The approximate law of Rydberg arises from the fact that the atomic weights of the elements form a series. Certain relations between this series and the series belonging to the spectra of the natural families are probably the cause of Rydberg's approximate law, which is not suitable for the extrapolation attempted by Runge and Precht with their modified form of it, unless other better means of estimating the atomic weight are lacking. All that we are warranted in saying at present is that the atomic weights of some of the elements in a family are nearly proportional to some power of $A+B(1-3n/2+7n^2/2)$, where n has positive integral values, and A and B are parameters characteristic of the family. WILLIAM SUTHERLAND.

Melbourne, March.

Graphic Methods in an Educational Course in Mechanics.

I SHOULD be glad if I could, through the columns of NATURE, elicit opinions from those who have taught mechanics from the beginning as to the advisability of either omitting graphical methods altogether from an educational course in mechanics or of introducing them at a very late stage.

By graphical methods I mean those methods which depend entirely on the use of mathematical instruments of precision, and from which calculation is absent. I do not refer to the plotting of curves from results obtained analytically, or to such simple graphical considerations as enable one to draw (freehand) a useful working figure.

I myself, after many years of teaching, have come to the conclusion that until the principles of statics and dynamics have been thoroughly grasped, it is better to keep graphical methods out of sight altogether.

My contentions are as follows:—

(1) *Analytical methods give a grasp of the principles of statics, while graphical methods disguise them.* When a body is at rest and in equilibrium, the obvious facts are that it does not move in this direction or in that, and does not rotate. Now the idea of a *resolute* as the effective component of a force in any direction is one readily grasped, and the analytical statement that "the resolutes in any direction balance one another" brings vividly before the mind the equilibrium as regards *translation*. Any experiment made suggests this balancing of resolutes. But the closing of a polygon of forces, on the contrary, does not suggest, with anything like the same degree of vividness, that there is no translation. In fact, the closed polygon of forces, representing as it does a couple, rather suggests that there *is* rotation. An experiment with a body on an inclined plane, for example, suggests a balance of resolutes and does not suggest a triangle of forces.

Again, as regards *rotation*. The analytical method of the "balancing of moments" brings clearly before the mind the fact that the body does not rotate. I am sure that most people will agree with me when I say that the corresponding graphical proposition, that "the funicular polygon closes," will not suggest non-rotation to any ordinary learner.

(2) *Analytical methods must be mastered in any case.* In any educational course, it is important that the learner shall have to rely on as few principles as possible. Now when he has mastered the principles of "resolution" and "taking moments," he can be led to attack any useful problem in statics without further theory.

But he may master the "polygon of forces" and the "funicular polygon," and yet find himself totally unable to deal with machines and with other constantly occurring cases of equilibrium. He will find that, while he can obtain by graphical methods the resultant of a system of forces if these be parallel, he will probably fail if the forces be not parallel (and non-concurrent), owing to the difficulty of getting his diagram on to a given sheet of paper. In fact, analytical methods must be mastered, while graphical methods, however convenient in certain cases, need not be mastered save for special professional purposes. If, then, there be not time for both, it is the latter that should be sacrificed. A student well trained in analytical methods can always pick up graphical methods rapidly when he needs them for special work.

(3) *Analytical methods connect statics with dynamics.* I do not think that this contention will be disputed. Regarded analytically, statics are a part of dynamics; the equations are the same and the ideas are the same, only the acceleration, in statics, is zero.

(4) *Graphical methods confuse learners of statics.* Here I rely on experience, and report what I have observed. I have noticed, over and over again, that, while a learner of analytical statics may fail to solve a problem, he yet knows what he is trying to do, and he does not, as a rule, lose sight of principles.

But I find that beginners, who have learned something of graphic statics, appear to lose sight of principles altogether, and are content to make the wildest "shots." They make triangles out of ladders, walls, and ground, and continually take the lengths of bars or strings to represent the stresses in them in their attempts to "get a triangle of forces."

I find no beginner so difficult to teach as one who has learned some graphic statics at a preparatory school, and I much prefer those who have learned no statics at all. There seems to be something in graphical methods that paralyses the learner's powers of thought and reasoning, or at least allows them to slumber.

To sum up. I have come to the conclusion that graphical methods (as defined above) should be reserved for a relatively late stage in any educational course in mechanics, or even be omitted altogether until required for special work. In addition to the reasons given above, I may add that graphical work consumes an amount of time that seems out of proportion to the mental training and knowledge of principles gained. W. LARDEN.

Devonport, April.

Sunspots and Temperature.

THE following view of this subject (related to that given by Dr. Lockyer a short time ago) may be of interest.

Consider the last five sun-spot waves, as measured from the first year after a minimum to the next minimum, thus:—

(1) 1844–56 (13 years)	... ...	Maximum 1848
(2) 1857–67 (11 years)	... ...	,, 1860
(3) 1868–78 (11 years)	... ...	,, 1870
(4) 1879–89 (11 years)	... ...	,, 1883
(5) 1890–1901 (12 years)	... ...	,, 1893

Using Wolf and Wolfer's sun-spot numbers, and finding the annual average for each of these waves, we get the curve marked A (dotted line) in Fig. 1 (p. 608).

Ascertaining next the averages of several meteorological items at Greenwich for those periods, we obtain curves B, C, D, E, F. The items are:—

(B) Mean temperature of winter (December–February).

(C) Frost days in winter (an inverted curve).

(D) Days with maximum temperature 70° or more (in year).

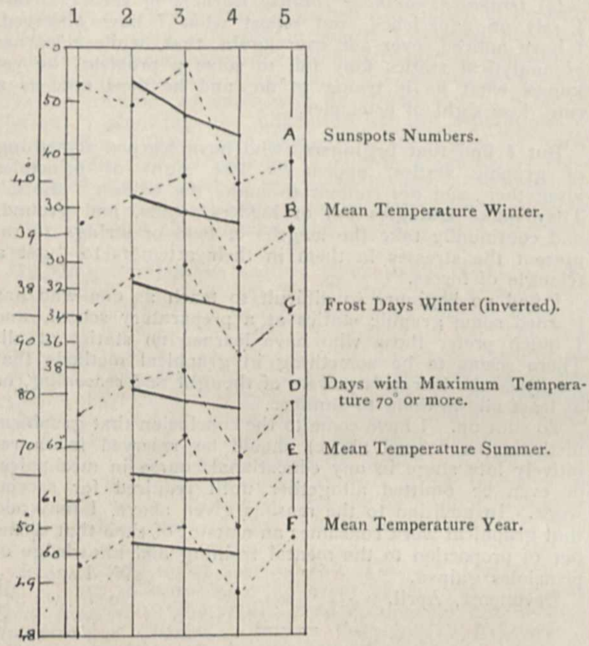
(E) Mean temperature of summer (June–August).

(F) Mean temperature of year.

The amount of agreement between these weather curves and the sun-spot curve seems remarkable. The sun-spot wave with *highest* average number (that for 1868–78) corresponds with the time of *greatest* warmth in each case, and the sun-spot wave with *lowest* number (1879–89) with the time of *least* warmth. If the relative position of all five points does not exactly correspond in the solar and terrestrial curves, we should remember the large uncertainty necessarily attaching to sun-spot measurements.

We might smooth these curves with averages of three, getting the thick line curves, which indicate general decline (in a wide sense). Thus in the case of temperature, we find the grouped sun-spot waves 1, 2, 3, associated with more warmth than 2, 3, 4, and the latter with more than 3, 4, 5.

It is known that the recent researches of Nordmann, extending and confirming the work of Köppen thirty years ago, indicate a state of things in the tropics which is



essentially opposite to that in our region, that is, minimum of sun-spots is associated with *much* heat (relatively) and maximum with *little* heat.

I may here be allowed to submit for criticism a speculation regarding northern regions. I know little of temperature conditions in the Arctic regions and of ice in the Atlantic, and I suppose very little is known of these in their relation to the sun-spot cycle. Let us suppose, however (and the supposition does not seem a wild one), that it is in the Arctic regions as in the tropics, that is, more heat about sun-spot *minima* than about *maxima*, and that the Arctic *régime* is further opposite to ours in showing a general *rise* of temperature (in a wide sense) since the 'forties. (I may remark that Nordmann's data for the tropics seem to point to a gradual rise in the last thirty years.) What should we expect from this state of things? Would not the greater heat with minima cause more melting and loosening of ice, a more open season, and more ice to be carried down into the Atlantic? This would have a cooling effect on the Gulf Stream, and our temperatures would correspondingly decline. Thus heat in the Arctic would mean cold to us, and a gradual rise of temperature in the far north would mean a gradual fall in western Europe.

I have been told that a certain shrinking of the northern ice covering has been noticed in places in recent times, and I read lately, in connection with the voyage of the *Discovery*, that since Ross's time the Antarctic ice pack has broken back some thirty miles.

There may, however, be facts adverse to the above theory. Perhaps some of your readers may be able to throw light on the subject. Alex. B. MacDowall.

A NEW EPOCH IN SOLAR PHYSICS.

Up to the year 1868 those rose coloured appendages round the solar limb, the prominences, could only be observed at the times of total eclipses of the sun. The ingenious method for watching these phenomena *any time* when the sun shines we owe to the labours of Lockyer and Janssen, and the striking of a medal by the French Government in honour of this important solar physical advance properly noted an epoch in this branch of astronomy.

By this new device, which was spectroscopic, the positions, forms, structure and movements of the prominences that encircle the solar disc could be accurately watched and determined, and we owe a debt of gratitude to such men as Respighi, Tacchini, Ricco, Mascari and others for the great work they have accomplished in taking advantage of this new line of research by recording daily the state of the solar limb in respect to these appendages. It must not be forgotten that all this work has been accomplished by *eye* observations alone. Sweeping round the solar limb and noting accurately the position, form, &c., of each prominence is not the work of a moment, even if the sky is clear, and it is astonishing what a great amount of valuable information has been gathered by this apparently sluggish method. When it is considered that one sweep of the spectroscopic slit round the solar limb only makes us acquainted with the prominences that exist in a very small section of the solar atmosphere and at only one particular moment of time, it was natural that early attempts were made not only to employ photography as a means of quickly recording these, but of devising, if possible, some method by which prominences *on* the solar disc itself could be also photographed.

It is not the object of the present article to trace the history of the development of the instrument, the photospectroheliograph, which now affords a means of satisfying these and other unlooked for requirements, but to give an account of the latest form adopted and results obtained by Prof. George E. Hale, of the Yerkes Observatory, to whom belongs a large part of the credit of designing and constructing an instrument capable of giving most successful results.

It may nevertheless be mentioned that Janssen in 1869 conceived the first idea of the method; he was followed by Braun, of Kalocsa, in 1872, and by Lohse, of Potsdam, in 1880. In 1889 Hale commenced work in this direction, and after him came Evershed in England and Deslandres in Paris, who both designed and used instruments which gave excellent results.

From time to time Prof. Hale has published accounts of the design of, and work accomplished by, his former instruments, but in a recent publication[1] he gives us a very full and detailed description not only of the latest form he has adopted, but of the magnificent photographs which he has secured with it.

To pass then at once to the modern photospectroheliograph, reference may first be made to the principle involved. The feature of the instrument is that it is capable of giving us pictures of the sun in light of one wave-length, or in monochromatic light. The instrument itself differs little in principle from an ordinary spectroscope if the eye-piece be replaced by a (second) slit. If the solar image be thrown by means of a lens on the first slit, then after the solar light has passed through the lenses and prisms of the spectroscope it will fall on the second slit, which will only allow a narrow portion of the spectrum to pass through it

1 *Publications* of the Yerkes Observatory, vol. iii. part i.; also the *Astrophysical Journal*, vol. xix., No. 1, p. 41.

corresponding in width to this slit. The position of this second slit is, however, adjustable, and it can be made to coincide with any line in the solar spectrum. Thus any particular line can be completely isolated by this device. If now the solar image falling on the first slit be kept stationary, and the whole spectroscope be moved in a plane at right angles to the axis of the incident solar beam and in a direction at right angles to the length of the first slit, then the light that will pass through the second slit will be a succession of images in monochromatic light corresponding to the strips of the solar image which entered the first slit.

By adjusting the second slit on, say, the K line of calcium, and placing a photographic sensitive plate fixed independently of but nearly in contact with the surface of the second slit, then while the first slit is passing over the solar image, the second is moving over the film of the photographic plate at rest and allowing the monochromatic calcium K light to impress its successive images on the plate. The result is a picture of the sun in "K" light. Isolating different lines by means of the second slit, various monochromatic images of the sun in different "lights" can be secured.

An instrument made on the above principle is the ideal form to be used, but it can only be adopted when sunlight is thrown by means of a heliostat on to the lens which forms the image. It may be mentioned, by the way, that an instrument on this principle has recently been erected at the Solar Physics Observatory, South Kensington.

Prof. Hale wished, however, to employ his spectroheliograph in connection with the great Yerkes refractor of 40 inches aperture, so that he was obliged to adopt another method, because the movement of the spectroheliograph, which is of considerable weight, across the solar image formed at the focus of this large lens would have made the telescope vibrate, and produced in consequence bad solar images.

The method which he eventually adopted was to keep the whole spectroheliograph still in relation to the telescope itself, and to move the solar image uniformly across the first slit by means of a motor which actuated the declination slow motion of the telescope. Another difficulty then arose as regards the movement of the photographic holder, for this had to be made to travel across the second slit at the same uniform speed as the image over the first slit; this was finally overcome by connecting the plate holder directly with the declination motor, thus moving them simultaneously.

Although very similar in principle to the ordinary spectroscope, the spectroheliograph is different from it in many important details. In the first place both slits, instead of being straight as is usually the case in spectroscopes, are curved, and curved to a radius which is determined by the material of the prisms employed. Again, it is most convenient if the two tubes, carrying each a slit with its respective objective, and corresponding to the collimator and telescope tubes of the ordinary spectroscope, are arranged parallel to each other. This is accomplished by inserting between the collimator lens and the prisms (two in this case) a plane reflector which can be so adjusted that the light, after being reflected and passing through the prisms, emerges parallel to the beam falling on the reflector or to the collimator's axis.

By the use of the reflector in this position, thus rendering the prisms clear of the optical axis of the collimator, the instrument may be employed for another line of solar research, because when greater dispersion is required, as will be described further on, a grating may be inserted in its place. The optical arrangement, as briefly described above, can be seen from the accompanying illustration (Fig 1), which shows this portion of the instrument alone. To indicate the path of the beam of light from the collimator objective to the second slit objective a white line has been drawn, the direction being indicated by the arrow head.

For further information regarding the details of the construction of the instrument the reader may be referred to Prof. Hale's account, but a few dimensions may be given here. Since the solar image formed by the forty-inch telescope measures seven inches in diameter, the two slits, both being supplied with the necessary means of adjustment, are eight inches long. The collimator and camera lenses are of the portrait type by Voigtländer, and are of equal aperture ($6\frac{1}{4}$ inches) and focal length. These lenses are really too small for the large solar image dealt with, but Prof. Hale's statement that the considerable cost of lenses of about ten inches, the required size, rendered their purchase difficult explains this defect.

Passing over several important points that are vital to the efficient working of this instrument, which would

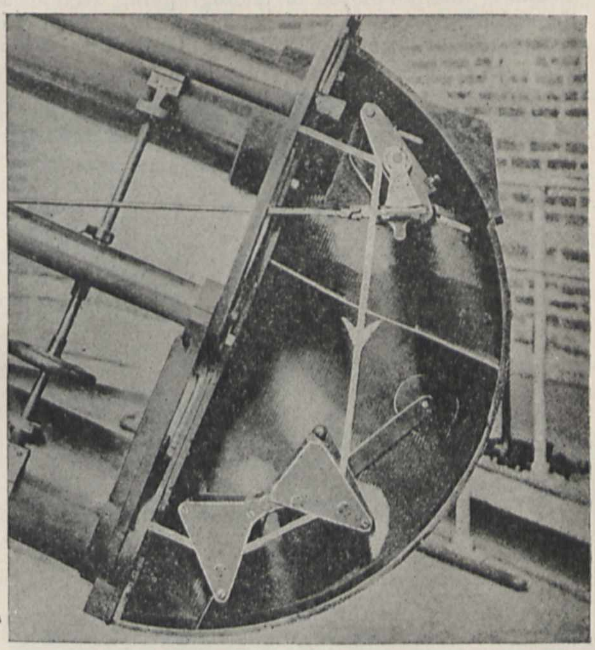


FIG. 1.—Showing the optical arrangement of the Spectroheliograph.

here take up too much space even to refer to at short length, such as a description of the movable plateholder, the adjustment of the several parts of the spectroheliograph, the value of diaphragms to reduce diffuse and reflected light, the method of setting the second slit on any particular line in the spectrum, &c., we now come to describe some of the results which are the first fruits of this research.

It has been stated above that if a line due to calcium be isolated by the second slit then we shall obtain a picture of the sun in calcium light; if a hydrogen or iron line be used, then a hydrogen or iron solar picture will be obtained. The lines which are the most easy to employ, and which give the best results, are those of H and K due to calcium. These lines in the solar spectrum (Fig. 2) are broad, of a composite structure, and are composed of three main parts, (1) a broad, dark band, designated by Prof. Hale as H_1 or K_1, (2) a comparatively narrow, bright line, lying at the centre of this band at points on the sun's disc where the slit crosses hot masses of calcium vapour (H_2, K_2), and (3) a very narrow, dark line running through the centre of H_2 and K_2 designated H_3 and K_3.

Now according as the second slit is made to isolate any part of either of these lines, so a calcium picture of the sun corresponding to this particular part of the line is obtained.

It may perhaps be mentioned that the name "flocculi" is here employed to designate the clouds of vapour which are photographed with the spectroheliograph. When the calcium line is employed "calcium flocculi" are photographed, or if the hydrogen line be used we obtain "hydrogen flocculi." These flocculi are, according to Prof. Hale, situated at a greater level above the photosphere than the "faculæ," the latter being elevated regions of the photosphere.

As the width of the H and K bands depends on the density of the calcium vapour, and the denser calcium in the sun is below that of less density, the pictures of the sun secured by using different parts of these lines will correspond to different levels. In fact, a means is thus employed of photographing sections of the calcium vapour, or of sounding the solar atmosphere with respect to this element. Thus, if the second

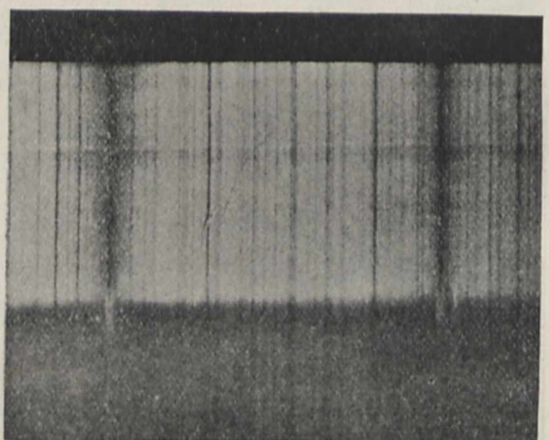


Fig. 2.—Reproduction of a photograph showing the H and K lines of calcium in the solar spectrum when large dispersion is employed.

slit be set at the extreme edge of H_1 or K_1, the resulting photograph will only show that calcium vapour which is dense enough to produce a line of this breadth, in fact, a section across the base of the calcium flocculus will be obtained. If set nearer the centre of the line a section of the flocculus corresponding to a higher level will be produced.

Further, this calcium picture in the final positive is always bright on a dark background no matter which parts of the H or K lines are employed. That this is so can be seen from Prof. Hale's pictures taken in the H_1 or H_2, or K_1 or K_2 light; this is an important point to which reference will be made later.

An examination of several photographs has led Hale to deduce that the calcium flocculi when secured with the slit nearer H_3 or H_2, or K_3 or K_2 are more extensive than those taken near the outer edge of H_1 or K_1. It is argued from this that the calcium flocculi are most probably in general composed of a series of columns of vapour expanding as higher levels are reached, and possibly overhanging laterally (Fig. 3).

To explain this point a little more fully perhaps the accompanying diagram (Fig. 4) may prove of service. In the centre of the diagram is drawn (on rather an exaggerated scale) the H line of calcium, and below this are lettered the detailed portions of it according to Hale's nomenclature. Above this are drawn three layers to represent three strata of calcium vapour corresponding to the width of the H line, which varies according to the density of the vapour. To investigate the distribution of the densest layer the portion H_1 of the H line is used, H_2 is employed for the less dense layer, and H_3 for the least dense.

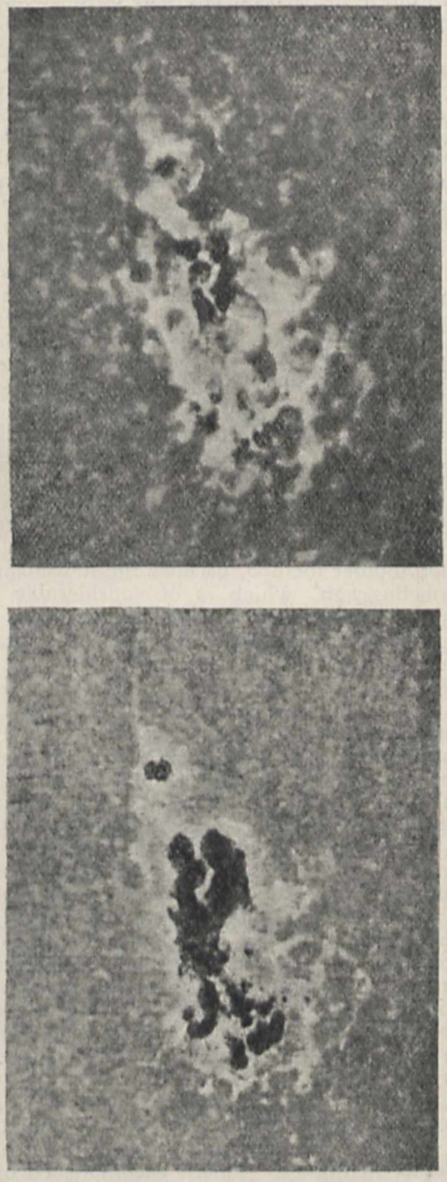


Fig. 3.—Showing that the bright calcium flocculi are more extensive at the H_2 level (upper photograph) than at the H_1 level (lower photograph). Notice that the spot is nearly obliterated at the H_2 level.

At the right-hand side of Fig. 4 is a sketch of a portion of the solar surface taken separately with H_1, H_2, and H_3 lines, and we have therefore the H_1, H_2, and H_3 flocculi. As, according to Hale, the area of the H_3 flocculus is more extensive than that of H_2, and H_2 more extensive than that of H_1, if we project this to gain a mental image of the vertical distribution of this calcium vapour we obtain an object somewhat after that drawn above the three calcium flocculi.

In fact, the object will take a form which is very like a tree-like prominence.

It is therefore of great interest to examine the same region of a large spot as photographed at two different levels, as in Fig. 3.

This illustration shows the region of the large spot of October 9 of last year, and the secondary slit was

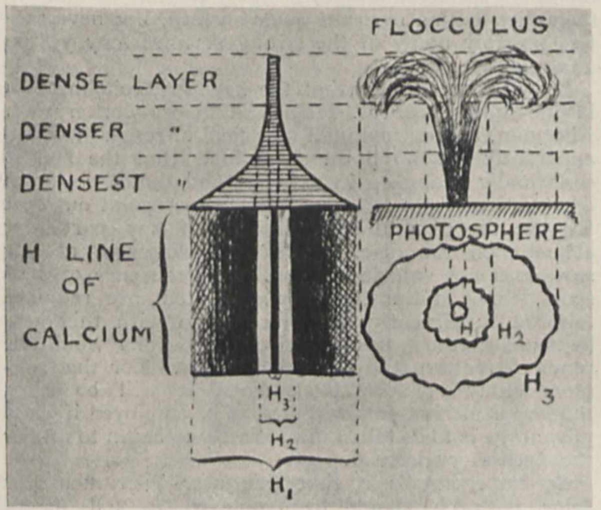


FIG. 4.—Diagram to illustrate the relation between the various portions of the H calcium line, the layers of different density, the resulting extent of the calcium flocculi and the probable appearance of their vertical sections.

placed at the middle of the calcium H_1 level (lower picture), and at the calcium H_2 level (upper picture); the plates were exposed at 3h. 43m. and 3h. 30m. p.m., so that they may be taken to represent approximately the solar conditions at these two different levels for the same moment of time. The actual spot itself is best seen at the H_1 level, where the flocculi are not so extensive. At the H_2 level the spot is nearly completely covered up by the flocculi, which are here far more pronounced and extensive. At this level the calcium vapour overhangs parts of both the umbra and penumbra of the spot.

The general appearance of the disc of the sun taken in calcium light is shown in the accompanying figure (Fig. 5). Under good atmospheric conditions the whole disc is covered with minute structure resembling somewhat the granulation of the photosphere. Scattered along distinct zones in both hemispheres are large bunches here and there of flocculi.

These masses of flocculi partake of the general movement of rotation of the disc like the spots. Not only do their areas vary very considerably from time to time, but the positions at which they make their first appearance change both as regards latitude and longitude. The enormous extent of these calcium flocculi in relation to the solar disc, and their variation in amount from time to time, a fact also known, suggest that here we have an indication of solar action that has only up to the present time been feebly shown by spots.

It is the investigation of the amount and distribution of these flocculi from day to day and from year to year that makes the spectroheliograph such an important instrument at the present moment, for it is the only means existing of recording these important phenomena.

Not only has Prof. Hale employed the calcium lines in this work, but he has used other lines, notably those of hydrogen. For this investigation the plane reflector used in the optical train of the instrument is replaced by a grating, as larger dispersion of the spectrum has to be obtained. By this means the hydrogen or other lines are rendered somewhat broader, and it then becomes possible to isolate them completely by the second slit, the width of which is adjusted to be less than that of the lines employed, in order to cut out the continuous spectrum on both sides. Numerous photographs were secured with each of the Hβ, Hγ, and Hδ lines, and comparisons were made with the calcium photographs.

The striking point which this comparison at once showed was that where on the solar disc the calcium flocculi did not exist the hydrogen flocculi were most apparent (Fig. 6), or, as Prof. Hale says, "the hydrogen flocculi are, in general, dark, and that while they have a general resemblance in form to the bright calcium flocculi, the differences are in many cases very striking."

Perhaps a short digression may here be made, as it does not seem quite clear, at any rate to the writer of this article, what Prof. Hale really means by the terms "dark" hydrogen or "dark" calcium flocculi.

The principle of the spectroheliograph is that if a calcium line be chosen to work with, then the resulting solar disc is built up of two kinds of markings, namely, (*a*) where the calcium exists (bright), and (*b*) regions where it does not exist (dark). Further, as has already been pointed out, it does not matter which part of the calcium lines is used, as both the dark and bright parts produce bright calcium flocculi on the completed positive. Again, if a hydrogen line be used we have a disc built up of two kinds of markings, (*c*) where the hydrogen exists (bright), and (*d*) where no hydrogen exists (dark).

Since the *existence* of each of these substances on the sun's disc is indicated by *bright* markings, it is not quite clear why Prof. Hale calls the dark patches

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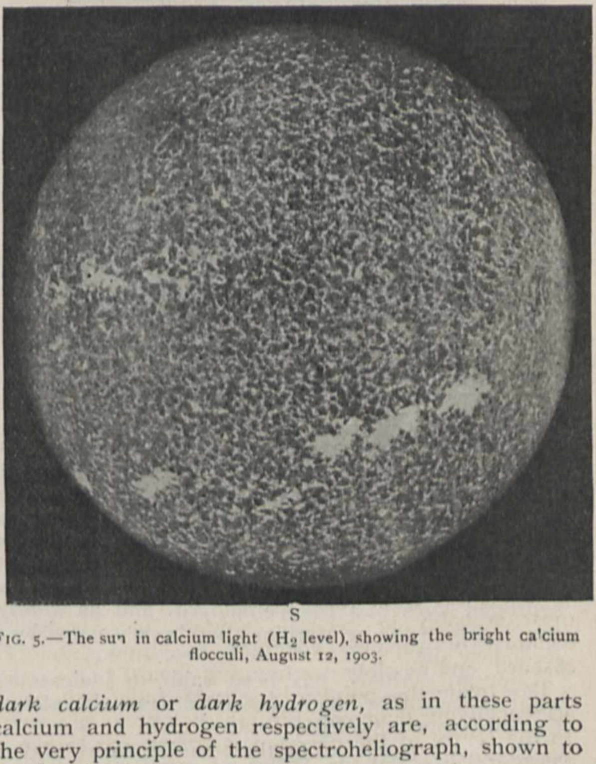
E  W

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FIG. 5.—The sun in calcium light (H_2 level), showing the bright calcium flocculi, August 12, 1903.

dark calcium or *dark hydrogen*, as in these parts calcium and hydrogen respectively are, according to the very principle of the spectroheliograph, shown to be *absent*.

It seems preferable to say that the regions where calcium exists correspond to those regions where hydrogen is absent than to say that the bright calcium flocculi resemble in form the dark hydrogen flocculi.

To show the confusion to which such a form of description as the last mentioned can lead one, a good instance is given on Plate viii., Figs. 3 and 4, of Prof. Hale's publication. There are shown two illustrations of the same region of the sun, one taken with the calcium line (K_2), and the other with the hydrogen line ($H\beta$). On each of these there is a peculiarly shaped *dark* patch, evidently the same region on the solar disc, and the photographs show that in this region neither calcium nor hydrogen is present. According to Prof. Hale's notation, this patch should be called both a "dark calcium" *and* "dark hydrogen flocculus"! As a matter of fact, the marking might be due to quite another substance altogether, and although it appears dark when analysed with either

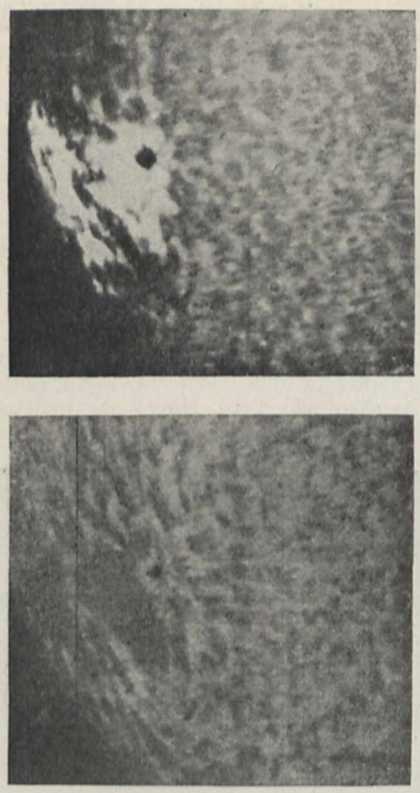


FIG. 6.—Two photographs of the same region of the solar disc taken on the same day, showing that where the bright calcium flocculi are present (upper photograph), the bright hydrogen flocculi (lower photograph) are absent.

the calcium or hydrogen lines, it might appear as a "bright flocculus" if a line in the spectrum of the substance of which it is composed were used. Thus if at the particular levels at which the photographs were secured we knew that helium had been present in this region, then it would have been shown on the photograph as a dark patch if the calcium and hydrogen lines had been employed, and as a *bright* one if any of the helium lines had been isolated by the secondary slit.

Enough, perhaps, has been said to indicate that what is meant by the "dark hydrogen or calcium" flocculi is not quite clear.

The fact brought out by the beautiful series of photographs of Prof. Hale, that when the bright calcium flocculi are absent the bright hydrogen flocculi are present, raises a number of important points in solar physics which the spectroheliograph alone at the present time can attempt to solve.

Calcium and hydrogen are not, however, the only substances which exist in the solar atmosphere. How are the other materials distributed? The comparative thinness of the lines of these other substances in the solar spectrum makes it more difficult to analyse their distribution over the solar surface, but nevertheless possibly many of the strongest lines may yet be analysed.

It will thus be seen that the new spectroheliograph in the hands of Prof. Hale and his co-worker, Mr. Ellerman, has opened up a new field of research which apparently has no limit. The facts that the sun is continually changing in activity and that the sky in any particular place is not always clear point out that for the study of the distribution of any particular element on the disc, *one* spectroheliograph at *one* station is not sufficient. Just as in the case of sunspots, three stations, widely separated, are required to produce a nearly daily record, so with this new instrument the same number of stations would be required for the study of one element. For the complete study of several elements, it will be seen, numerous instruments will have to be employed if every advantage is to be taken immediately to begin to gather the necessary material.

So important is it that this new instrument for solar research should be employed to tell us of the changes that are taking place in the sun from day to day and from year to year, that no time should be lost in constructing a sufficient number of them, in distributing them where the raw material, sunlight, can be most often procured, and in organising a homogeneous plan of campaign.

When it is considered that a study of the solar changes is vital for the clear understanding of the numerous terrestrial variations which are so closely associated with our everyday life, the necessity of such a programme is obvious.

Just as in the case of the charting of the heavens, so this work should be of an international character, for every country would be able to reap equally the benefits which such an organisation would bring.

The Rumford spectroheliograph of the Yerkes Observatory having thus shown the exceptional value of this new method of solar research in the hands of Prof. Hale and Mr. Ellerman, future workers will find their task very much lightened by a study of this magnificent and epoch-making contribution to solar physics. It is satisfactory to note that for this work in particular among other valuable contributions to astronomy by the same author, the Royal Astronomical Society has this year awarded Prof. Hale its gold medal.

WILLIAM J. S. LOCKYER.

COMMEMORATION DAY AT THE UNIVERSITY OF GLASGOW.

ON Tuesday, April 19, many of us were thinking of the Kelvin jubilee, which attracted the foremost scientific men of Europe here in 1896. It is only a fortnight since the body of graduates unanimously elected Lord Kelvin to be our academic chief. In 1901 the university celebrated the ninth jubilee of her own foundation. On April 19 she inaugurated an annual commemoration day.

The ceremony opened with a short religious service. After it Sir William Ramsay, who began his great career as a chemist here, discoursed on Joseph Black—the most famous chemist who has been connected with

Glasgow. Black was made professor in 1756, when he was twenty-eight, and remained here until he was translated to Edinburgh ten years later. Prof. R. Dundas Thomson wrote fiftv years ago of Black, "These two capital discoveries"—of the loss of weight when limestone is converted into quicklime, and of the disappearance of an amount of heat which does not affect the thermometer when water is converted into steam—"have been of greater service to science than perhaps any equal number of data ever pointed out by philosophers. Dr. Black was a man of elegance, modesty, and indolence. His active life in science terminated in his thirty-eighth year, for after his removal to Edinburgh, he engaged in no inquiries, and contented himself with teaching the science." Some scientific men may look back with regretful eyes to the far-off Arcadia of their great predecessor—who had two epoch-making discoveries to his credit before he was thirty-eight, and nothing but quiet though admirable teaching to do for the balance of his days. Mendeléeff at seventy, and Lord Kelvin at eighty, are still incessantly at work on the most abstruse and far-reaching problems of the intimate constitution of the world. Dr. Black's incisive critic might have remembered that it has been given to very few men of science to take an unchallenged place both among the first investigators and the most accomplished and successful teachers of his time.

Wandering, after the lecture, about the university, which our predecessors in 1870 thought to have been housed so splendidly, one finds Sir Gilbert Scott's great central building surrounded by masses of modern additions. There is a huge engineering building which cost about 30,000*l*., a botany building costing about 18,000*l*., an additional anatomy building costing about 13,000*l*., an additional surgery building costing about 10,000*l*. All these were built within the last ten years, but before the days when Dr. Carnegie stepped in like a special providence to help the Scottish universities. His benefactions are of two kinds. The first provides 50,000*l*. a year towards the payment of the fees of all students in any of the universities who ask for it and who have shown themselves qualified to profit. It was no doubt hoped that this would largely increase the number of the students, and so greatly add to the resources of the universities. The hope has hardly been realised. The number of students has not materially increased, and the universities merely receive the fees of a very large number of their students through Mr. Carnegie's trustees instead of from the parents. Many students, of course, do not ask for this benefit, but, as a very great number do, the fee money which Mr. Carnegie has provided goes, and no doubt it was to a great extent meant to go, to the relief of parents who used to pay, often, certainly, with difficulty, and it has made very little addition to the resources of the universities. It is by the second 50,000*l*. a year, destined for equipments and extensions, including buildings, that the universities have chiefly benefited. The trustees require that the university wanting new buildings for scientific teaching shall raise half the requisite money, in which case they will supply the other half. For some reason or other they have not so far helped the extensive addition—costing probably 12,000*l*.—which has just been made to the chemical department. But they are defraying half the cost of the new buildings for natural philosophy, for physiology, for medical jurisprudence and public health, and for materia medica, which are all in a state of considerable forwardness, and which will cost some 80,000*l*. The scientific world must have laboratories for practical teaching, and modern laboratories are expensive to build, and very expensive to maintain and to keep up to date. There is no more finality in scientific equipment and apparatus than in ironclads, and many things which are imperious necessities of to-day will be historic scrap iron after a dozen years. These vast laboratory extensions will be useless without great additions to the staff, and the universities will have to look not merely to the Carnegie trustees, but to the general public for further advances towards maintenance and renewal of equipment. Scientific students in Glasgow and elsewhere ought in the future to be taught more practically, but it is by no means certain that their numbers will be greatly increased. It is certain that there are many non-scientific departments which will need extensions, and cannot look to the Carnegie trustees.

I have perhaps wandered a little from the commemoration, but it is in these visible extensions actually or prospectively completed within ten years through the benevolence of Glasgow donors and the generous help of the Carnegie trustees that scientific graduates and visitors have taken the greatest interest. After their look round, they betook themselves to the Hunterian Museum, where a medallion bust of the late Prof. John Young, who was its *genius loci* for thirty-six years, was unveiled. No archæologist, numismatist, zoologist or geologist can be ignorant of his name and work. "Those who knew him best," says his life-long friend and comrade, Dr. Yellowlees, "know that they will never see another John Young."

The commemoration day is now over. It included the ceremony of conferring honorary degrees, six D.D.'s and eight LL.D.'s, including Mr. Choate, the American Ambassador, and—*in absentia*—Prof. Mendeléeff, the great Russian chemist, perhaps the foremost man in modern chemistry, and the fittest to connect the chemists of this generation with the brilliant young Glasgow professor of a century and a half ago whom the great Lavoisier was proud to acknowledge as his teacher. Mention must, however, be made of the banquet in honour of Sir William Ramsay, whose Glasgow degree is not of yesterday, and of the honorary graduates of to-day. But banquets are, after all, very much alike. W. J.

THE CELEBRATION OF SIR HENRY ROSCOE'S GRADUATION JUBILEE.

THE half-century which has elapsed since Sir Henry Roscoe graduated as doctor of philosophy at Heidelberg has been devoted by him uninterruptedly to the furtherance of science and education.

As professor of chemistry for thirty years at Owens College, he succeeded by his teaching, writings and researches in establishing a great school of chemistry, besides earning a world-wide reputation as a scientific man; as member of Parliament he assisted to lay the foundations of a scientific system of technical education; and as Vice-Chancellor of the University of London and a member of the Carnegie trust and other bodies, he has spent his later years in the organisation of scientific teaching. It was therefore fitting that at the celebration of his graduation jubilee he should be greeted by addresses from his old students and from universities, colleges, and learned societies, both at home and abroad, which bore eloquent testimony to the intense appreciation which is felt for his services to the cause of scientific and educational progress.

The ceremony took place on Friday last, April 22, at Manchester, in the Whitworth Hall of the Owens College, which, by its great architectural beauty, sets a fitting seal on the splendid group of buildings which Sir Henry Roscoe has seen grow up to replace the old house in Quay Street in which his first classes were held.

The philosophical faculty of the University of Heidelberg marked its sense of the importance of the occasion by renewing the diploma of doctor of philosophy granted half a century ago, and addresses were also presented from the Victoria University of Manchester, the old students, the universities of London, Cambridge, Liverpool, Birmingham, Edinburgh, Glasgow, Aberdeen, St. Andrews, and Montreal, University College, London, Yorkshire College, King's College, London, University College, Sheffield, Durham College of Science, University College, Dundee, Royal Society, British Association, Literary and Philosophical Society of Manchester, Chemical Society, Society of Chemical Industry, German Chemical Society, Bunsen Gesellschaft, Physikal. Verein, Frankfort, Kön. Gesellschaft, Göttingen, Pasteur Institute, Lister Institute, Owens College Chemical Society, Chemical Society of Rome, the Dutch Chemists, American Academy, American Philosophical Society, and American Chemical Society.

A large number of personal congratulations were also received from scientific men all over the world. To each of the addresses a separate reply was made, and in these concise and pointed speeches, each embodying some fresh line of thought, the audience was delighted to recognise the best possible proof of the continued mental and physical vigour of the speaker.

SIR CLEMENT LE NEVE FOSTER, F.R.S.

THE tidings of the death of Sir Clement Le Neve Foster on April 19 brought to a wide circle of friends a great shock as well as sincere sorrow, for all hoped that he might enjoy for many years the final stage of an active and honoured career. His death is a serious blow to the public service to which his life was devoted.

Born at Camberwell on March 23, 1841, he was the second son of the late Peter Le Neve Foster, who for a quarter of a century was secretary of the Society of Arts. He received his preliminary education at Boulogne-sur-Mer, and obtained his degree of Bachelor of Science of the University of France at the age of sixteen. In 1857 he entered the Royal School of Mines, and in two years achieved the remarkable distinction of securing the associateship in the mining, metallurgical and geological divisions, as well as the Duke of Cornwall's scholarship and the Edward Forbes medal. He then proceeded to the mining college of Freiberg, in Saxony, which at that time was supreme in its special field. In 1860 he received from Sir Roderick Murchison an appointment on the Geological Survey, and for five years was engaged in mapping the Wealden beds of Kent and Sussex, and the Carboniferous rocks of Derbyshire and Yorkshire.

In 1872 Le Neve Foster was appointed H.M. Inspector of Mines. The new Metalliferous Mines Regulation Act, which had just been passed, was received with a certain amount of disfavour by the Cornish miners, and the work of the first inspector was particularly difficult. The severity of which Le Neve Foster was sometimes accused bore, however, remarkable fruit. The average death rate from mine accidents in his district was reduced from 2 per 1000 during the first three years of his inspectorship to 1·3 per 1000 during the last five. In 1880 he was transferred at his own request to the North Wales district, where he remained until his retirement in 1901. His twenty-nine annual official reports afford clear evidence of the mass of work that he got through, and indicate the many ways in which the laws for the regulation of mines have been improved in consequence of his efforts. In 1890 he was, on the death of Sir Warington Smyth, appointed professor of mining at the Royal College of Science and Royal School of Mines, and continued to hold that appointment until his death. He largely improved the system of instruction, and insisted upon adequate attention being given to practical training.

He was a frequent contributor to the *Proceedings* of the many scientific societies of which he was a member, and in spite of the exigencies of his official appointments he found time for literary work. He published in 1867 a translation from the Dutch of P. van Diest's book on the tin deposits of Banca, and in 1876, with Mr. W. Galloway, he translated from the French Callon's "Lectures on Mining." He also wrote the article on mining in the "Encyclopædia Britannica." In 1894 he published his great work on "Ore and Stone Mining," the first systematic English treatise on the subject, of which the fifth edition has just been issued; and at the beginning of this year he published a smaller volume on "Mining and Quarrying," noticed in this issue of Nature (p. 603).

In 1895 Le Neve Foster issued his first annual report upon the mineral industry. This formed an entirely new departure in official literature, and embodied the results of a vast amount of labour and technical skill in comparing the mineral industries of the United Kingdom with those of other countries. Its value was so much appreciated that his services as editor were retained by the Home Office after his retirement from the post of inspector.

Sir Clement was elected a fellow of the Royal Society in 1893. He was a juror at the Paris Exhibitions of 1867, 1878, 1889 and 1900, and was created a Knight of the Legion of Honour in 1889. He also acted as juror at the Inventions Exhibition in 1885, and at various other less important exhibitions. He served upon various departmental committees on mineral statistics, open quarries, slate mines, and explosives in mines, as well as upon the Royal Commissions for the Chicago Exhibition and for the St. Louis Exhibition. His faithful and long continued services to the public weal were officially recognised by the knighthood conferred upon him on the King's birthday last year.

No man in this, or perhaps in any other, country has rendered more conspicuous services to metalliferous mining than Le Neve Foster did. In his twenty-nine years of Government mine inspection he did much to ameliorate the lot of the miner, and by his teaching and writings he secured for metal mining, that had previously been practised mostly as an empirical art, a scientific basis. B. H. B.

A large number of men of science attended the funeral of Sir Clement Le Neve Foster on Friday last, among them being the following representatives of scientific societies and other bodies:—Sir Norman Lockyer, president of the British Association; Sir George Armytage, Sir W. T. Lewis, and Prof. Hull, representing the Royal Commission on Coal Supplies; Prof. J. W. Judd, F.R.S., Dean of the Royal College of Science, and Mr. J. J. H. Teall, F.R.S., Director-General of the Geological Survey of the United Kingdom, representing the Royal Society; Mr. H. B. Woodward, representing the Geological Society; Mr. H. Jennings and Mr. Charles McDermid, representing the Institution of Mining and Metallurgy; Mr. Aubrey Strahan, representing His Majesty's Geological Survey, and Mr. Morant's private secretary, representing the permanent secretary of the Board of Education. The Royal College of Science and the Royal School of Mines were represented by the council and some of the students.

LORD MILNER ON SCIENCE AND INDUSTRY.

WE notice with much satisfaction that Lord Milner is a statesman who recognises that scientific knowledge is essential to national progress. In a speech as honorary president of the Chemical, Metallurgical, and Mining Society of South Africa, reported in the *Rand Daily Mail*, Johannesburg, of March 28, he declared himself strongly in favour of generous expenditure upon science, and the utilisation of the services of scientific men for the development of industries. The following extracts from his address will be read with interest by all men of science:—

There is one form of expenditure which is sometimes called extravagance which is not extravagance, and that is expenditure in getting the very best scientific advice. Whatever expenditure we may curtail in the future, there is one form of expenditure which I hope we shall never curtail, and that is the expenditure upon science. And if, as I believe, in the course of a few years you find a great improvement in the agricultural conditions of this country, which means an enormous change in the economic position, greatly benefiting, among others, the mining industry, that change will have been due to the fact that from the first moment almost of ordered administration in this country after the war we sought to get the best scientific advice in all branches of agriculture in different parts of the world, a matter which does not lead to any immediate change, or to any sudden or astonishing results, but which, I believe, in course of time will be found to have been the most profitable investment possible.

The same principle applies to industry as it does to agriculture—perhaps in a higher degree you may say to industry; but then industry here always has had it from its beginning—the benefit of first-rate scientific assistance. I mean that the immediate advantages resulting from the scientific treatment of the great industry of this country have been so enormous, so obvious, that from the first moment that capital flowed into the country to develop its buried resources, the aid of science has been called in. Science in the industry has not required that Governmental support and impetus which it does require in the more neglected branches of our public economy, such as agriculture. Science has always been present in the development of the great industry of this country through the fact that the capitalists who have put their money into it have recognised from the first its supreme importance. But although private enterprise has done with relation to mining a great deal which, with regard to agriculture, for instance, only the State could do, there still remains something which the State can do even for the highly developed and highly scientific industries of this country. It can do something, and I hope it has already begun to do something.

I believe we should all agree that it is not enough that this great centre of mining industry should be able to attract, as it does, the highest ability, the highest scientific ability, from different parts of the world. We want to do something more than this; we want to grow it for ourselves. And we look forward to the time when Johannesburg will have, among other things, a mining school which shall be the first in the world, and it shall have, I hope, after that, in time, a university and a teaching university—not only confined to science—comprising science and the arts—but of which the scientific faculties will be the most eminent known to mankind. Now, you may say that is rather high-faluting and it is looking a long way ahead. It may be high-faluting, but it is my honest belief that this thing can be accomplished, and it is my intention—I am sure it is the intention of the Government, so far as our humble powers and abilities go—you know our resources at the present time are not the greatest—to do as much as we can to begin the foundations of those great institutions of the future.

This is a welcome expression of belief in the importance to the community of scientific study and organised knowledge. Only on these foundations can a country be raised from a raw state of nature to a highly-developed civilisation, or a great nation satisfy the demands of the present day.

NOTES.

A PROVISIONAL programme of the meeting of the International Association of Academies, to be held in London at Whitsuntide, has been sent to the delegates appointed to attend the assembly. The following are among the arrangements announced, but they are subject to modification in detail according to the circumstances which may arise between now and the date of the meeting. On Tuesday, May 24, the commission inquiring into the anatomy of the brain will probably meet at Burlington House in the morning. In the evening the delegates will be entertained by the Royal Society at a banquet at the Whitehall Rooms. Wednesday, May 25, and the morning of the following day will be devoted to the business of the assembly. His Majesty the King has expressed his wish, if his engagements will permit, to receive the delegates, and it is hoped that arrangements may be made for this event in the afternoon of May 26. On Friday evening, May 27, the delegates are invited to a reception by the University of London; and on the afternoon of May 28 it is proposed to pay visits to the Universities of Oxford and Cambridge. On Monday, May 30, the Lord Mayor of London will entertain the delegates at a banquet at the Mansion House.

LORD AVEBURY has been elected president of the Society of Antiquaries; and Sir Guilford L. Molesworth has been elected to succeed Sir William White as president of the Institution of Civil Engineers.

A SUBCOMMITTEE has been appointed by the council of the Library Association to consider the question of the "deterioration of modern binding leathers," and to suggest a remedy. A circular is being issued to the chief libraries in the United Kingdom with the view of ascertaining, among other matters, what effective support is likely to be forthcoming from librarians in favour of leathers of the standard specified by the Society of Arts' committee.

THE *Times* correspondent at Rome announces that an archæological undertaking of an important character is about to be set on foot, namely, the complete excavation of Herculaneum. It is proposed that this vast work should be carried out by the cooperation of Italy with all civilised countries, and that there should be a central managing committee in Rome with national committees elsewhere.

ON Tuesday next, May 3, Mr. L. Fletcher, F.R.S., will deliver the first of three lectures at the Royal Institution on meteorites. The Friday evening discourse on May 6 will be delivered by Dr. Chalmers Mitchell on anthropoid apes, and on May 20 by Prof. Rutherford on the radiation and emanation of radium.

AN International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the St. Louis Exposition during the week of October 3 to 8. The congress will be one of a series of international scientific congresses to be held at the exposition under the general authority and with the cooperation of the Director of Congresses.

ON April 23 and 24 the Society of German Ironmasters celebrated at Düsseldorf the completion of the twenty-fifth year of its existence, and also of the twenty-fifth year of the presidency of Mr. Carl Lueg. The society is in a very flourishing condition. It numbers 2957 members, and of its journal, *Stahl-und-Eisen*, every fortnight 4900 copies are published. The meeting was well attended on both days, about eight hundred members being present.

On April 23 papers were read by Mr. Boveri, on the steam turbine, and by Mr. R. M. Daelen, on the continuous open-hearth process. On April 24 Mr. E. Schrödter traced the progress of the German iron trade during the twenty-five years of the society's existence. The announcement was then made that a gold medal had been instituted, to be called the Carl Lueg medal, and to be awarded for conspicuous services to German metallurgy. The first award was made to Mr. Lueg. Congratulatory addresses were then delivered by representatives of the Government and of numerous kindred societies. The Iron and Steel Institute was represented by a deputation of the council consisting of Mr. A. Tannett-Walker, Mr. A. Greiner, and Mr. B. H. Brough. In presenting the illuminated address from the institute, Mr. Tannett-Walker made a graceful reference to the hospitality received from the German society in 1880 and in 1902, and read a characteristic letter of congratulation sent by Mr. Carnegie.

M. DE FONVIELLE writes:—The fourth congress held by the International Committee of Scientific Aërostatics will be held at St. Petersburg from Monday, August 29, to Saturday, September 3. Prof. Hergesell has sent an intimation of the congress to the various delegates of France, Italy, Austria, and England. The official invitations will be sent through the Russian Foreign Office, in the name of the Imperial Academy of Sciences, which is to make arrangements for the meetings. The object of the conference, as resolved at the Berlin session, is to establish a permanent office with a regular budget paid by the various Governments, similar to the Berne bureau for telegraphy and that at Paris for meteorology. The bureau of the commission is controlling the monthly ascents which are taking place at about fourteen different stations situated in France, Germany, Russia, Austria, Switzerland, Spain, and Italy. Kite ascents are taking place at Boston and in England. The results are discussed regularly in a special publication, frequently noticed in NATURE, printed at the expense of the German Government, which has spent for this purpose not less than 18,000 marks, and will continue its work up to the end of the forthcoming meeting.

THE first German congress for experimental psychology was held in Giessen on April 18–21. About 130 persons accepted the invitation to attend the congress, including most of the prominent psychologists of Germany, besides physiologists, philosophers, alienists and teachers attached to various institutions, and about one hundred attended the sittings. Nearly fifty papers were read and discussed, and in order to get through this large programme the sittings were continued far into the evenings. There was an excellent exhibition of apparatus arranged by Dr. Sommer, the distinguished professor of psychiatry, who has done so much to apply the methods of experimental psychology to the investigation of mental diseases. Prof. G. E. Müller, of Göttingen, so well known for his accurate investigations of the memory, presided over the sittings, and one of the most interesting features of the congress was his demonstration and exposition of a case of exceptionally good memory. The subject, who is an intelligent and well educated man, has, in addition to a remarkable memory, principally visual in type, a power of seizing very rapidly various arithmetical relations between groups of figures presented to him, and this combination of faculties enables him to excel all the achievements of Diamanti, Inaudi, and the other "arithmetical prodigies" that have been investigated from time to time. It is proposed to institute a German association for experimental psychology for the organisation of annual congresses and of cooperative research.

SIR WILLIAM WHITE, the president of the Institution of Civil Engineers, and a number of other engineers and persons interested in the manufacture and uses of steel, paid a visit on April 20 to Hadfield's Steel Foundry at Sheffield. The object of the visit was to inspect the processes adopted and to enable the visitors to acquaint themselves with the work carried on by the Hadfield Company. The *Times* of the following day published an appreciative description of the enterprise exhibited by the company in numerous directions. In this report great prominence is given to the value placed by the Hadfield Company upon scientific laboratory research and upon experimental tests, and this part of the article in particular deserves to be read widely. As the *Times* says, "Abroad manufacturers have been quick to recognise the need for a fully staffed and equipped research department, and the amounts expended annually for this purpose in some foreign works appear almost incredible. It is only by enterprise of this nature, however, that manufacturers can keep in the van of progress, and, properly directed, this so-called 'non-productive' expenditure brings a rich reward. In Great Britain we have been somewhat apt to relegate research work to the laboratories of professors, the manufacturers devoting themselves to what are styled 'practical results.' This divorce of practice and theory does not lead to industrial success." We hope with Sir William White soon "to see the time when the example of Mr. Hadfield will be more widely followed in this country, and when inquiries, both scientific and practical, will be carried out on a very large scale in the works of manufacturers all over the country."

THE Weights and Measures Committee of the Herefordshire County Council has had under consideration the Bill introduced in the House of Lords early this session to provide for the introduction of the metric system into this country. The committee does not recommend the County Council to support the Bill. The report states that the committee is of opinion that the subject is so difficult and important that it should be dealt with by the Government of the day and not by private legislation; that as it stands, the Bill does not attempt to meet the serious inconvenience and expense necessarily attendant upon the compulsory adoption throughout the country of metric weights and measures; that the decimalisation of our coinage is as important as that of our weights and measures, and that either without the other is robbed of more than half its value. At the same time the committee believes that well drawn up and well thought out measures dealing with the metric system and with the coinage, and brought in by the Government, would command the confidence of the country, go through Parliament by a large majority, and ultimately benefit both our home and foreign trade. "We lag far in the rear of all civilised nations on these questions," to quote the report, "and all that is wanted, to remove from us the stigma of marching a century behind the rest of the world, is skilful and thorough treatment of them by the Government of the day."

AN address delivered by Dr. R. T. Glazebrook on April 21 as president of the Optical Society is printed in the *Optician and Photographic Trades Review*. Dr. Glazebrook pointed out that the success of German manufacturers of optical and other scientific instruments is due to the fact that the value of science as a commercial factor is more fully realised there than with us. What the Optical Society has to do in order to advance the industry which it represents is to promote cooperation among manufacturers, technical education of opticians and standardisation, or the application of scientific methods and standards to organisation and the checking of optical work. In Germany a large proportion of recent progress is due to the stimulating and helpful influence of the Reichsanstalt. Dr. Glazebrook hoped that in a few years' time a future president of the Optical Society would be able to say, when reviewing the progress of the optical trade, that a large proportion of the advance was due to the work of the National Physical Laboratory.

The report of the Meteorological Council for the year 1902–3, recently presented to Parliament, has now been issued. The work of the Meteorological Office is briefly summarised under (1) ocean meteorology; collection and discussion of data from all parts of the ocean, and the loan of instruments to the Royal Navy and Mercantile Marine. The total number of instruments of all kinds issued during the year for the use of the Navy and Mercantile Marine was more than 1700. Barometers are also supplied to fishing stations; the total number of these instruments on loan was 229 at the end of the year in question. (2) Weather telegraphy; collection of telegraphic observations three times a day from selected stations in the British Isles and Europe, the issue of daily weather reports, weather forecasts, and storm warnings, also of special forecasts for agriculturists during hay and corn harvests (June to September). (3) Climatology; collection and publication of observations from observatories and land stations in the British Isles and British possessions. (4) Miscellaneous investigations; *e.g.* work in connection with an inquiry into London fog, and a statement of the conspicuous features of the weather during the year, including the readings of anemometers amounting to or exceeding a velocity of 44 miles per hour, corresponding to an estimated wind-force of 9 by Beaufort's scale. To this latter subject a special appendix is devoted. All the branches of the office are utilised for the preparation of replies to numerous inquiries by public bodies, newspaper reporters and private persons. The report shows greatly increased activity in all branches; special mention may be made of the supply of weekly and quarterly returns for the Registrar General's reports, and of the collection and publication of observations from foreign and colonial stations. Notwithstanding the increase of work, the funds at the disposal of the Meteorological Council remain stationary. The perusal of the report clearly shows that the useful operations of the office are to a considerable extent crippled by the want of sufficient means to carry on the work of a practically important public department on the lines followed by some of the foreign meteorological offices, and to enable it to fulfil the constantly increasing requirements of the service in this country.

In the *Bulletin de la Société d'Encouragement* M. J. Pillet presents a report on the "Little" universal drawing instrument submitted by Commander Mahon, of the U.S. Federal Army. The instrument consists essentially of two jointed parallelograms or frames, by means of which a piece called the turning plate can be shifted from one part of the diagram to another without rotation. Pivoted to this portion are two rulers at right angles, which by means of a scale of degrees can be rotated through any desired angle, and these rulers have scales by which any desired length can be measured off. The advantages of the apparatus for quickly drawing force-diagrams for engineering purposes are obvious from the illustration accompanying the paper.

Steps are being taken to promote public instruction in silk-culture on a modern scientific basis in America, and accordingly a special *Bulletin* (No. 39) has been issued by the Entomological Division on the culture and life-history of the silkworm and its moth.

A report, published at Birmingham, on injurious insects and other animals observed in the midland counties during last year has been drawn up by Mr. W. E. Collinge, of Birmingham University. It is well illustrated, and contains much valuable information for farmers and gardeners. Future annual reports are promised.

The Boston Natural History Society is preparing complete lists of the fauna of New England, of which the first part, containing the reptiles, has been issued in *Occasional Papers*. These lists are to prepare the way for a complete illustrated monograph of the fauna which the society proposes to publish.

A paper dealing with noxious insects is published in the *Boletim* of the Goeldi Museum under the title of "Os Mosquitos no Parã." The author, Prof. E. Goeldi, directs special attention to *Stegomyia fasciata* and *Culex fatigans*, and is desirous of obtaining information as to their range and habits from all parts of the country. The former species, at any rate, is believed to have been introduced from Africa. Many experiments are recorded as to the infections produced severally by these species, of which the first is diurnal and the second nocturnal.

The April number of *Bird Notes and News* contains a reference to various rare birds—including an avocet, bustards, and waxwings—which have lately visited our islands, and have mostly shared the usual fate of such wanderers. The need for effectual legal protection (if such could be devised) for rare birds of this type is emphasised, but it is pointed out that even were such birds made Crown property, as has been suggested, this would not help the case of locally rare species.

An important place was assigned at the fifteenth annual meeting of the Association of Economic Entomologists, held at Washington in December, 1902 (of which the report appears in No. 40 of the *Bulletins* of the Entomological Division of the U.S. Department of Agriculture), to a survey of the literature of the subject published in the States, and to a discussion of the best means of bringing the work of the division to the notice of those sections of the public more especially concerned. It was suggested that newspaper articles, leaflets, somewhat larger popular bulletins treating of particular species or groups of species, and larger popular monographs seemed the best means for attaining the end in view.

To the April number of the *Independent Review* Dr. A. R. Wallace contributes the first part of an article on "The Birds of Paradise in the Arabian Nights." In the introductory paragraphs the author states that he is generally disposed to believe in the truth of popular legends connected with natural history, the assertion that vipers swallow their young being a case in point. Accordingly he is predisposed to look with favour on the theory that the "Islands of Wak-Wak" mentioned in the "Arabian Nights" are really the Aru Islands, and that they take their name from "wawk-wawk," the cry of the great bird-of-paradise. The portion of the article contained in the issue before us deals only with the identification of the locality to which "the bride with the feather-dress" was brought with the south-eastern lower slopes of the Elburz Mountains. We shall await with interest Dr. Wallace's proofs that "Hasan" actually visited the home of the birds-of-paradise.

Two zoologists have apparently been working synchronously and independently of one another on the same subject—the anatomy and development of *Amphilina foliacea*, the tape-worm infesting the sterlet—and the results of their investigations appear in the current issue of the *Zeitschrift für wissenschaftliche Zoologie* (vol. lxxvi. part iii.). Both writers, Dr. L. Cohn and Dr. W. Hein, take up the subject as left by Salensky, and both are of opinion that his conclusions require emendation. Two papers on the histology and morphology of insects likewise appear in the same issue. In the one Mr. W. Plotnikow, of St. Petersburg, discusses the integument and certain peculiar structures found therein, while in the second Mr. N. Holmgren, of Stockholm, commences a series of articles dealing with the morphology of the head, commencing with that of the Chironomus larva, as displayed by the periodical moults.

We have received the March and April numbers (Nos. 3 and 4, vol. ii.) of the *Journal* of the Royal Army Medical Corps. The *Journal* is now edited by Colonel David Bruce, F.R.S., R.A.M.C., and maintains the high standard of the earlier parts. Among other articles of interest may be mentioned "para-typhoid infections," by Lieut.-Colonel Firth, R.A.M.C., cases of dum-dum fever by various writers, an illustrated description of the new Royal Army Medical College by the commandant, various clinical and editorial articles, and corps news, &c.

The report of the director (Lieut.-Colonel Semple, R.A.M.C.) of the Pasteur Institute of India (Kasauli) for the third year, ending August, 1903, has recently been issued. The inoculations for bites of rabid animals numbered 584, of which 6 were failures, a percentage of 1·02. In addition to the inoculations, experiments are in progress in order to obtain an anti-rabic serum, and the preparation of anthrax vaccine and of antivenene for snake bites has been undertaken. Various bacteriological examinations have also been carried out, the report showing that a great deal of valuable work has been accomplished. Attention is directed to the climatic difficulties that have to be surmounted, especially the liability to septic infection of the material used for the anti-rabic inoculations.

A small collection of Mycetozoa gathered in the Botanical Gardens, Tokyo, is described by Mr. A. Lister, F.R.S., and Miss Lister in the *Journal of Botany* for April. Several of the species are found in Great Britain and Europe, but one, *Erionema aureum*, which has affinities with the genus Physarum, has only been recorded once previously, and then from the Buitenzorg Gardens in Java.

Experiments conducted by Mr. M. Kanda, and recorded in the *Journal* of the College of Science, Tokyo, on the influence of very weak solutions of certain poisonous salts applied to water- and pot-cultures of flowering plants agree with the effects produced by similar salts on cryptogamic plants. A percentage appreciably less than the minimum poisonous solution in several cases stimulated the plant to accelerate its growth and increase in weight. The effect was most marked when a 5×10^{-8} gram molecule solution of zinc sulphate was added to the water-cultures.

In an account of the fibre plants which grow wild or are cultivated in the Hawaiian Islands, Mr. L. G. Blackman, of the Bernice Museum, in Honolulu, attests the value of the indigenous plant, *Touchardia latifolia*, which furnishes the fibre known as oloná. The plant is not common, and thrives best in woods at a moderate altitude. The fibre has been requisitioned for climbing ropes on account of its great tenacity. At present the cultivation of fibre yielding plants in these islands is practically limited to sisal hemp, but the writer suggests that the climate is suitable for growing *Sansevieria zeylanica*, which furnishes bow-string hemp, and *Furcraea gigantea*, the source of pita fibre.

Writing in the *Botanical Gazette* upon the morphology of the common American water-weed, *Elodea canadensis*, Mr. R. B. Wylie gives an account of the development of the floral parts, and describes the details of pollination and fertilisation. The staminate flowers are at first submerged, but owing to the accumulation of bubbles of gas in the closed flowers, they break off and rise to the surface. The pollen grains are kept afloat by the air which is held round the spines. In the pistillate flower the ovary is situated at the base of a long floral tube; the stigmas curve out well over the floral envelopes, and since they are not readily wetted, they cause a depression in the surface film of the water into which the pollen grains are drawn, and so come into contact with the stigmas.

The whole of the fourth number of vol. iv. of the *West Indian Bulletin* is devoted to information relating to Sea Island cotton in the United States and the West Indies. As the West Indian islands are considered to be specially suited for the cultivation of the Sea Island variety, the very finest and most expensive product on the market, the object of the Agricultural Department is to encourage its general introduction to the exclusion of the commoner and cheaper sorts. It is important, therefore, that the colonial cultivators should be in possession of the most trustworthy information to guide them in the re-introduction of the cotton industry. With this object in view Sir Daniel Morris, accompanied by Mr. J. R. Bovell, visited the Sea Island cotton regions of South Carolina, Georgia and Florida some months ago, and obtained, at first hand, a mass of facts bearing upon every phase of the business, from the nature of the most suitable soil to the final disposal of the cotton on the market. In addition to the report on the visit to the States, the number contains valuable notes on the various pests which injure the cotton plant in the West Indies, on the ginneries already established in the islands, on the cost of production, on the prices realised on the home markets, and so on.

A description of the topography and geology of the Baharia Oasis, in the Libyan desert, has been prepared by Dr. John Ball and Mr. H. J. L. Beadnell (Survey Department, Public Works Ministry, Cairo, 1903). This oasis is a large natural excavation in the great Libyan plateau, and is entirely surrounded by escarpments of Upper Cretaceous limestones and sandstones, with thin cappings of Nummulitic limestone (Eocene). The grey limestone and white chalk of the Danian form the prominent upper scarps, while the oldest strata are represented by the Nubian sandstone, partly Cenomanian and partly Senonian. The greatest length of the oasis is 94 kilometres, and its greatest width about 42 kilometres. Within the excavated area there are many isolated hills, some capped by white limestone, others by (? Oligocene) dolerite and ferruginous quartzites. The lowest part of the oasis is 113 metres above sea-level, and the floor consists of sandstones and clays strewn with rock fragments. There the springs occur and also the villages.

Partially dried salt areas are to be observed, with glittering incrustations of salt, and sand-dunes likewise diversify the scene. The authors give details of the stratigraphy and palæontology. They note that the Danian is overlain unconformably by the Eocene, between which disturbances with faulting and denudation took place. In post-Eocene times there were further earth movements accompanied by the igneous intrusions. It is not clear, however, whether these disturbances were prior or subsequent to the deposition of the ferruginous quartzites. These latter were formed in a slight depression of the Eocene and Cretaceous rocks before the great erosion of the oasis. The authors remark that the agent of denudation cannot be stated with certainty. The effects of the disturbances had weakened the rocks, and the main erosion was carried out in the moist climate which existed in Egypt in Pliocene and early Pleistocene times, and is being continued to-day by the powerful agency of the desert wind-borne sand and changes of temperature.

A FIFTH edition of Mr. W. Jerome Harrison's "Text-book of Geology" has been published by Messrs. Blackie and Son, Ltd. The book has been revised and brought up to date, and many new illustrations have been used to embellish its pages.

MESSRS. WHITTAKER AND CO. have published the *School Calendar* for 1904. It is a convenient and useful guide to the scholarships offered by the universities, public schools, and other educational institutions. Full particulars of the public examinations to be held during the current year are also given.

THE April number of *Cassell's Magazine* opens with a well illustrated description of the Royal Botanic Gardens at Kew, written by Mr. Richard Davey. An illustrated article on radium and its possibilities, by Dr. Louis Elkind, is also included in the same issue.

MR. J. W. JARVIS, St. Mark's College, Chelsea, S.W., has undertaken the duties of secretary and treasurer of the London Geological Field Class. The excursions this season are to Merstham on April 30, and to Purley, Henley, Wimbledon, Aylesford, Leighton, Bedford, and Chislehurst on succeeding Saturdays.

THE Department of Agriculture and Technical Instruction for Ireland has published the second *Bulletin* in its science and art series. The pamphlet deals with the spectrometer: its construction, adjustments, and uses, and is written by Mr. W. J. Lyons, of the Royal College of Science for Ireland.

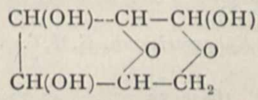
WE have received a copy of the *Chemisch Weekblad*, a new weekly publication of the Dutch Chemical Society, under the editorship of Dr. L. T. Reicher and Dr. W. P. Jorissen.

A PRIZE of 1200 marks is offered by Prof. J. H. van 't Hoff for the collection and systematic arrangement of all the literature bearing upon catalytic phenomena. Competitors for the prize are required to send in their manuscripts before June 30, 1905, to the Redaktion der *Zeitschrift für physikalische Chemie*, Leipzig, Linnéstrasse 2. The award will be decided by Profs. van 't Hoff, Arrhenius and Ostwald.

IN the *Journal of Physical Chemistry* Miss Clara C. Benson directs attention to an interesting reaction, the rate of which is diminished by raising the temperature. The reaction in question is the liberation of iodine from potassium iodide by chromic acid in presence of ferrous sulphate. The only reactions previously studied which have a negative temperature coefficient appear to be those in which a colloidal catalytic agent is involved, and the decrease of velocity with rise of temperature is in these cases probably due to the coagulation of the colloid.

THE mode of action of the oxides of nitrogen in the oxidation of sulphur dioxide in the lead chamber process is discussed in a detailed manner and from a physico-chemical standpoint by Dr. Trautz in the current number of the *Zeitschrift für physikalische Chemie*. It is pointed out that although the theories of Lunge and of Raschig throw considerable light on the reactions involved, yet the problem can by no means be regarded as solved. According to the author's experiments the essential reactions involved in the lead chamber process all take place with such large velocities that their nature cannot be determined with the aid of modern criteria.

IN the *Zeitschrift für Farben- und Textil-Chemie*, vol. iii. p. 97, Prof. A. G. Green discusses the question of the constitution of cellulose. It is pointed out that the grounds for the assumption that cellulose must have a large molecular weight are insufficient, and the simple formula $C_6H_{10}O_5$ seems more probable. As representing the constitution of this important body, the formula



is suggested. According to this, cellulose is an inner anhydride of glycose, and the formation of the latter on hydrolysis is thus easily explained. The formula, moreover, accounts for all the principal reactions, for the formation of the trinitrate and triacetate, for the production of ω-bromo-methylfurfurol by action of hydrobromic acid, and also explains its latent aldehyde character.

THE additions to the Zoological Society's Gardens during the past week include two Cheetahs (*Cynaelurus jubatus*) from Africa, presented by Colonel B. Mahon, C.B., D.S.O.; a Lesser Black-backed Gull (*Larus fuscus*), European; a Royal Python (*Python regius*) from West Africa, presented by Mr. E. W. Wildeblood; a Goshawk (*Astur palumbarius*), European, presented by Major-General Kinloch; two Roseate Cockatoos (*Cacatua roseicapilla*) from Australia, presented by Mr. T. J. Kynnersley; a Western Slender-billed Cockatoo (*Licmetis pastinator*) from Western Australia, presented by Miss Newbold; four Moorish Geckos (*Tarentola mauritanica*) from North Africa, five European Tree Frogs (*Hyla arborea*), a Common Toad (*Bufo vulgaris*), European, presented by Mr. F. M. Davis; four Common Vipers (*Vipera berus*), European, presented by Mr. G. E. Bon Bernais; a Suricate (*Suricata tetradactyla*) from South Africa, four Crowned Cranes (*Balearica pavonina*) from West Africa, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, three Madagascar Porphyrios (*Porphyrio madagascariensis*) from Madagascar, two Antarctic Skuas (*Stercorarius antarcticus*) from Antarctic Seas, two Yellow-vented Parrakeets (*Psephotus xanthorrhous*) from Australia, deposited; two Natal Duikers (*Cephalophus natalensis*) from South-east Africa, five Rose-coloured Pastors (*Pastor roseus*) from India, purchased; five Fat-tailed Desert Mice (*Pachuromys depresi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in May:—

May 1–6. Epoch of Aquarid meteoric shower (Radiant 338° − 2°.)
2. 16h. 50m. Inferior conjunction of Jupiter's Sat. IV. (Callisto).
9. Neptune 10′ south of μ Geminorum (Mag. 3·2).
,, Saturn. Major axis of outer ring = 38″·98, minor axis = 9″·09.
12. 1h. Moon in conjunction with Jupiter. Jupiter 0° 44′ N.
15. Venus. Illuminated portion of disc = 0·969, of Mars = 0·999.
16. Pallas in opposition to the Sun (Pallas Mag. 8).
20. 10h. 52m. Minimum of Algol (β Persei).
21. 9h. 1m. to 9h. 26m. Moon occults o Leonis (Mag. 3·8).
30. 6h. Mars in conjunction with the Sun.

Comet 1904 *a*.—*Circular* No. 65 from the Kiel Centralstelle contains a telegram received from Prof. Pickering, who announces that the comet 1904 *a* was photographed at Harvard on March 11 and 15, and April 1, 5, 13 and 16, and also gives the coordinates for those dates. He further gives the following set of elliptic elements, and an ephemeris, calculated by Messrs. Curtiss, Albrecht, and Leuschner from observations made on April 17, 18 and 19:—

Epoch 1904 *April* 18·62 *Greenwich.*

M = 159° 8′	q = 1·7177
ω = 258 57	e = 0·1773
Ω = 272 13	U = 3^y·02
i = 126 39	

Ephemeris 12h. G.M.T.

1904	α h. m. s.	δ ° ′	Brightness
April 21	16 44 32	47 13	0·98
25	16 31 8	49 30	
29	16 16 8	51 34	
May 3	15 59 44	53 22	0·88

The comet was observed on April 19 and 20 by Herren Wirtz and Becker respectively, who determined the following positions:—

M.T. (Strassburg) h. m.	α ° ′ ″	δ ° ′ ″	Mag.
April 19 ... 9 11·3	252 44 56	45 55 13	9·1
20 ... 11 37·4	251 56 1	46 35 38	9·3

Elements and Ephemeris for Wolf's Comet (1884 III.).—The following elements for Wolf's comet (1884 III.), corrected for the planetary perturbations up to the epoch June 12, 1904, are given by Herr A. Berberich in No. 3940 of the *Astronomische Nachrichten*:—

Epoch 1904 *June* 12·0 *Berlin.*

M = 312° 52′ 22″·66
ω = 172 50 38·22 }
Ω = 206 28 59·66 } 1900·0
i = 25 14 40·20 }
ϕ = 33 48 59·19
μ = 520″·05191
log a = 0·5559733

An ephemeris for the period May 7–August 11, 1904, from which the following is an extract, is also given:—

Ephemeris 12h. (*M.T. Berlin*).

1904	α h. m. s.	δ ° ′	log r	log Δ	Brightness
May 7	18 2 21	+2 50·9	0·5298	0·4223	0·012
11	18 1 1	+3 27·8			
15	17 59 21	+4 4·2	0·5243	0·4044	0·014
19	17 57 23	+4 39·7			
23	17 55 7	+5 13·9	0·5186	0·3881	0·015
27	17 52 35	+5 46·6			
31	17 49 48	+6 17·4	0·5128	0·3739	0·017

Stars having Peculiar Spectra.—In *Circular* No. 76 of the Harvard College Observatory, Prof. Pickering gives a list of stars which have been found, on the Henry Draper Memorial photographs, to possess peculiar spectra. The present list contains the designation, the coordinates, the magnitude and the nature of the spectrum peculiarity of twenty-two stars, and is supplementary to the similar lists previously published.

Circulars No. 77 and No. 78 have also been received. The first is a supplement to the "Provisional Catalogue of Variable Stars" published in vol. xlviii. of the Harvard College Observatory *Annals*; the second deals with the variable stars in the nebula of Orion, and in many cases confirms Dr. Max Wolf's conclusions respecting the variability of a number of the stars published in Dr. Bond's discussion of the nebula, which appeared in vol. v. of the Harvard College Observatory *Annals*.

Spectra Obtained from the Wehnelt Interrupter Discharge.—Mr. H. W. Morse, of the Jefferson Physical Laboratory, Harvard University, has obtained the spectra of a number of elements, using as the light source the brilliant glow which surrounds the "active" electrode of a Wehnelt interrupter when the current is passing. He hoped to obtain, among other results, some indications, from the nature of the spectra, that the temperature of this glow was intermediate between that of the flame and arc, or arc and spark, and thereby to provide another definite step in the laboratory temperature scale. From the spectra obtained, however, it appears that the environment of the electrode passes through a very great range of temperature with each interruption of the current, for under the same constant experimental conditions the strongest lines of the condensed spark appeared at the same time as lines usually attributed to the flame. Usually the "Wehnelt" spectrum is closely allied to that of the spark, but often some of the strongest lines are missing.

Mr. Morse discusses in detail the results obtained for each of the thirteen elements he used, and in a series of tables gives the wave-length of each line obtained, together with the relative intensity of the line in the arc, spark, and "Wehnelt" spectra respectively. A number of reproductions of the spectra obtained also accompany the paper, which is published in No. 3, vol. xix., of the *Astrophysical Journal*.

Variable Stars of the Orion Nebula.—Prof. Ernst Hartwig, in a communication to No. 3936 of the *Astronomische Nachrichten*, gives a list of corrections to the "Chart of Stars in the Nebula of Orion" which was published in vol. v. of the Harvard College Observatory *Annals*. The corrections have been obtained from observations made by Dr. Max Wolf and from the measurement of a photograph taken by Prof. Scheiner, and are given in tabular form for the equator of 1857.

THE GERMAN ANTARCTIC EXPEDITION.[1]

THE German South Polar Expedition was absent altogether twenty-eight months, of which fourteen months were passed in the south polar ice, ten months with our operations in the South Atlantic and South Indian oceans, and four months with our work and residence in the islands of the Indian and Atlantic Oceans and at the Cape.

After leaving Cape Town on December 7, 1901, a successful series of soundings and investigations was carried on between there and Kerguelen, and further on as far as the fringe of ice. Amongst the results, I lay stress on the demonstration of a trough more than 4500 metres deep, running between the Crozet Islands and Kerguelen, and connecting the abysses of the Indian Ocean with a deep ravine on the outer edge of the Austral Glacial sea.

The results of the expedition cannot be comprehensively surveyed until the whole material and the copious collections, all of which have been brought back in good condition, are worked up and made accessible. It may, however, be already affirmed that the *Gauss* Expedition achieved everything in the region assigned to it that it was possible to achieve in the time available. It discovered a new land, and thereby cleared up an old contested question regarding the nature and extent of the Antarctic continent

1 Abridged from a paper by Dr. Erich von Drygalski read before the Royal Geographical Society on April 25.

for more than ten degrees of longitude, certainly for about half the debated region between Knox and Kemp's Lands, and perhaps for the whole. At least, for the actual determination of the westerly tract, observations are now at hand by which light may be shed on the specified question. An important factor is the steep fall of the land down to a deep sea discovered by us; important, also, is the structure of the land, which consists of old crystalline rocks; lastly, it is important to find that this margin of the continent is occupied by a volcanic formation the lavas of which contain molten gneisses which have been forced up with them from the bed-rock.

The inland ice covering the continent presents a picture of our former Ice age, and is undoubtedly the vastest Glacial area now existing. Yet it was still more extensive in former times, as shown by traces on the Gaussberg.

To this continent we directed our operations, and endeavoured to study all the phenomena presented by it. In the biological field, these studies ranged with Prof. Dr. Vanhöffen from the large marine mammals and the flocks of rare birds on the seaboard, through the numerous species of the smaller marine fauna to the bacteria which Dr. Gazert was able to detect, if not in the Glacial sea itself, at least in its organisms, as well as in the rookeries of the stormy petrels on the Gaussberg, and in its few lichens and mosses. On the physical side, our observations extended from Dr. Philippi's studies of the Gaussberg lavas and of the continental boulders borne to great distances by the ice, through the numerous properties of the Glacial sea and of the Glacial formations by myself, up to determinations of the force of gravity, and to Dr. Bidlingmaier's determinations of the most delicate oscillations of the terrestrial magnetic forces, both in their normal periodicity and in their stormy perturbations, such as are displayed especially during the appearance of the southern auroras.

But should anyone doubt that we there lived and worked in a new region on the fringe of the south polar continent, conviction will be afforded by the climate. In the north we left behind us the zone of west winds and crossed a trough of low barometric pressure, remaining on its southern slope, where the pressure again rises to a maximum over the continent. Hence the prevalence of the easterly winds, which sweep down from the south over the vast uniform and but slightly inclined surfaces of the inland ice, and appear on the seaboard as easterly, Föhn-like gales.

These gales impart to the south polar region its character and its limits; by their frequency and uniformity they reveal the immensity and the homogeneous nature of those Antarctic lands. Their northern confines may have some importance for practical navigation whenever there is a question of circumnavigating the zone of the Austral west winds.

EDUCATION IN INDIA.

THE promulgation of an elaborate and comprehensive State document by the Home Department of India, already referred to in NATURE (April 7, p. 550), exhaustively reviewing the subject of education in all its branches and laying down the policy adopted by the Government in regard to each, and the recent passing of the Universities Act in the Viceroy's Legislative Council in India, naturally direct attention to the efforts being made in the Indian part of our Empire to place every grade of education upon a satisfactory basis. The various stages in the agitation which preceded the adoption of the Universities Bill by the Legislative Council have already been referred to on several occasions in these columns. In the following brief summary of the distinguishing characters of each of these efforts to advance education in India, continual reference has been made to the columns of the *Pioneer Mail* of Allahabad.

First to deal with the official minute with which Lord Curzon is naturally conspicuously associated. We find the system of public instruction in India includes five universities, those of Calcutta, Bombay, Madras, the Punjab, and Allahabad, which prescribe courses of study and examine the students of affiliated colleges. These colleges are widely scattered throughout the country, and number in all 191 (exclusive of some colleges outside British India, which are not incorporated in the provincial statistics), with 23,000 students on the rolls. In them provision is made for studies in arts and Oriental learning, and for professional courses of law, medicine, engineering, teaching and agriculture. Below the colleges are secondary schools, to the number of 5493, with an attendance of 558,378 scholars, and primary schools numbering 98,538, with 3,268,726 pupils. Including private institutions, there are about 4½ million scholars, maintained at a cost of 400 lakhs, of which nearly one-half is derived from public funds. The total grants from public funds fall short of 1,300,000*l.* a year, and the extension and improvement of education in India are chiefly a matter of increased expenditure.

In India, far more than in England, the majority of students who frequent the higher schools and the universities are there for the purpose of qualifying themselves to earn an independent livelihood; Government service is regarded by the educated classes as the most assured, the most dignified, and the most attractive of all careers. It is, however, justly complained by competent authorities that higher education is too much pursued with a view to Government service, that excessive prominence is given to examinations, that studies are too literary in character, that the memory is trained rather than the intelligence, and that in the pursuit of English education the vernaculars are neglected, and so fail to become the vehicles for the diffusion of western knowledge among the masses. But it is clear from the minute that the Government of India holds that the multiplication of competitive tests for Government service neither results in advantage to Government nor is consistent with the highest interests of a liberal education. In fixing the educational standards which qualify for appointments, it is stated that the natural divisions of primary, secondary, and university education should be followed. School and college certificates of proficiency should, so far as possible, be accepted as full evidence of educational qualifications, and due weight should be attached to the recorded opinions of collegiate and school authorities regarding the proficiency and conduct of candidates during their period of tuition. The questions as to what subjects should be taught and by what means proficiency in them should be tested are considered as a part of the larger problem of the true object of secondary education. The Government of India thinks that the solution of the difficulty will be found in adapting to Indian conditions the system of leaving examinations, held at the conclusion of the secondary course, which has been tried with success in other countries.

Referring to technical education, the minute points out that the first call for fresh effort is toward the development of Indian industries. Technical instruction directed to this object must rest upon the basis of a preliminary general education of a practical kind, which should, as a rule, be imparted in schools of the ordinary type. In fixing the aim of the technical schools, the expansion of the existing Indian markets is of superior importance to the creation of new export trades. As a step towards providing men qualified to take a leading part in the improvement of Indian industries, the Government of India has determined to give assistance in the form of scholarships to selected students to enable them to pursue a course of technical education under supervision in Europe or America. The Government hopes that the technical schools of India may in time produce a regular supply of young men qualified to take advantage of such facilities, and that the goodwill and interest of the commercial community may be enlisted in the selection of industries to be studied, in finding the most suitable students for foreign training, and in turning their attainments to practical account upon their return.

Agricultural education in India is then passed in review. India possesses no institution capable of imparting a complete agricultural education. The existing schools and colleges have neither produced scientific experts nor succeeded in attracting members of the land-holding classes to qualify themselves as practical agriculturists. Both of these defects must be supplied before any real progress can be expected. In the first place an organisation must be created by which men qualified to carry on the work of research, and to raise the standard of teaching, can be trained in India itself. The Government of India has therefore under its consideration a scheme for the establishment of an Imperial Agricultural College in connection with an Experimental Farm and Research Laboratory, to be carried on under the general direction of the Inspector-General of Agriculture, at which it is intended to provide a thorough training in all branches of agricultural science, combined with constant practice in farming work and estate management (see p. 564). There will be courses of instruction extending to five years, which will qualify men to fill posts in the Department of Agriculture itself, such as those of assistant directors, research experts, superintendents of farms, professors, teachers, and managers of encumbered estates.

In conclusion the Governor-General in Council states in the minute that the system of education thus extended makes provision in varying degrees for all forms of intellectual activity that appeal to a civilised community. It seeks to satisfy the aspirations of students in the domains of learning and research; it supplies the Government with a succession of upright and intelligent public servants; it trains workers in every branch of commercial enterprise that has made good its footing in India; it attempts to develop the resources of the country and to stimulate and improve indigenous arts and industries; it offers to all classes of society a training suited to their position in life; and for these ends it is organised on lines which admit of indefinite expansion as the demand for education grows and public funds or private liberality afford a larger measure of support. It rests with the people themselves to make a wise use of the opportunities that are offered to them, and to realise that education in the true sense means something more than the acquisition of so much positive knowledge, something higher than the mere passing of examinations, that it aims at the progressive and orderly development of all the faculties of the mind, that it should form character and teach right conduct—that it is, in fact, a preparation for the business of life.

The aspirations of the Government of India, so far as university education in particular is concerned, may be gathered both from the minute already referred to and from the Viceroy's speech at the meeting of his Legislative Council on the occasion of the passing of the Universities Act. The minute points out that it has been realised in India that universities which are merely examining bodies tend to accentuate the defects of the Indian intellect—the disproportionate development of the memory and the incapacity to observe and appreciate facts. It is proposed to reconstitute the unwieldy senates of the universities, and to define and regulate the position and powers of the syndicates. The universities are to be empowered to provide teaching, while collegiate teaching will be tested by inspection in addition to examination, and a higher educational standard will be enforced from collegiate colleges. Government is prepared to afford liberal financial aid to enable universities to adapt themselves to the new conditions, and it is hoped that such aid may stimulate private beneficence.

Lord Curzon, in his speech to the Legislative Council, said that the fact that the Government had taken the power of the last word in the entire programme of reconstruction of Indian universities is the best guarantee that the programme will not be inoperative, though he regretted that the Government is compelled to be so dominant a factor in the settlement of Indian problems. But, he continued, if the Government had not taken up this particular problem of higher education, who would have done it? and if the Government had not made itself responsible for seeing it through, who could give any guarantee that it would not have proved abortive? It is quite likely, said the Viceroy later, that the senates and syndicates of the universities of India will be perfectly competent to stand by themselves and will make no mistakes, but if not, and until they are created, the matter must necessarily be in doubt, and the Government must, in common prudence, retain the power.

It is consequently clear enough that the improvement of education in India in the immediate future is now fully assured, and it may be expected with confidence that the result of this development will in our eastern empire be identical with that in other countries, viz. an increased prosperity and national well-being.

PLATING UPON ALUMINIUM.

MANY attempts to plate other metals upon aluminium have been tried, but although apparent success has—for a short time—attended some of these efforts, the film of metal plated on has not been of such a nature as to stand wear or rough usage. Messrs. C. F. Burgess and Carl Hambuechen publish a new method in the March number of *Electrochemical Industry*. The difficulty of plating on aluminium is generally, and probably correctly, attributed to the invisible film which forms upon that metal when exposed to air. Therefore most of the methods previously described depend upon the removal (or attempted removal) of this film by means of solvents, such as acids or alkaline hydroxides, and the rapid transference from the pickling to the plating bath.

An ideal method would be to plate in a bath containing some substance which would dissolve off the film of oxide from the aluminium and thus leave it clean for the deposition of the metallic film. Messrs. Burgess and Hambuechen find that the presence in the bath of soluble fluorides, such as sodium or ammonium fluoride, or preferably a small quantity of free hydrofluoric acid, dissolve off or prevent this film formation.

The next important point is to plate as a base metal, upon the aluminium, one which will adhere tenaciously to its surface, or partially alloy with it. Zinc appears to possess this property of adhesion to a high degree.

The method of procedure is first to clean the aluminium by immersion for a few minutes in a bath of hydrofluoric acid; this produces a suitable roughening of the surface; the adhesion to a perfectly polished surface is not satisfactory. On removal from this bath the aluminium is rinsed in running water, dipped for a few seconds in a bath consisting of a mixture of sulphuric acid 100 parts and nitric acid 75 parts, again rinsed in water, and placed in the plating bath.

The plating bath consists of a mixture of zinc and aluminium sulphates, which is very slightly acidified, and contains about 1 per cent. of hydrofluoric acid and an equivalent amount of potassium fluoride. After the deposition has continued for a few minutes with a current density of 10 to 20 amperes per square foot the article is taken from the bath, washed and dried. Other metals, such as copper or silver, may now be deposited upon the zinc coating, using the ordinary precautions commonly observed in the deposition of such metals upon zinc.

If gold is to be deposited upon it, it is necessary first to plate on a thin coating of copper, otherwise in a short time the gold sinks into the zinc and in a few weeks almost disappears.

The authors do not state whether aluminium coated with zinc can be readily soldered, but probably there would be no difficulty in doing this. F. M. P.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

WE learn from *Science* that Mr. John D. Rockefeller has given 100,000*l.* to the Johns Hopkins Hospital, in order that the work of the institution may not be curtailed owing to the losses from the recent Baltimore fire. The Maryland Legislature has voted 5000*l.* annually for two years to the Johns Hopkins University. By the will of Mrs. Farnham, widow of the late Prof. Henry Farnham, Yale University receives 10,500*l.* for the endowment fund of the medical school and 7900*l.* for the endowment fund for the library.

IT is announced in *Science* that the Assembly has passed a Bill appropriating 50,000*l.* for the New York State College of Agriculture at Cornell University; that President C. E. Miller, of Heidelberg University, Tiffin, Ohio, has secured pledges to the amount of 30,000*l.* for the fuller equipment of this university, 10,000*l.* of this amount to be expended in buildings, and 20,000*l.* to be added to the permanent endowment; and that Mr. Andrew Carnegie has given 6000*l.* to Berea College in Kentucky.

AT a recent meeting of the New York section of the American Chemical Society a discussion on the training of technical chemists was opened with a paper by Mr. J. B. F. Herreshoff. The paper insists that before deciding on the best methods of training technical chemists, it must be seen that they are sufficiently educated on the proper lines to enable them readily to become technical chemists of great value. To achieve the greatest success in such work a technical chemist should perfect his mathematics and become thoroughly familiar with physics as well as with mechanical engineering. After men have gone through a regular course in chemical engineering they should be trained before leaving college in a practical manner in the application of chemistry as well as in examples of engineering problems. Later, the paper lays it down that to become a skilful investigator in a research chemical laboratory requires both a proper education at college as a chemical engineer, especially full in chemistry, and also a training at college in original thought as applied to practical investigation, and to working up and improving processes. Applied chemistry would be greatly benefited if colleges would come in closer touch with the manufacturer. A plan that has been in successful practice at Brown University for the last few years was then described. A separate committee for each department of study is carefully selected from the old students. These committees visit the college once or more a year; they consult and exchange views with the heads of the departments. Each member reports his recommendations to the chairman of his committee, who incorporates the same in his report to the president of the college. In this way the college authorities are kept in close touch with modern technical requirements.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, April 19.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Mammals obtained by the late Mr. W. G. Doggett on the Anglo-German Boundary Commission: Oldfield **Thomas**, F.R.S., and Harold **Schwann**. Twenty-one species were enumerated, of which three were described as new.—Contributions to the anatomy of the Lacertilia, ii.: F. E. **Beddard**, F.R.S. The present part dealt with some points in the structure of the Teguexin (Tupinambis).—The Triassic reptile *Telerpeton elginense*, based on new material recently procured at Lossiemouth by Mr. William Taylor: G. A. **Boulenger**, F.R.S.—Descriptions of twenty-three new species of butterflies belonging to the family Erycinidæ, from tropical South America: Herbert **Druce**.—The theriodont mandible and its mode of articulation with the skull: Dr. Robert **Broom**.

Royal Meteorological Society, April 20.—Captain D. Wilson-Barker, president, in the chair.—The variation of the population of India compared with the variation of rainfall in the decennium 1891–1901: W. L. **Dallas**. The author showed that during the four years 1891–5, the rainfall was generally normal or heavy over nearly the whole country, and during the six years 1895–1901 the rainfall was greatly deficient. During the former, or "wet" period, the rainfall was deficient over Upper Burma and Madras, was normal over the remainder of Burma, Assam, Bengal, and the west coast of the peninsula, and was excessive elsewhere; while during the latter, or "dry," period, the rainfall was again deficient over Upper Burma, normal or excessive over the remainder of Burma, Assam, Bengal, the United Provinces, the North-west Frontier Province, and the south of Madras, and was deficient elsewhere, mostly so over Rajputana and neighbouring areas. The general census of India on March 1, 1901, showed the total population to be 293,475,477, which, excluding the territories not included in the 1891 census, was an increase of only 1·3 per cent. The population had thus failed to increase according to the normal rate during the decade. Part of this failure was, no doubt, due to epidemics. The author, however, shows that there is an unmistakable relationship between the variations of the population and the variations of rainfall during the dry years. The area within which the most serious decrease of population occurred coincides almost exactly with the area of greatest deficiency of rainfall.—The cause of autumn mists: Dr. J. B. **Cohen**. The author describes experiments made by him on Coniston Lake some time ago.

DUBLIN.

Royal Irish Academy, April 25.—Prof. Atkinson, president, in the chair.—The secretary read a paper by Dr. J. L. E. **Dreyer** containing the results of a survey of the great spiral nebula Messier 33 in the constellation Triangulum; 431 stars and nebulous points of condensation found on a photographic negative taken by Dr. Isaac Roberts were micrometrically measured, and their standard coordinates computed.

PARIS.

Academy of Sciences, April 18.—M. Mascart in the chair.—On the horistic method of Gylden: H. **Poincaré**. In a work on the series employed in the theory of planets, Gylden has expounded two methods which he entitles horistic. The first of these has been shown to be open to grave objections, and in the present paper the second is examined, with the result that it is found to give not the general solution, but a particular solution, which the author calls a periodic solution. It differs numerically from the solution given by Gylden.—On the presence of argon in the gas from the fumerolles at Guadeloupe: H. **Moissan**. The gases were collected under conditions which precluded the possibility of any contamination by any atmospheric air, and proved on analysis to consist chiefly of carbon dioxide and nitrogen, together with small quantities of sulphuretted hydrogen, oxygen, and argon. This latter gas has been found in all samples of gases from fumerolles which have been analysed by the author up to the present.—The action of silicon upon water at a temperature near 100° C.: H. **Moissan** and F. **Siemens**. By the prolonged action of water at about 95° C. upon silicon, either crystalline or amorphous, a small quantity of hydrogen is evolved, and each particle of silicon is surrounded by a coating of hydrated silica. This effect was shown to be due to the minute amount of alkali dissolved from the glass, since it was stopped by the presence of a small quantity of acid, and no such effect could be observed in vessels of platinum or of fused silica.—On a new entire function: G. **Mittag-Leffler**.—Permanent modifications. On the properties of systems affected with both hysteresis and viscosity: P. **Duhem**.—The influence of lateral pressures on the resistance of solids to crushing: M. **Considère**. The crushing resistance of cement is increased by lateral pressure on the specimen. The curves given in the paper show that there is a linear relation between the crushing resistance and the external pressure on the sides of the test piece.—On certain ordinary differential equations of the second order: S. **Bernstein**.—On a series analogous to modular functions: M. **Lerch**.—On the theory of systems of differential equations: L. **Schlesinger**.—On the compensation of interferences and the measurement of small thicknesses: Georges **Meslin**. The retardation due to a thin isotropic plate is balanced by the retardation due to the rotatory polarisation of quartz. In this way a thickness of air of the order of 0·01 mm. is balanced by a piece of quartz several centimetres in thickness. The great sensitiveness of the method lends itself to the determination of the optical properties of crystalline bodies which can only be obtained in the form of thin plates.—On the spectrum of zinc: Maurice **Hamy**. The interference method has been recently subjected to criticism; the author has re-determined some of the wave-lengths of the principal rays of zinc, and shows that they are in absolute accord with the results of Perot and Fabry.—On some bodies acting on the photographic plate: Edmond **van Aubel**. A description of experiments with resin giving results analogous with those of Russell and Graetz on hydrogen peroxide and turpentine.—The action of the Hertzian oscillations on faintly luminous objects: C. **Gutton**. The action of the Hertzian waves is similar to that of the *n*-rays.—On a system of damping: MM. **Favé** and **Carpentier**. A system of very fine wires or glass capillary tubes is arranged radially round the moving needle, the damping effect being produced by the viscosity of the air. The resistance to motion has been worked out experimentally as a function of the diameter of the wire, and the results compared with the theory of Stokes.—On the apparent diminution of energy of a feeble acid in the presence of its neutral salt: G. **Chesneau.** The incomplete precipitation of metallic acetates in the presence of sodium acetate by means of hydrogen sulphide appears to be due to the formation of small quantities of an alkaline sulphide, and it is unnecessary to resort to the electrolytic theory of dissociation to interpret this phenomenon.—On the methyl ether of acetol: Louis **Henry.**—On the acetolate of methyl: André **Kling.**—Halogen ether oxides, $RO(CH_2)_nX$, and their magnesium compounds. New syntheses in the tetramethylene series: J. **Hamonet.**—On a new general reaction of aldehydes: L. J. **Simon** and A. **Conduché.** Aldehydes condense with oxalacetic ester and ammonia to give crystalline compounds, the constitution of which is not yet completely made out.—The chlorination of phenyl carbonate in the presence of antimony chloride: Et. **Barral.**—The action of sulphur and selenium on the organomagnesium compounds of aromatic hydrocarbons, with one or two halogen atoms in the ring: F. **Taboury.** Sulphur gives thiophenols and disulphides; selenium forms analogous compounds.—The purification and characterisation of alcohols: L. **Bouveault.** Pyruvic esters are readily formed, and give characteristic semicarbazones.—On two isomeric β-methylcinnamic acids: M. **Tiffenau.**—The action of organomagnesium compounds on phthalimide and phenylphthalimide: Constantin **Reis.**—On the hydrates of methyl alcohol and acetone: E. **Varenne** and L. **Godefroy.** The existence of several hydrates of methyl alcohol and acetone is inferred from a study of the viscosity of various mixtures of these substances with water.—On the perception of luminous radiations in nocturnal moths, and on the use of lamps as decoys: Joseph **Perraud.**—On the peduncle of some Vorticellæ: Emmanuel **Fauré.**—On the presence of a new American genus (Abronia) in the Tertiary flora of Europe: L. **Laurent.**—On the sulphur spring of Matsesta (Transcaucasia) and the relation between caves and thermomineral springs: E. A. **Martel.**—The histology and bacteriology of mud extracted from a depth of 10 metres in a well at the necropolis of Bernard (Vendée): Marcel **Baudouin.**—The influence of acidity on enzymes: P. **Petit.**—Chemical researches on the thyroid apparatus: Jean **Chenu** and Albert **Morel.** It is possible to differentiate by chemical analysis between the thyroid and parathyroid bodies, the latter containing much less iodine.—The effect of ablation of the liver on the coagulation of the blood: M. **Doyon** and N. **Kareff.**—Contribution to the study of sand filters: M. **Marboutin.**

DIARY OF SOCIETIES.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.—Further Experiments on the Production of Helium from Radium: Sir William Ramsay, K.C.B., F.R.S., and F. Soddy.—The Effects of Changes of Temperature on the Modulus of Torsional Rigidity of Metal Wires: Dr. F. Horton.—The Sparking Distance between Electrically Charged Surfaces. Preliminary Note: Dr. P. E. Shaw.—Studies on Enzyme Action. Part II. The Rate of the Change Conditioned by Sucroclastic Enzymes, and its Bearing on the Law of Mass Action. Part III. The Influence of the Products of Change on the Rate of Change Conditioned by Sucroclastic Enzymes: Dr. E. F. Armstrong.—Part IV. The Sucroclastic Action of Acids as Contrasted with that of Enzymes: Dr. E. F. Armstrong and R. J. Caldwell.—Enzyme Action as bearing on the Validity of the Ionic-dissociation Hypothesis, and on the Phenomena of Vital Change: Prof. H. E. Armstrong, F.R.S.—On the Changes of Thermoelectric Power produced by Magnetisation, and their Relation to Magnetic Strains: Dr. S. Bidwell, F.R.S.—The Behaviour of the Short-period Atmospheric Pressure Variation over the Earth's Surface: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S. Lockyer.

ROYAL INSTITUTION, at 5.—Dissociation: Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Power Station Design: C. H. Merz and W. McLellan.

FRIDAY, APRIL 29.

ROYAL INSTITUTION, at 9.—Westminster Abbey in the Early Part of the Seventeenth Century: The Very Rev. J. A. Robinson.

MONDAY, MAY 2.

ROYAL INSTITUTION, at 5.—Annual Meeting.

ARISTOTELIAN SOCIETY, at 8.—Kant's Idealism: G. E. Moore.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—(1) The Determination of Minute Quantities of Bismuth in Copper and Copper Ores. (2) The Determination of Minute Quantities of Arsenic in Copper Ores and Metallurgical Products: T. C. Cloud.—The Estimation of Mercury: D. A. Sutherland.

TUESDAY, MAY 3.

ROYAL INSTITUTION, at 5.—Meteorites: L. Fletcher, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Osteology and Systematic Position of the rare Malagasy Bat *Myzopoda aurita*: Oldfield Thomas, F.R.S.—Contributions to the Anatomy of the Lacertilia. III. On some Points in the Vascular System of Chamæleon and other Lizards: F. E Beddard, F.R.S.—Notes on the Gill-rakers of Polyodon: A. D. Imms.

SOCIETY OF ARTS, at 4.30.—Canada and Great Britain: W. L. Griffith.

WEDNESDAY, MAY 4.

ENTOMOLOGICAL SOCIETY, at 8.—Some Breeding Experiments on *Catopsilia pyranthi*, and Notes on the Migration of Butterflies in Ceylon: Major Neville Manders, R.A.M.C.

SOCIETY OF ARTS, at 8.—Statistics of the World's Iron and Steel Industries: W. P. Digby.

SOCIETY OF PUBLIC ANALYSTS, at 8.—(1) Cod Liver Oils and other Fish Oils; (2) Note on Mushroom Ketchup: J. F. Liverseege.—Note on Some Constants obtained in the Examination of Margarine: E. Russell and V. H. Kirkham.—Note on the Estimation of Sugars in Concentrated Malt Extract: A. R. Ling and Theodore Rendle.

THURSDAY, MAY 5.

LINNEAN SOCIETY, at 8.—British Freshwater Rhizopoda: J. Cash.—On Coloration in Animals and Birds: J. Lewis Bonhote.

RÖNTGEN SOCIETY, at 8.30.—The Röntgen Society; its Past Work and Future Prospects: J. J. Vezey.—Some Experiments with Alpha Rays: F. H. Glew.

CHEMICAL SOCIETY, at 8.—The Slow Combustion of Ethane: W. A. Bone and W. E. Stockings.—Note on the Hydrolysis of Starch by Diastase: J. S. Ford.—The Resin Acids of the Coniferæ. Part I. The Constitution of Abietic Acid: T. H. Easterfield and G. Bagley.—The Action of Radium Rays on the Halides of the Alkali Metals, and Analogous Effects produced by Heat: W. Ackroyd.—The Dynamic Isomerism of Glucose and of Galactose. Solubility as a means of Determining the Proportions of Dynamic Isomerides in Equilibrium: T. M. Lowry.—A Study of the Substitution Products of *ar*-tetrahydro-α-naphthylamine, *ar*-4-bromotetrahydro-α-naphthylamine and *ar*-tetrahydro-α-naphthylamine-4-sulphonic acid: G. T. Morgan, Miss F. M. G. Micklethwait, and H. B. Winfield.—The Additive Products of Benzylideneaniline with Methylacetoacetic Ester and Acetoacetic Ester: F. E. Francis and Miss M. Taylor.

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