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Fuel Research.

ONE of the most important of the subjects dealt with in the recent annual Report of the Committee of the Privy Council for Scientific and Industrial Research is that of fuel. Fuel is in Great Britain practically the sole source of the power which is essential to all our large industries. The only fuel of national importance produced at the present time is coal, and on the economic use of our diminishing supplies of it the prosperity of the country largely depends. This is now becoming a platitude, but the complexity of the problem involved is by no means realised by many popular writers on the subject.

The coal as it exists in the ground is a highly complex substance, and its constitution varies very widely, even through the thickness of a single seam. The quantity and nature of the volatile content, of the "ash" content, the coking power, the moisture content, and the calorific value all vary, as well as the amount of impurities such as sulphur, arsenic, or phosphorus which, while never intrinsically large, may for some purposes be very important. Analyses and determinations of calorific value, while giving much useful information, by no means give all the information required to determine the suitability of a coal for any given purpose. For example, it is obvious that a large ash content is undesirable, as the cost of carriage of the ash is the same as that of the coal, and in addition the ash has to be removed from the furnace and disposed of. This is, however, not the whole story. The melting-point of the ash is of importance, and while, for example, a low melting-point is not objectionable for domestic purposes, as it tends to prevent the formation of a powdery ash in the grate, a high melting-point is wanted for industrial purposes to prevent the too ready formation of clinker. Similarly, the composition of the ash may have a considerable influence on the refractory linings of the furnace. Recent investigations indicate that the ash may have subtle effects on the decomposition of the coal under heat, and further investigation may show that these effects are of great importance to the carbonisation industries.

Of recent years increased attention has been given to the removal of ash by washing or other purification processes, but much work remains to be done before it will be possible to recommend the best methods to adopt and the degree of purification that is economically desirable.

Much fine coal is left underground, or if brought up is at present unsaleable, and this constitutes a great waste of potential resources. The difficulty in using this coal is due partly to the high ash content and partly to the difficulties of transport and storage.

There is here a large field for useful research which embraces coal-washing, the causes of spontaneous combustion, and methods of briquetting, but there can be no single solution that will suit all fine coals. The solution must depend on the circumstances of each case, and a knowledge of these circumstances can be gained only from a survey of the physical and chemical characteristics of the various coal seams.

Another field of research which has as yet been but little explored is that dealing with metallurgical coke. The prosperity of the great iron and steel industries depends very largely on the possibility of reducing the cost of the fuel per ton of metal dealt with. It is well known that cokes vary widely in their properties and in the economy with which they can be used, but so far, it has proved impossible to say in detail why one coke is better than another. It is, then, of importance to find out (*a*) the properties of the coke that are of fundamental importance for metallurgical purposes, (*b*) the characteristics of the raw coal necessary to obtain these properties in the coke, and (*c*) the best method of obtaining the coke from the coal. For this purpose again a knowledge of the characteristics of the various coal seams is necessary before the problem can be fully solved.

For metallurgical purposes raw coal is often unsuitable, but there are many other purposes where, while raw coal could be used, it is both convenient and economical to treat the coal so as to obtain other forms of fuel. The real object of all such treatments is to increase the availability of the heat units, *i.e.* to provide a fuel which can be more efficiently and conveniently transported and utilised than can the coal itself. The most widely used of such treatments is the carbonisation of coal to produce coal-gas and coke, the manufacture of which incidentally produces as by-products a large proportion of the raw material required by our chemical industries. The importance of this and of the smokeless nature of the gas and coke needs no emphasis here, but the gasification of all our coal would not be advantageous, even if all coals were suitable for the process. There is necessarily a thermal loss in any carbonisation process, and this loss can only be justified if it is compensated for by the more economical use of the heat units remaining, and in economy of use must be included economy of transport. The over-all thermal efficiency of a carbonisation plant plus a boiler plant, where the combustible products of the carbonisation are all immediately burned under boilers, is necessarily lower than that of a boiler plant utilising the raw coal.

The carbonisation of coal at "low temperatures" has been much to the fore of recent years, with the object of obtaining home supplies of oil and a smokeless solid fuel for domestic and industrial purposes, and considerable progress has been made towards the solution of its particular problems. Here again it is not all coals that are suitable for the purpose, and all suitable coals will not respond to the same treatment.

Whatever aspect of the fuel problem is considered, it is found that a solution of its problems, if looked at from a national point of view, depends on a fuller knowledge of the characteristics of the coal available than we at present possess. The Fuel Research Board is therefore correct in placing the physical and chemical survey of the national coal resources in the forefront of its programme, and it is gratifying to learn that the Government has decided that this work shall "be pressed forward at the maximum speed compatible with obtaining proper value for the expenditure."

The Fuel Research Board considered "that the actual work in the coalfields would best be carried out by means of local committees, the personnel of which included colliery owners, managers, consumers, and representatives of the Board and of the Geological Survey. By this means it was hoped to obtain the sympathetic co-operation of the owners and managers without which the work could not be carried on." In the two areas in which local committees have been formed, the report states that this co-operation has been given freely. It is to be hoped that the same spirit will animate the owners and managers in the other coalfields of the country. There need be no fear that more economical methods of utilising our fuel resources will be detrimental to the coal-producing industry, as the cheapening in the cost of our manufactured products which would result would lead to a greater demand for them, and so keep up the demand for the coal, to say nothing of the possibilities of enabling the collieries to find favourable markets for coal at present unsaleable.

The practice adopted by the Survey, of taking samples in the form of a pillar of coal through the whole thickness of the seam, enables each portion of the seam to be examined separately, and thus brings out any peculiarities that may exist in the different layers. It has already been abundantly shown that very striking differences may exist, and that in some cases the different layers may be advantageously separated before the coal is marketed, the extra labour involved being more than compensated for by the increased value of the coal. The work of the Survey is, however, not confined to the laboratory examination of small samples, and in suitable cases samples of several hundred tons may be tried out to ascertain their behaviour in full-scale plant.

Logarithms de Luxe.

Logarithmetica Britannica: being a Standard Table of Logarithms to Twenty Decimal Places. By Alexander John Thompson. Part 9: Numbers 90,000 to 100,000. (Issued by the Biometric Laboratory, University of London, to commemorate the Tercentenary of Henry Briggs's publication of the "Arithmetica Logarithmica," 1624.) Pp. xviii + 100. (Cambridge: At the University Press, 1924.) n.p.

ON the appearance of the first section of this important book, it is appropriate to give some account of the evolution of logarithmic tables.

Henry Briggs, the computer of the first great table of logarithms, was born about 1556 at Warley Wood, a hamlet near Halifax, Yorkshire. He showed signs of mathematical ability at an early age, and proceeded to St. John's College, Cambridge, in 1579. Briggs was elected a fellow of his College in 1588 and remained there until 1596, when he became the first reader in geometry at Gresham College in London.

In 1614 Napier's first work on logarithms was published, the "Mirifici Logarithmorum Canonis Descriptio." This book came into Briggs's hands soon afterwards: he began to read it with interest, which was changed into enthusiasm by the time he had finished. He soon perceived that the system of logarithms which would now be described as having 10 for base would be more convenient in use than that on which Napier's system had been calculated. After describing this improvement to his classes, Briggs travelled to Edinburgh in 1615 and discussed it with Napier. He remained there a month as Napier's guest, and on his return to London busied himself in calculating logarithms according to the new plan. In 1616 he again visited Napier, taking with him the calculations he had made. The results of these calculations were printed in 1617, for the benefit of his personal friends, as "Logarithmorum Chilias Prima." In this rare brochure were given the logarithms of the first 1000 numbers to 14 decimal places. Specimen pages are reproduced as a frontispiece to the work now under notice.

In 1619 Briggs became the first Savilian professor of geometry at Oxford, settling at Merton College, and resided there for the remainder of his life. He continued to carry on his computing, and in 1624, after about eight years' labour, produced the "Arithmetica Logarithmica." This work contains the logarithms to 14 decimal places, together with their first differences, of all numbers from 1 to 20,000 and from 90,000 to 100,000. It is accompanied by a masterly introduction, in which the construction of tables, interpolation by means of differences, and other matters of the greatest importance were dealt with for the first time. Although this work is now very rare and costly, it is said that the edition of the tabular portion was too large and that surplus copies were hawked in the streets of London at eighteen pence each. After completing this great book, Briggs, with the help of a few friends, began to fill up the large gap of 70,000 logarithms which had been left. These were almost completed when, in 1628, Adrian Vlacq, a Dutchman, published the logarithms of the first 100,000 numbers to 10 decimal places, in a book which he also called "Arithmetica Logarithmica." Although Vlacq had only copied 30,000 logarithms from Briggs's book (cutting them down from 14 to 10 decimal places) and had calculated 70,000 himself, he described his work merely as a second edition. Briggs may have felt some disappointment at the way in which he had been forestalled by Vlacq: he seems, however, to have been relieved that the burden of printing 70,000 logarithms had been removed from his shoulders. In such circumstances most men would have given up computing; but not so Briggs. When about seventy years of age, he commenced another great work, the logarithms of the trigonometrical functions, and had almost completed it at the time of his death in 1631. Vlacq printed these logarithms at his own expense and published them in 1633 under the title of "Trigonometria Britannica."

No complete reprint of Briggs's great table of the logarithms of numbers has ever been made, and, up to last year, only two 10-figure tables have been published since Vlacq produced his table in 1628. The need for an extended table has long been felt, and the present work is intended to meet this need. Logarithms to a few figures are seldom used in present-day computation, and the modern calculating machines often fail to give results of sufficient accuracy without great expenditure of labour. In statistical and computing laboratories—especially where new tables have to be prepared for publication—the original Briggs or original Vega are in greater demand than more contracted logarithmic tables. Yet their high cost, their rarity, and uncorrected errors have long rendered new tables desirable.

No tribute more fitting than the publication of this new 20-figure table could be paid to the memory of a great man on the tercentenary of his greatest work. After extensive inquiries, the compilers have been unable to trace any portrait of Briggs for reproduction in the book.

The section now issued gives the first 20 figures in the mantissa of log N for each integer N from 90,000 to 100,000, together with second and fourth central differences for use in interpolation. First differences are not tabulated: their inclusion would have greatly

increased the bulk of the volume and rendered the cost of producing it prohibitive. It is intended to issue eight similar sections at intervals of a few months to include the range from 10,000 to 90,000.

Linear interpolation is sufficient to evaluate the logarithm of any number, given as a decimal, correct to 10 figures—and the calculation involved is slight. Methods for evaluating a logarithm to 15 or 20 decimals are described on the assumption that the computer has access to a calculating machine. Such machines are now used widely, and the amount of work involved is less serious than would appear at first sight. Naturally, a computer who undertakes calculations to 20 significant figures must be prepared for a certain amount of arithmetical labour. To evaluate log γ where $\gamma = 0{\cdot}57721\ 56649\ 01532\ 86061$, first put $\gamma/a = \gamma/0{\cdot}6 = 0{\cdot}96202\ 61081\ 69221\ 43435$, which is within the range of the tables. Next, $\gamma/a = 0{\cdot}96202\ 61 \times 1{\cdot}00000\ 00084\ 91683\ 78524 = bc$. Log b is found from log 96202 and log 96203 by Prof. J. D. Everett's central-difference interpolation formula. The numerical coefficients involved are taken from an earlier publication of the Biometric Laboratory, prepared by the same author (A. J. Thompson's "Table of the Coefficients of Everett's Central-Difference Interpolation Formula," Tracts for Computers, V., Cambridge University Press, 1921). A short supplementary table gives the logarithms of numbers between 10^{10} and $10^{10}+100$, and log c is obtained by interpolation between log $(10^{10}+84)$ and log $(10^{10}+85)$. Finally, $\log \gamma = \log a + \log b + \log c = \bar{1}{\cdot}76133\ 81087\ 83167\ 61054$, and this is correct to the twentieth decimal place.

Of the scheme which has been begun we have but one criticism to offer. We think the table should be extended so as to include 21-figure logarithms of integers between 100,000 and 110,000. The $(k+1)$th figure of N when $1{\cdot}0 < N < 1{\cdot}1$ has only the same significance as the kth figure in the main body of the table. If α, β are small and positive,

$$\delta = \log(1+\alpha) - \log(1+\beta) = \mu(\alpha-\beta),$$
$$\delta' = \log(1-\alpha) - \log(1-\beta) = -\mu(\alpha-\beta)$$

approximately. Since, however,

$$1+\alpha = 1{\cdot}0\ \ldots,\ 1+\beta = 1{\cdot}0\ \ldots,$$
$$1-\alpha = 0{\cdot}9\ \ldots,\ 1-\beta = 0{\cdot}9\ \ldots,$$

the tabulated value of δ, when k-figure logarithms are used throughout, will be ten times as great as the tabulated value of δ'. The value of the $(k+1)$th figure in the logarithm of a number just exceeding unity is apparent in many applications of the tables, *e.g.* in actuarial work and in stability problems in dynamics. This need has been recognised by the compiler of Chambers's 7-figure tables, which include 8-figure logarithms of numbers between 100,000 and 108,000.

Both Mr. Thompson and the Director of the Biometric Laboratory in University College (Prof. Karl Pearson), London, are to be heartily congratulated on the publication of this book, the former for his enthusiastic energy which has not been damped by the seriousness of the labour involved in calculating the table, and the latter for undertaking the production of it. Such an enterprise is not one of profit: a wide readiness on the part of the mathematical world to commemorate with the promoters the tercentenary of the "Arithmetica Logarithmica" can alone ensure the success of the venture.

Earthquakes and Geology.

La Géologie séismologique: les tremblements de terre. Par le Comte de Montessus de Ballore. Pp. xiv + 488 + 16 planches. (Paris: Armand Colin, 1924.) 50 francs.

TO those who value the work of M. de Montessus de Ballore, this posthumous volume will be a welcome surprise. It forms the third of a well-known series. The first, "Géographie séismologique," based on the distribution of 171 thousand earthquakes, was published in 1906. The second, "La Science séismologique"—the most detailed treatise that we possess on earthquakes in general—appeared in 1907. Then followed a long gap during which the author was mainly occupied in organising the Chilian Seismic Service. In the evening of his active life he has written the volume before us, the text of which he lived to send to the press, though the task of proof-correcting and the selection of the illustrations were done by others. M. Pierre Termier has contributed the preface, and M. Armand Renier a short biography of Montessus and a useful list of his books and memoirs.

"La Géologie séismologique" is less a treatise on the origin of earthquakes than a series of descriptions of important earthquakes with special reference to the phenomena of geological interest. Montessus divides earthquakes into two main classes, glyptogenic or geological and external dynamic earthquakes. The former are further rearranged into epeirogenic, tectonic, and epeirogenic and tectonic, according as the surface displacements are vertical, horizontal, or vertical and horizontal combined. Under the term external dynamic earthquakes are included volcanic earthquakes and rock-fall earthquakes (tremblements de terre d'écroulement). Between the two classes lie the majority of earthquakes, those which produce no apparent individual effect on geological structure, and which he therefore leaves unconsidered. He regards the connexion of these shocks with glyptogenic earthquakes as a very plausible induction and nothing more. Yet if, as in the Inverness earthquakes of 1901, the

epicentres can be traced shifting to and fro along a line of fault, if in their migrations they follow the same law as the after-shocks of the Japanese earthquake of 1891, the conclusion that they are glyptogenic is surely more than plausible. In any case, do not such earthquakes deserve consideration as much as purely volcanic earthquakes (to which 62 interesting pages are given), and more than rock-fall earthquakes, which are unimportant from a geological point of view?

The terms adopted by Montessus are, in one or two respects, unfortunate. The word *tectonic* has hitherto been applied to all earthquakes due to the growth or moulding of the earth's crust. There seems no valid reason for confining it to earthquakes connected with horizontal displacements. The name of the third class, epeirogenic and tectonic, is cumbrous. Terminology, however, is of less consequence than the classification implied, which is a useful one.

Under the heading of epeirogenic earthquakes are included the great earthquakes of New Madrid in 1811, Assam in 1897, and Kangra in 1905. The Chilian earthquakes of 1822, 1835, and 1837 would have been added if it were certain that they were accompanied by elevation of the land. But the author accepts Suess's arguments—which seem to me inconclusive—and considers that those who saw definite traces of elevation were mistaken. Possibly he would have revised this opinion could he have known of the recent observations in Japan (see NATURE, January 10, p. 65) on the later settling of elevated tracts.

Typical examples of tectonic earthquakes are the Owen's Valley earthquake of 1872, the Sumatra earthquake of 1892, and the Californian earthquake of 1906; those of epeirogenic and tectonic earthquakes are the New Zealand earthquakes of 1848 and 1855, the Japanese earthquake of 1891, and the Alaskan earthquakes of 1899. Of volcanic earthquakes, accounts are given, among others, of the Hawaiian earthquake of 1868, the Ischian earthquakes of 1883, etc., and earthquakes connected with various eruptions in Japan and the Philippine Islands.

The chapters in which these earthquakes are described form, roughly, two-thirds of the book. Of the remaining third, half is given to secondary glyptogenic effects of earthquakes, such as the isostatic readjustment of alluvial plains, the subsidence of coasts and submarine talus (including accounts of the Jamaica earthquakes of 1692 and 1907 and the Messina earthquake of 1908), and avalanches, effects on glaciers, etc. The latter half contains interesting discussions of some miscellaneous questions, such as changes in topography produced by earthquakes, the influence of geological conditions on the trend of isoseismal lines, the migration of epicentres, and the geographical distribution of earthquakes. The last two chapters might well have been longer; perhaps they were hurriedly finished in the closing days of the author's life. Of the migration of epicentres, two examples only are given, of the Calabrian earthquakes on a small scale, and of earthquakes along the unstable circum-Pacific circle on a large scale. A page or two on the migration of after-shock epicentres, which is merely touched on, would have been a welcome addition. As the author remarks, such a study would tend to nothing less than the prevision of earthquakes. Still more effective for the purpose would have been a study of the migration of fore-shock epicentres. For example, in those of the Japanese earthquake of 1891, the distribution of epicentres during the years 1890 and 1891 outlined the future zones of dislocation and clearly pointed to the coming earthquake.

There are few omissions of any consequence. Some have been suggested above, the principal one being the absence of reference to shocks of small intensity. In the account of the Ischian earthquakes, Johnston-Lavis's monograph is not mentioned. The important part played by after-shocks is not considered in detail. Such omissions, however, are of small account in comparison with the great service that the author has rendered. Here, under one cover, are gathered materials collected from widely scattered sources. Few, if any, writers have had Montessus's acquaintance with the literature of earthquakes, and there are not many libraries, either public or private, that contain all the works from which he has drawn his admirable illustrations. In no way is this last volume inferior to its two predecessors. To have produced it is a worthy ending to a life of unceasing labour in the cause of science.

C. DAVISON.

Egyptian Mummies.

Egyptian Mummies. By Prof. G. Elliot Smith and Warren R. Dawson. Pp. 190+65 plates. (London: G. Allen and Unwin, Ltd., 1924.) 25*s.* net.

PROF. ELLIOT SMITH and Mr. Warren Dawson have written a very interesting and useful book on mummies, which appears in a most attractive guise (except for some of the illustrations). Its outward show would seem to indicate that it is intended for the general reader who is "keen on" mummies and mystery rather than for the scientific student, but the latter will find in it much detail of purely scientific (and more especially pathological) interest, besides a sketch of the history of the practice in Egypt which, being written by the chief authority on the subject, can be accepted without question. The book takes the place of the old and out-of-date work of Pettigrew,

which hitherto has been almost the only treatise specially devoted to the subject, though the archæological reader will find a very useful chapter on the matter in Sir Ernest Budge's long out-of-print book, "The Mummy."

On the archæological side the book is unexceptionable, until the writers (as we fear was to be expected) launch into a dogmatic statement (rather than, as one would have preferred, a reasoned justification) of the now well-known "diffusionist" theory of the spread of all human culture from Egypt, even so far as America via Polynesia, of which Prof. Elliot Smith is the protagonist. They inform us, as if the matter were settled fact, that mummification spread via India to Malaysia, Torres Straits, Polynesia, and finally Peru and Mexico, "and became widely diffused in both continents of America" (pp. 164, 165). There is no peradventure in this matter for these authors: it is as settled a fact for them as is any religious dogma for its *croyants*; and is calmly assumed to be a known fact. Let it first be proved to be even a probable theory. It is not yet accepted as such by the archæologists. It may eventually be proved to be a probable theory; we do not say that it will not or cannot, because we have no *beliefs* on these subjects whatever: we consider *beliefs* about anything relating to the early history of man and the origins and diffusion of his culture to be totally unjustified and unscientific: one is still dimly groping in the dark of theories and hypotheses, not dealing with mathematical certainties. The "diffusionist" theory is just one of these hypotheses which *may* be true but cannot yet be proved to be so, any more than any other theory of the kind, and until it is proved so, should not be stated as uncontroverted fact, which it is not.

On the archæological side, the authors clearly state the extremely probable origin of mummification in the drying-up of the body in the hot rainless desert sand of the primitive Egyptians' graves, which first gave the idea of preserving the dead in the pathetic hope that they could in some muddle-headed way be made to live again. It was a protest against death, which the Egyptians loathed: "O ye who love life and hate death," begins the prayer which summons the living to come and bear their offerings of food to the tomb that the dimly imagined "double" or *ka* of the deceased might feed upon it and somehow "live." Then we are told how true mummification began with the addition of preservatives and bandages, first only in the case of the king and then of his nobles. The common people were not embalmed even in the most summary way until much later. Then we see how the practice grew and developed, until it reached its apogee in some respects in the time of the XVIIIth–XIXth Dynasties, though it was not until the XXIst that the mummy became a sort of human statue much like those proposed by Jeremy Bentham. Finally we see how it declined until Christianity abolished it, after a short struggle with those Egyptian Christians who wished to retain their ancient national practice.

Chapters on the funerary furniture and amulets of the mummy, the spells of the Book of the Dead, etc., are given, and a useful list of those kings whose tombs and mummies are known.

The pathological side of the inquiry is, of course, well represented, and physicians will find interesting the proofs of the existence of dental and tubercular caries, leprosy, Pott's disease, gall-stones, osteosarcoma, mastoid disease, talipes, and *Dystocia adiposo-genitalis* among the ancient Egyptians, to whom, however, syphilis seems to have been unknown. Prof. Elliot Smith gives several photographs of such pathological conditions.

The photographic illustrations are good, but the non-photographic ones are very unsatisfactory woodcuts after well-known photographs which surely might themselves have been used. Fig. 16 is a case in which one of the least unpleasing mummies has been made hideous in the woodcut, which is drawn from an admirable photograph. We are sorry to see these ugly blemishes in a most useful book. H. R. HALL.

Our Bookshelf.

Allen's Commercial Organic Analysis. Edited by Samuel S. Sadtler, Dr. Elbert C. Lathrop, and C. Ainsworth Mitchell. Vol. 2: *Fixed Oils, Fats and Waxes, Special Characters and Methods, Butter Fat, Lard, Linseed Oil, Higher Fatty Acids, Soap, Glycerin, Wool-fat, Cloth Oils, Sterol Alcohols.* Fifth edition, revised and in part rewritten. Pp. ix+807. (London: J. and A. Churchill, 1924.) 30*s.* net.

A PERIOD of fourteen years has elapsed since the publication of the equivalent volume in the last edition of Allen's "Commercial Organic Analysis." The reputation of this standard text-book is definitely upheld in the new volume. A comparison of the old and new shows that a thorough revision of data from the analytical investigation of fixed oils, fats, and waxes has been made, resulting in a considerable increase in the size of the book. A part of the increase is due to the fact that, while giving the latest and best methods, the older methods have in many cases been also intentionally retained. The section on the special characters and modes of examination of fats, oils, and waxes has been doubled in size and now covers nearly half the book, while some of the smaller sections show a fourfold expansion. Many subjects practically unknown in commercial analysis when the previous issue appeared (*e.g.* fermentation glycerin, vitamins, montan wax, etc.) have now their place in the new edition.

In the refined glycerin section, a reference is given

to the excellent "Ardeer Analytical Methods" book, but, so far as the reviewer is aware, this analytical process book is only available for private use in the Nobel Laboratories.

The book, which is printed in the United States, is excellently produced and the price reasonable compared with present-day standards. The increase in cost compared with the price of the former edition is less than proportional to the increase in size.

J. REILLY.

Evenings with the Stars. By Mary Procter. Pp. ix+212+8 plates. (London: Cassell and Co., Ltd., 1924.) 10*s.* 6*d.* net.

THIS work is not to be confused with the "Children's Book of the Heavens" by the same author. It is an entirely new work and is intended for amateur astronomers, and for those who wish to learn something about the constellations, both in their appearance in the sky, and in the wealth of legendary lore connected with them. Accordingly, the division is into twelve evenings or chapters, each dealing with a certain number of constellations near to one another in the sky, until the whole of the constellations visible in northern latitudes have been passed in review. The work is, in a spirit of filial piety, dedicated to the father of the author, the late distinguished astronomer, R. A. Procter, "who taught me how to know and love the stars." From him she has inherited another gift, that of lucid and interesting description.

Each chapter is illustrated by a series of very clear and well-drawn original charts, by means of which the reader and student is safely piloted through the constellations. After a description of the constellation, the chief objects of interest are pointed out, with many aptly-chosen illustrative quotations from literary and legendary allusions to such objects. Appended to the twelve chapters is an interesting poem, the "Voices of the Suns," by the father of the author. There is also an excellent index, and in addition eight beautiful plates of nebulæ. The frontispiece in particular is a fine reproduction of the great cluster in Hercules, as photographed at the Dominion Astrophysical Observatory with the 72-inch reflector.

The book, too, is very well printed. Both for its astronomical and its literary excellence it can be highly recommended, and is deserving of a wide circulation. It is the work, too, of an expert.

A. L. C.

The Soil and its Management. By Prof. Merritt F. Miller. Pp. vi+386. (Boston and London: Ginn and Co., 1924.) 7*s.* 6*d.* net.

PROF. MILLER'S book is designed for schools teaching vocational agriculture and for short-course students in agricultural colleges, and forms an admirable introductory course in agriculture. Little or no acquaintance with chemistry and other sciences is assumed. The author has succeeded notably in avoiding technicalities and has produced a most interesting and readable account of soils, soil fertility, and soil management without loss of clearness or accuracy.

The general arrangement is not very different from that adopted in most text-books dealing with the soil, but the treatment is unusually full for an elementary work, and the constant reference to farm practice and to observations and experiments which may readily be made on the farm and in the countryside is an attractive characteristic. At the end of each chapter there is a series of questions, together with skilfully selected practical exercises, both in the laboratory and in the field, and "home projects" for the benefit of the boy who lives on a farm. There are also references to more advanced books dealing with the various aspects of the subject. The numerous illustrations from photographs are another special feature: they are well reproduced and are very much to the point—particular mention may be made of the little series of pictures showing the crops in different rotations.

The author writes for American students and with American farming practice in view, and there is a good deal that is not directly applicable to conditions in Great Britain; but it is a work which all who have to do with the elementary teaching of agriculture will find most useful.

C. T. G.

Butterflies of India. By Chas. B. Antram. Pp. xvi+226. (Calcutta and Simla: Thacker, Spink and Co., 1924.) 30 rupees.

THIS book is intended for the uninitiated, and its primary object is to illustrate all the Indian butterflies, except a few which are very closely alike. More than 500 species are dealt with, leaving the Lycænidæ and Hesperiidæ for treatment in a second volume. A few notes on the collection and preservation of specimens are given, and the remainder of the book is occupied with short and, so far as possible, non-technical specific descriptions. The characters given for three out of the four families are popularised, we think, to the extent of inefficiency, while the Nymphalidæ are not diagnosed at all. Generic keys or tables are dispensed with, no doubt on account of the difficulty of translating them into non-technical language. The reader, therefore, needs to compare his specimens with the illustrations and descriptions until he alights upon the correct species. After a little practice he will probably experience no great difficulties in doing so.

The book is well produced and will, no doubt, prove to be a useful popular guide for the many collectors of these insects scattered through India. On p. 38 there is a description of a new species of Parnassius from Tibet: it is hoped that the author will also publish a technical diagnosis of the insect, if he has not already done so, in some scientific periodical.

Lehrbuch der anorganischen Chemie. Von Karl A. Hofmann. Fünfte Auflage. Pp. xiv + 761 + 7 Tafeln. (Braunschweig: F. Vieweg und Sohn A.-G., 1924.) 17·50 gold marks.

PROF. HOFMANN'S text-book has been carefully revised and brought up-to-date. It gives a clear and fairly detailed account of the subject along recognised lines, including the rarer elements, and will be found useful by advanced students. As in most German text-books, a section on explosives is added. It gives an impression that German students make a special study of this subject.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dutch Pendulum Observations in Submarines.

IN the letter from Mr. Bowie on the subject of Dr. F. A. Vening Meinesz's pendulum observations on board a submarine, which appeared in NATURE of December 27, 1924, p. 930, there is a passage which seems to me to suggest a wrong idea of Dr. Meinesz's method and thereby perhaps to engender doubts as to the possible accuracy of his results.

Mr. Bowie quotes the following pargraph from a paper which he presented at the Pan-Pacific Scientific Congress of 1920: "It is hoped that a satisfactory apparatus may be devised for determining the intensity of gravity at sea, using special vessels or commercial vessels. There are several types of apparatus in existence, but no one of them gives results of sufficient accuracy for the study of isostasy. The writer suggests that it may be possible to obtain a fair value of the intensity of gravity at sea by the use of the land apparatus properly mounted on a vessel. The apparatus would have to be swung in double gimbals and should be placed near the point of minimum translation resulting from the pitching and rolling of the vessel," and adds, "It was with great satisfaction that I read that Dr. Meinesz had accomplished the accurate determination of gravity at sea with the use of pendulums. No doubt he arrived at the conclusion that the pendulum could be used independently of my suggestion in 1920."

The passage gives the impression that Dr. Meinesz's method consists of so mounting the apparatus as to reduce the disturbance due to the pitching and rolling of the vessel to a negligible quantity. But this is not the method at all, and indeed one may reasonably doubt whether it would ever be possible to produce on board a ship a stillness at all comparable to that enjoyed by what the inhabitants doubtless consider the *terra firma* of the western part of Holland; yet in that region the instability of the ground is such that Dr. Meinesz found it impossible to obtain any result by means of the pendulum apparatus used in the ordinary way, as the disturbance of the time of oscillation of the pendulum caused by the movements of the ground was far too great. The same difficulty has been met by other observers in places where the conditions are similar to those found in western Holland.

To overcome this difficulty, Dr. Meinesz thought of the ingenious plan of swinging two pendulums simultaneously on the same stand. He showed by analysis that from observations of the times of swing of the two disturbed pendulums it was possible to deduce the time of swing of a hypothetical pendulum, the length of which is constant so long as those of the two real pendulums do not vary, and the time of swing of which is independent of the disturbances suffered by the real pendulums. The two pendulums are swung in the same plane and on the same support; that is to say, their knife-edges are parallel and the surfaces on which they swing are rigidly connected. The idea of the method, to state it quite roughly, is that the two pendulums suffer equal but opposite disturbances, so that a mean undisturbed value is deducible.

This method was found to give excellent results on the slightly unstable soil of Holland, and has also been found to give good results on a submarine where the instability, though much less than that of a ship floating on the surface, is nevertheless enormous compared with the least stable of the land stations.

I cannot believe that attempts to reduce the effects of a ship's movements by such devices as gimbals and the like would ever have been successful in freeing a pendulum, swinging by itself, from disturbances too great to be tolerable, but Dr. Meinesz introduces a new idea quite different from that of damping out the effects of the movements.

It is very desirable that the originality of Dr. Meinesz's method should be recognised and that he should have full credit as the sole inventor of a plan which seems to have solved the problem of the determination of gravity at sea.

G. P. LENOX-CONYNGHAM

Trinity College,
Cambridge, December 30.

On a Connexion between the Spectra of Argon and Ionised Potassium.

THE quantitative relations between the spectra of argon and ionised potassium have been for some time a subject of investigation in the Amsterdam Laboratory. The available observations are chiefly due to Schillinger (*Wiener Sitz. Ber.* 118, 605, 1909), McLennan (Proc. R.S., 100, 182, 1921), and Dik and Zeeman (*Proc. Kon. Acad. Amsterdam*, 1922, 1923). Schillinger used a spark for the production of the K^+ spectrum, McLennan, as well as Dik and Zeeman, the electrodeless discharge. Dik and Zeeman got a rather pure K^+ spectrum, because with very intense discharges the arc lines were entirely suppressed, a result at variance with that of other observers. The observations were obtained with a quartz spectrograph. The accuracy is, therefore, not sufficient for a scrutinising analysis, and observations with a grating spectrograph were projected.

Prof. Konen kindly informed us that in Bonn such measurements were already in hand, so that they were here postponed. From the preliminary observations, Dik and Zeeman concluded that, in the spectrum of ionised potassium, constant differences of about 847 and 1696 were present, and this would point to a connexion with the red spectrum of argon (Rydberg). Afterwards the present authors (De Bruin and Zeeman, NATURE, Sept. 6, 1924, p. 352) investigated the blue spectrum of argon (accurate measurements of Eder and Valenta), and it appeared that a difference of about 846 here is also characteristic, as well as about 414 also found with the spectrum of K^+. Afterwards we found that Paulson (*Astr. Journ.*, 41, p. 75, 1915) had also hit upon the difference of about 846 in argon. Recently, Dahmen (*Zeitschr. f. Phys.*, 29, 1924, p. 264), of Bonn, has published measurements on ionised potassium, using a large grating, and potassium electrodes in an atmosphere of argon. In his experiments the arc lines are not absent, but his results are far more accurate.

From an examination of this new material, we have come to the conclusion that the difference of about 847 is not characteristic and probably cannot be maintained. The difference of about 1696 is present, a more accurate value being about 1712. Instead of the difference of about 414, we now find 418·2 for ionised potassium.

We have found some groups of regularly distributed lines exhibiting also regular distribution of intensities, a fact of some importance for the further analysis, because the intensities are closely connected with the inner quantum numbers. In the "quintets," the second component has the greater intensity, surpassing

always the first and third component. These groups of lines allow us to conclude that in Dahmen's observations some lines are absent which are present in Dik and Zeeman's tables.

Some examples of " quintets " may be given here.

I.

I.	ν (Vacuum).		
2	20224·50	(D, Z)	
	1468·83		
5	21693·33	(G)	
	1089·05		
3	22782·38	(G)	
	417·95		
4	23200·33	(G)	
	473·01		
5	23673·34	(G)	

890·96 → 1507·00 ← 1980·01

II.

I.	ν (Vacuum).		
2	21753·81		
	1468·82		
3	23222·63	(G)	
	1089·18		
1	24311·81	(G)	
	417·82		
2	24729·63		
	473·22		
3	25202·85		

891·04 → 1507·00 ← 1980·22

III.

I.	ν (Vacuum).		
4	22189·68	(G)	
	1468·93		
5	23658·61	(G)	
	1088·79		
1	24747·40		
	418·25		
3	25165·65		
	473·14		
2	25638·79		

891·39 → 1507·04 ← 1980·18

IV.

I.	ν (Vacuum).		
6	24178·63	(G)	
	1469·17		
8	25647·80		
	1088·85		
2	26736·65		
	418·26		
6	27154·91		
	473·54		
5	27628·45		

891·80 → 1507·11 ← 1980·65

V.

I.	ν (Vacuum).		
(7)	23449·36	(G)	
	1468·76		
1	24918·12		
	1088·88		
0	26007	(D, Z)	
	418·23		
1	26425·23		
	473·50		
1	26898·73		

891·73 → 1507·11 ← 1980·61

(D, Z) means observed by Dik and Zeeman.

(G) refers to Goldstein's observations of the " Grundspectrum." Goldstein (*Verh. deutsch. phys. Ges.* 321. 1907; 426. 1910), who was the first to obtain the spectrum of ionised potassium, observed 16 lines in the red part of the spectrum. Ten of these lines are incorporated in the " quintets " given.

Further details will be published by one of us (de B.) on another occasion.

T. L. DE BRUIN.
P. ZEEMAN.

Amsterdam, December 29.

The Ages of Peat Deposits.

DR. W. H. PEARSALL'S article on this subject in NATURE of December 6 refers to the absence of definite forest layers in the Pennine peat, in contrast to the peat with tree layers described by Lewis and others. Dr. Pearsall appears to have overlooked the fact, however, that both the age and composition of mountain peat may differ considerably from that of marsh peat, in which tree layers are invariably found, and the presumption is that the Pennine peat to which he refers belongs to the former class. The absence of tree layers in mountain peat is general throughout Ireland, whatever it may be elsewhere. This is due, not to the elevation at which it is formed, but to the stratum on which it rests, and which is invariably a surface soil, not always waterlogged, but deficient in lime and other alkaline bases, and on which the ordinary decomposition of humus is retarded or checked altogether. Tree stumps of Scots pine and birch, and more rarely oak, occur under the mountain peat up to elevations of 1500 feet to 2000 feet, and in situations where trees could not attain a similar size or rate of growth to-day.

Dr. Pearsall states that tree layers are not necessarily an indication of climatic change, and I agree with him. But they are undoubtedly an indication of change in the soil or peat water upon which the tree layers subsist, and also of the level at which the water table stood when they were growing. These root layers invariably show a decreasing size and rate of growth the higher they stand above the water table of the marsh which gave rise to the peat formation. The question is somewhat complicated by the fact that in most mountain districts, marsh and mountain peat are intermixed over wide areas, the mountain peat covering the higher and better drained surfaces, and the marsh peat the depressions or hollows which were originally small shallow lakes. The former never contains definite root layers, the latter root layers up to the level at which the sphagnum peat was formed, indicating a point at which sterility prevented all plant growth except mosses, stunted heather, and similar plants.

So far as I am aware, few investigators distinguish between these two types of peat, and when tree layers are found in the shallow marsh peat of mountain districts, the fact is overlooked that they may be distinctly older than the mountain peat lying between them, and *under*, but *not in* which the tree stumps occur on the natural soil. It is highly probable that the mountain peat corresponds in age to the Submerged Forest period, and also to the margins of the deeper and larger bogs of Ireland and Scotland. In these margins Scots pine and oak are usually found mixed, but in the deeper layers oak is absent.

It is possible that considerable errors may arise by assuming that Scandinavian peat is of the same age as that of Ireland and Scotland. Existing peat could not have been formed until the final retreat of the ice sheet, but probably began immediately after that retreat in the form of plant growth in the shallow lakes and marshes. Thousands of years may have separated the final retreat of the ice from the British Isles and its retreat from Southern Scandinavia, and in the interval peat has been forming wherever the conditions were suitable, irrespective of climate, although climate must have affected its rate of growth. That peat formation is going on to-day can be seen in many parts of the north and west wherever stagnant water accumulates, or soil surfaces are leaching out. Neither the marsh peat in the one, nor the mountain peat in the other, is necessarily an indicator of climate, but the root layers in and under the marsh peat suggest that it is of a much greater age than the mountain peat so far as the lower layers are concerned. The sphagnum peat is evidently a more recent growth, and reaches a more or less definite height in relation to the average diameter of the bog.

A. C. FORBES.

Forestry Branch,
Dublin.

IN NATURE for December 6, 1924, Dr. W. H. Pearsall directed attention to the results which have recently been achieved in work on the Pennine peat of Yorkshire; and discussed some of the problems of correlation which arise. Several of the points raised demand further comment.

After enumerating and discussing the validity of the conclusions reached by Lewis for the Scottish Peat Mosses, Dr. Pearsall says: " Samuelsson has

reinvestigated the Scottish deposits and his main conclusions agree with those of Lewis." This statement might almost be described as a travesty of the facts. Samuelsson (Bull. Geol. Inst. Upsala, Vol. X. pp. 197-260) does indeed confirm the general *succession* established by Lewis; but even in this there is not entire agreement. (See, for example, p. 222.) Lewis's main conclusions are surely contained in his correlation of the peat succession with the later glacial and interglacial periods of the system devised by James Geikie; and with this correlation Samuelsson disagrees. In the early part of a critical discussion (see especially pp. 217-226) he says: "Lewis has started from Geikie's point of view and endeavoured to bring his results into accordance with Geikie's opinion as much as possible. But by holding one-sidedly on to the correctness of Geikie's classification of the late quaternary history of Scotland, Lewis has been led to some conclusions that are certainly wrong."

The arguments of Geikie and Lewis for the interglacial age of part of the Scottish peat may be summarised thus:

(1) A submerged forest (with present day flora) underlies the carse lands of the Forth and Tay.
(2) These carse lands rise inland and pass into the gravels of the 45-50 ft. Raised Beach.
(3) Moraines have been seen resting on this beach.

Therefore, the Submerged Forest is earlier than the glaciation represented by the moraines. The Submerged Forest is taken to be represented in the Scottish peat by the Lower Forestian, the glaciation by the 2nd Arctic Bed (Lower Turbarian), a subsequent emergence by the Upper Forestian, and a further submergence (25 foot Beach) by the Upper Turbarian.

This beautifully sequential argument is utterly destroyed by the following considerations:

(1) There is no contemporaneity between the carse lands of the Forth and Tay and the gravels of the 45-50 ft. beach.
(2) There is no independent evidence for the emergence which is supposed to be represented by the Upper Forestian; and, in any case, Samuelsson has pointed out that no such emergence is necessary.

Not content with quoting results based on a miscorrelation, Dr. Pearsall states: "Now along the Scottish coasts, the submerged forests are replaced by the 40-50 ft. beaches, also of Neolithic date. . . ." This is confusion worse confounded indeed! It is not that the results and conclusions of later workers are hidden away in obscure and widely scattered journals. On the contrary, in Wright's "Quaternary Ice Age" (chap. xvi.) there is a delightfully clear, concise and well-written presentation of the evidence bearing on the raised beaches and submerged forests of the British Isles. Here it is plainly stated that there exists in Scotland a group of raised beaches, ranging from the 100 ft. to the 40 ft. level, which are in part contemporaneous with the existence of large glaciers; and that these are separated from the 25 ft. raised beach of Scotland, Northern England and Ireland, by a period of emergence in which the submerged forests grew. It is to this ("25 ft.") period of submergence that the carse clays of the Forth and Tay belong, and these clays, as well as the associated beach gravels, have been proved, in all cases where the relation can be observed, to overlie the Submerged Forest.

The 25 ft. beach contains Campignien implements exactly similar in type to those which are found associated with the kitchen middens of the maximum of the Littorina depression in Scandinavia: and, in Scandinavia, this Campignien industry is associated with pigmy flints of Tardenoisien type. This evidence appears to contradict Clement Reid's assignation of a Neolithic date to the submerged forest, which is quoted by Dr. Pearsall. In this connexion, however, it must be remembered that Clement Reid was not speaking of the submerged forests of Scotland and Northern England, and also that the submerged forests increase in number and in depth outwards from Scotland. The uppermost submerged forest of Southern England and Wales appears to be of Neolithic or even Bronze Age, but it is possible that the Scottish submerged forest, of which the pre-Tardenoisien age is undoubted, represents the lowest submerged forest of the areas further south.

Now Dr. Pearsall tentatively correlates the Submerged Forest with the birch forest at the base of the Pennine peat, and suggests that its destruction coincided with the colder climate assumed for the Lower Turbarian. Dr. Woodhead, however (*Journ. Bot.*, Oct. 1924, p. 303), does not assume any increasing cold to account for the destruction of this forest. Further, if the Pennine forest lies above sand containing relics of a Tardenoisien industry, and the Submerged Forest lies below gravels of the same date, the two cannot be contemporaneous.

It is, of course, very desirable that correlation should be attempted, but, until Dr. Pearsall can build on better and on sounder foundations than he has done, it seems a pity that the very beautiful and precise work done by Mr. Holmes, Mr. Buckley and Dr. Woodhead should be obscured by such speculations.

LAURANCE H. TONKS.

Manchester, December 12, 1924.

MR. TONKS raises some interesting points to which further reference seems to me desirable, in regard to my article on the ages of peat deposits. That article refers to the peat horizons recognised by Lewis in Scotland and uses the names which Lewis adopted. It points out that these "roughly correspond" to Geikie's well-known climatic periods. Mr. Tonks appears to assume from this that I have accepted and argued from the whole of the implications of the Lewis-Geikie system. Nothing could be further from the truth. Mr. Tonks then apparently accuses me of declaring that Samuelsson has agreed with these implications. It is, in fact, evident from the paragraph in which my reference to Samuelsson occurs—that the points of agreement between Samuelsson and Lewis to which I refer are the nature of the Scotch peat succession, its widespread character and its possible relation to climate. My opinion that these are the main conclusions to be drawn from the work of Lewis remains unshaken. The article further refers to the "submerged forests round the English coasts" and not to those known in Scotland, to which Mr. Tonks refers at length. There appears to be no clear evidence that the English and Scotch submerged forests are of the same age although the suggestion Mr. Tonks makes is quite possible. Much of Mr. Tonks's letter is thus based on misinterpretations and misunderstandings.

One of the objects of the article was to indicate, so far as possible, that if one attempts to correlate the results of the British and Scandinavian peat investigations, then the results throw considerable doubt on what may be termed the climatic hypothesis of peat stratification. This result is actually obtained whether the age of the Scotch peats is estimated through the 40-50 ft. beaches, a doubtful method as Mr. Tonks shows, or through the 25 ft. beaches. In the latter

case, according to Lewis, the mosses in Southern Scotland lying on the 25 ft. beaches have a basal layer of shrub remains (largely birch) above which are peat layers chiefly composed of Eriophorum. This stratification agrees with that of the upper layers of the older mosses further inland. The wood layer *may* thus approximate to that of Lewis's Upper Forest layer, and since the 25 ft. beaches are about Campignien age, the Upper Forest would be approximately Neolithic. On the climatic hypothesis, this might be held to suggest that the Neolithic period was relatively warm and dry in Scotland—agreeing on the whole with the Scandinavian conclusion. Yet in the Pennines this period appears to have been one of forest destruction and peat development, which would, on the climatic hypothesis, require cold and moist conditions.

The whole point of these attempted correlations, so far as I am concerned, is that on whatever they are based, they result in throwing doubt on the hypothesis that peat stratification is, in Britain, an indication of climatic change. The method employed in the original article results in the correlation of Lower Turbarian (presumably cold and moist) with the destruction of the Pennine Forest. While this is better so far as Britain is concerned, it means on the climatic hypothesis that in Neolithic Britain conditions tended to be cold and moist, while in Scandinavia they were relatively warm and dry. The point of my article as expressed in the last two paragraphs remains just as clear if the Scottish peats are wholly ignored. They represent, however, the chief British evidence for the climatic theory of peat succession, and hence the attempt was made to include them, though admittedly nothing but the establishment of cultural horizons can give an adequate basis for this correlation.

W. H. PEARSALL.

Acid-base Titrations and Equilibria of Weak Bases and Acids.

IT has been supposed in the past that substances with feebly acidic or basic properties, say with K_a or K_b less than $2{\cdot}5 \times 10^{-9}$ in the case of N/20 dilution, are incapable [1] of estimation by acid-base titrations. I have recently succeeded in elaborating a technique by which this object can be attained: the main principles involved are set out below.

The titration of strong acids or bases in the presence of indicators depends on the steep (and maximal) gradient in the degree of acidity (hydrogen ion concentration, P_H) at the "end-point" in the neutralisation. Thus, with a fairly strong base the P_H during a titration is governed by the well-known mass-law approximation,[2]

$$p_{Kw} - p_H = \log \frac{1}{[OH']} = \log \frac{1}{K_b} + \log \frac{[\text{Acid added}]}{[\text{Base remaining unneutralised}]} \quad (1)$$

from which can be deduced the indicator with most suitable transition zone for the titration. An analogous equation holds for the titration of fairly strong acids.

Equation (1) rests on the assumption that all the acid added to the weak base goes to form a completely dissociated salt and that the free base is itself non-ionised. The first assumption is no longer true with a very weak base having a dissociation constant commensurate with that of water: a highly acid solution is formed, a large fraction of the added acid is uncombined with the base, and the effect of the acid on the solute is masked by its effect on the solvent, no end-point being shown when P_H is plotted against added acid. This difficulty has been overcome by a formula and method of approach already applied by the writer to amino-acids and polypeptides.[3] From each value of "Acid added" is subtracted the amount present in the free state, which can be calculated from the equation

$$[H\cdot] = \alpha[\text{free HCl}], \quad . \quad . \quad . \quad (2)$$

where α is known and $[H\cdot]$ is the quantity determined experimentally; and it is found that the formula so modified becomes strictly applicable to the very feeblest bases, and the corresponding modified formula equally applicable to acids. The *modus operandi* of the technique is to determine the volume of standard soda or hydrochloric acid required to titrate the solute over a given P_H range or to a given P_H end-point: for any given K_a or K_b value this is directly proportional to the amount of solute present. With the simplified apparatus now available, such as the Cambridge Instrument Co.'s portable outfit and Mr. S. W. Cole's hydrogen electrode, a complete electrometric P_H determination can be carried out within the space of several minutes.

The theory has now been tested in detail in relation to some thirty acidic and basic groups. The accuracy obtainable is found to be of the same order as that of an ordinary acid-base titration by the old-fashioned method. Thus the very feeble second basic group in arginine ($K = 1{\cdot}2 \times 10^{-12}$) may be estimated with an accuracy of at least 1 part in 100 in, say, M/20 solutions; while the P_H during the course of a titration may be predicted to within 0·02 P_H units, that is, with an accuracy comparable with that attaching to the experimental reading. With mixtures of acids or bases of different strengths the corrected amounts of alkali (or hydrochloric acid) required to titrate over a given P_H range is the sum of the amounts for each acidic or basic group.

Utilising this fact, I have been able to resolve a compound titration curve into its various components and estimate each of a number of acids and bases or ampholytes present simultaneously in a mixture, even when the respective K_a and K_b values are sufficiently close to cause partial overlapping of the individual titration curves. In order to estimate a given substance, it is not essential to know the exact K_a or K_b values when once its P_H combination curve has been determined; and on this basis I have been able to make accurate determinations of proteins in solution. Details will shortly be published (Proc. Roy. Soc., B.). Other applications have included investigations of the molecular weight and chemical constitution and dissociation constants of several bodies of biochemical interest, and the detection of chemical changes (*e.g.* the disproof of the theory of acid or base addition at peptide linkage in dipeptides) particularly those occurring during denaturation and enzyme hydrolysis.

An experimentally determined "correction for blank" has previously been arbitrarily used by Tague [4] for the action of soda on amino-acids, but without reference to the titration theory, mass law equation, K_a and K_b values, or prediction of titration curves.

In deducing differential expressions for buffer value, Van Slyke [5] (1922) independently made use of a formula which is similar to the present writer's, but in which no account is taken of the incomplete dissociation of the titrant. The effect of the latter on the accuracy of the formulæ is evident from the

[1] J. Chem. Soc., vol. 119, pp. 140, 136 (1921).
[2] *Biochem. Z.*, vol. 78, p. 112 (1917).
[3] Proc. Roy. Soc., B, vol. 95, pp. 440-484, 500-522 (1923-4); J. Chem. Soc., vol. 123, pp. 3294-3303 (1923).
[4] J. Amer. Chem. Soc., vol. 42, p. 173 (1920).
[5] *J. Biol. Chem.*, vol. 52, p. 525 (1922).

following values for the second basic dissociation "constant" of arginine calculated from the experimental P_H values.

P_H.	$p_{K_2'}$. Harris's Formula.	Van Slyke's Formula.
3·14	11·90	11·89
2·52	11·90	11·88
1·84	11·90	11·75

It was shown[3] that for amino-acids, results sufficiently accurate for most purposes could be obtained if α in equation (2) were taken as 0·9 when concentrations less than N/10 were dealt with. As recently emphasised by Cohn, P_H determined electrically is a measure of hydrogen ion "activity" rather than "concentration." I have obtained results sufficiently accurate for analytical purposes by taking for α Noyes and McInnes'[6] figures for the activity of KCl of the same concentration as that of the total HCl (titrant) added at each stage in the titration. Similar conclusions have been reached in titrating weakly acidic groups with soda. For highly accurate theoretical purposes I have calculated values of α for use in the presence of weakly basic or acidic groups of amino-acids from Sorensen's very careful P_H determinations of glycine—HCl and —NaOH buffers. My theoretical investigations relate mainly the one acidic and one basic group in glycine, and the one acidic and two basic groups in arginine: it is intended to publish a detailed report in due course.

LESLIE J. HARRIS.

School of Biochemistry, Cambridge,
and Carrow Research Laboratory, Norwich,
December 16.

The Ages and Masses of the Stars.

IN his article on "The Ages and Masses of the Stars" (NATURE, December 6, 1924), Dr. J. H. Jeans, to account for the source of stellar radiation, considers the possibility of positive and negative charges falling together, annihilating each other, and passing away "in a blaze of glory," thus setting free enormous amounts of "sub-electronic" energy. Proceeding, he says, "Nothing in the suggestion appears to conflict with modern atomic physics" and gives his reasons.

This may be very true, since we have nothing to disprove such a theory; but to make an assumption of such a fundamental nature, and, as it seems to me, on insufficient grounds, is rather disconcerting to a conservative mind. It requires some imagination to think of an electron and a nucleus, the properties of which are so vastly different, as "cancelling" one another.

The author's one strong argument in favour of his theory is based on the loss of the mass of stars as obtained by Eddington (cf. NATURE, May 31, 1924). In support of his theory of the annihilation of matter, Jeans makes the highly contestable statement, that "we know of no normal process by which mass can escape except by radiation, whence we conclude that the diminution of mass is the equivalent of the energy radiated away." Objection to this can immediately be raised on the ground that we have direct evidence of a stellar body losing mass, in the case of the tails of comets. Moreover, it has been shown by Gouy (*Comptes rendus*, 157, 186, 1913) and Page (*Astrophys. Journal*, vol. lii. No. 2, September 1920) that, in the case of an atomic vibrator, the radiation pressure may very well exceed the gravitational attraction on the surface of our sun. It is, therefore, quite imaginable that the sun is losing mass from its surface in this way all the time. In a greater degree would this be the case on hotter stars, even though much more massive than the sun.

On the other hand, if we reject Jeans's hypothesis, we rob him of his nearly unlimited supply of energy; but could this not, in a small way, be compensated for by attributing to the stars a high degree of radioactivity, this source of energy, I take it, not having been included by the author in his computation of the "super-electronic" energy of the stars?

T. SCHUMANN.

Sloane Laboratory, Yale University,
New Haven, Conn., U.S.A.,
December 17.

THE merit I am inclined to claim for my hypothesis of sub-electronic energy is that this one simple hypothesis clears away a whole tangle of astronomical difficulties. The hypothesis may strike the physicist as unproved and unprovable, as it certainly is, but I think the following considerations will show that it ought not to be dismissed as fantastic.

A gram of every substance (except hydrogen) contains 3×10^{23} negative electrons and a corresponding quantity of positive electricity. Each gram of the sun's mass radiates 60 million ergs per annum, so that if sub-electronic energy is not drawn upon, each of these electric charges must fall through an average potential difference of 0·0012 volts. The fall for one year does not look big, but radiation for 10^9 years requires an average fall of 120,000 volts, representing a fall from infinity to only 10^{-12} cm. from a charge $\pm e$. The figure of 10^9 years is the absolute minimum that can be considered; evidence from the orbits of binaries and from the approximate equipartition of energy in stellar velocities calls rather insistently for 10^{13} or even 10^{14} years. Also giant stars radiate anything up to a thousand times as much per unit mass as our sun. It would be possible to find tolerably good reasons for replacing the above figure of 120,000 volts by 12×10^9 volts, and 10^{-12} cm. by 10^{-17} cm. If we have to contemplate positive and negative charges getting as near to one another as this, it would seem that they might as well go a bit farther. To my mind it is easier to imagine a few charges stumbling into one another than to imagine a whole lot falling through these enormous potential differences and then stopping.

Radioactive energy and energy of nuclear rearrangement can, of course, be covered by an argument of the same general type, except that we have to picture charges of the same sign starting at these infinitesimal distances from one another. There is nothing impossible in it, but neither, I claim, is there in the hypothesis of mutual annihilation. The inadequacy of the highest degree of radioactivity known to us has been pointed out by Lindemann and others, but it has to be conceded that substances of far higher radioactivity may exist in the stars.

A comet's tail can lose mass, and this loss of mass may be permanent, because the comet's own gravitational field is slight in comparison with the general field of the sun, but the conditions are different for a body of stellar mass. So soon as a particle expelled by radiation pressure loses or changes its period of vibration, it will fall back into the star. A cosmogony based on the conceptions suggested by Mr. Schumann would seem to me to create more difficulties than it removes, but others may think differently. Mr. Schumann's cosmogony would certainly fit in well with Prof. Lindemann's theory of the nature of spiral nebulæ.

J. H. JEANS.

[6] J. Amer. Chem. Soc., vol. 42, p. 239 (1920).

London Fog of January 11-12, 1925.

THE accompanying curve (Fig. 1) indicates the variation in the quantity of suspended impurity in the air of Westminster during the recent fog. There was nothing very abnormal until the night of Saturday, January 10, when the suspended impurity, instead of gradually falling in the afternoon as it usually does, commenced to rise at about 5 P.M., reaching about 2 milligrams per cubic metre by 9 P.M. This level of impurity was maintained until midnight, when the normal fall occurred to a minimum of less than 0·5 milligram per cubic metre at 5-7 o'clock on Sunday morning. After this the impurity rose rapidly until it passed beyond the scale of the recording instrument at 3 o'clock on Sunday afternoon. It remained at this abnormally high level, which was more than 6·5 milligrams per cubic metre—probably approaching 10—until 7 P.M., when a gradual fall commenced, which was maintained fairly steadily until 5 o'clock on Monday morning, when the impurity was a little more than 0·5 milligram. The same rapid increase in impurity again began on Monday morning about 7 A.M., reaching a maximum of a little less than 4 milligrams per cubic metre at noon. This was maintained until 3 P.M., when there was a rapid fall until 6 P.M.

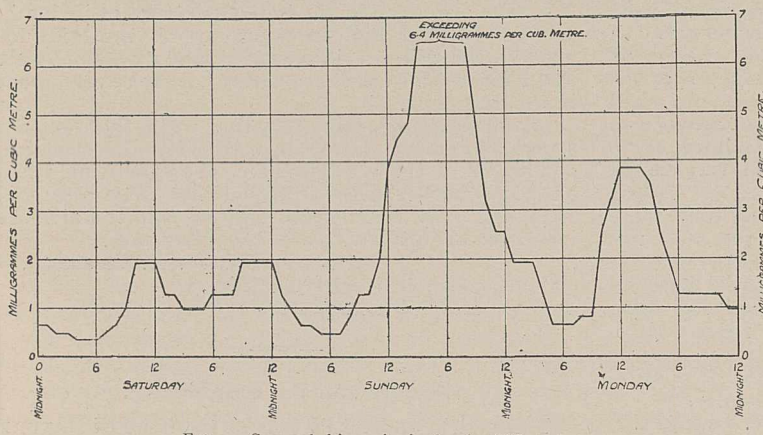


FIG. 1.—Suspended impurity in the air of Westminster, Saturday, January 10—Monday, January 12.

There were one or two interesting points noticeable in this fog. A dust record at 11 o'clock on Monday morning showed a reading of nearly 30,000 particles per c.c. Unfortunately, no dust counts were available for the maximum period on Sunday, but there is usually a relation between the impurity recorded automatically by filtration and the dust count, indicating that about 8000 to 10,000 particles per cubic centimetre correspond to 1 milligram per cubic metre. On this basis there must have been something approaching 100,000 particles per cubic centimetre during the height of the fog on Sunday.

Dust records taken 11 miles south-west of London, at Cheam, on Sunday afternoon, gave 15,000 to 16,000 soot particles per cubic centimetre, varying in diameter from 1·5 microns down, the average being about 0·7 to 0·8 micron. There were a few spherical particles and also a few drops of yellow oily-looking liquid, doubtless tar.

A dense record from 1000 cubic centimetres of air showed a number of dried-up stream beds blown out from the sides of the dust trace and formed by the water particles of the fog, and in the heads of these dried-up streams a large quantity of crystalline matter, in the form of skeletal crystals. The record itself was a thick, black line.

A microscope slide exposed from 4·37 to 4·55 P.M. and afterwards examined showed an extraordinarily rapid rate of settlement, the number of particles settling per square centimetre per minute at that time amounting to 80,000.

A cover glass exposed from 5·4 to 5·24 P.M. in the same way showed a deposit at the rate of 75,000 particles per square centimetre per minute. These particles were not water drops but solid matter and varied in size from about 1·5 microns down. There were a few small spheres. Most of the particles were in the form of aggregates, but very few showed any indication of having been held in the water drops. There were a few scattered particles, apparently crystalline in structure, and about 1·5 microns in diameter, which formed the centre of groups of smaller particles, suggesting the dried-up site of the impact of a drop. The formation of aggregates and the entire absence of wind may be the cause of the exceptional rate of settlement, as the number settling was much greater than would be accounted for by the normal deposit of particles of a diameter of about 1 micron.

On Monday morning the leaves and twigs in the hedges were covered with thick hoar frost which was brown in appearance. A slide left out overnight was covered with ice which, when melted, gave a pool of black water; the roads were coated with a dark scum which, on the pools of water, showed as an iridescent oily-looking film. It is very obvious that we were getting the London smoke in almost as great quantity as in a moderate London fog.

It would be of interest if any readers of NATURE living between south and west of London observed the phenomenon of this black deposit or discoloured ice crystals.

J. S. OWENS.
Advisory Committee on Atmospheric Pollution,
47 Victoria Street, Westminster, S.W.1,
January 14.

The Discovery of Argon.

SIR J. J. THOMSON'S reference to the discovery of argon, in his review in NATURE of December 6 of the life of Lord Rayleigh, will be read by chemists with surprise but without conviction, and though his comments upon chemistry must be received with the respect due to a late president of the Royal Society, they must also give rise to a certain amount of amusement. It is, however, with positive pain that many chemists have read Prof. Armstrong's letter upon this subject published in NATURE of January 10. What does he mean by "behind the scenes" and "Ramsay and his ways"?

As to the award of the medal, Prof. Armstrong omits to refer to Lord Rayleigh's speech on receiving it. This is printed in the Proceedings of the Chemical Society, from which I quote as follows: "Lord Rayleigh, on receiving the medal, said that, in returning his thanks to the Society, he was somewhat embarrassed, because he felt that there ought to be another standing by his side . . . the credit for it must be

shared equally between Professor Ramsay and himself. In some quarters there had been a tendency to represent that antagonism existed between chemists and physicists in the matter, though such a thought had never entered his head. Professor Ramsay was a chemist by profession, while he himself had dabbled in chemistry from an early age, and had followed its development with very keen interest."

I returned from France to Ramsay's laboratory as an assistant in the autumn of 1894, and the first words he said to me, after shaking hands, were, "Well, it is a new gas." From April 1895 I was daily associated with him for years, and I have heard the early history of the discovery told many times. This I know for a fact: when Ramsay communicated his preliminary results to Lord Rayleigh, he placed them at his disposal, but Lord Rayleigh was equally willing to allow Ramsay to go forward with the work alone. I do not believe that either of these two great men ever felt the slightest regret that the discovery was shared. As a matter of fact, if neither of them had discovered argon their reputation would be scarcely less enduring.

Even during the preliminary stage, there were attempts to disturb the friendly relations between the two discoverers. A well-known chemist called on Ramsay, and after being shown everything, after the manner of Ramsay, went home and wrote to Lord Rayleigh, telling him that he must place no reliance on Ramsay's work. Lord Rayleigh sent the letter on to Ramsay, with a brief comment, which Ramsay passed on to the author. Later the "Suum cuique" letters in the *Chemical News* showed chemists that there were people in their ranks capable of the most unworthy actions.

However, Ramsay, when alive, knew well when to meet and reply to criticism, and when to "Lat them say." Ramsay, dead, will not suffer from attacks directed from "behind the scenes"; but it may be hoped that the pages of NATURE will not be open to those who would discredit him in this manner.

MORRIS W. TRAVERS.

147 Queen Victoria Street,
London, E.C.4, January 12.

The Possibility of reproducing the Electrical Conditions of the Nitrogen Afterglow.

IN a paper by Johnson and myself (Proc. Roy. Soc. A, vol. 106, p. 200) on the effect of argon on certain spectra, attention was directed to structural modifications induced in the CH band, λ4315, and in the CN bands, these being similar to changes observed by Strutt and Fowler (Proc. Roy. Soc. A, vol. 86, p. 116), when these spectra were stimulated in the afterglow of nitrogen. In a recent paper by Johnson (*Phil. Mag.* vi., vol. 48, p. 1069) further evidence has been adduced for the similarity of the electrical conditions obtained in the afterglow to those existing when mild uncondensed discharges are passed through high-pressure argon. In particular, an energy displacement in the first positive band spectrum, as developed in a tube containing a little nitrogen in the presence of high-pressure argon, was regarded as the analogue of the selection of three of the more refrangible heads in the several groups constituting the visible spectrum of the afterglow. The energy displacement was related quantitatively to the percentage of nitrogen in the nitrogen-argon mixture. If the analogy can be sustained, it should follow that the intensity maximum in the several groups of the afterglow spectrum will be displaced a little towards the violet end as the afterglow is dying away (that is, as the percentage of activated molecules diminishes).

To test this, the spectrum of the afterglow has been photographed through a neutral wedge at two points about 7 inches apart in a glass tube, through which a stream of glowing nitrogen was pumped. Owing to the comparatively small light gathering power of the spectrograph, photographic exposures of 16 and 40 hours respectively were necessary, and even then the intensity was insufficient to permit of quantitative measurement of the plates. A close comparison, however, indicated no pronounced energy displacement.

Attempts have also been made to reproduce the β-group of the afterglow spectrum from discharge tubes containing nitrogen and argon, but no positive results have been obtained. Incidentally, I have examined the spectrum of the light from discharges through ammonia in high-pressure argon, in the hope of obtaining the spectrum of the afterglow when atomic nitrogen (arising from the destruction of the NH_3 molecule) returned to the molecular state. There was no evidence, however, of either the characteristic α or β groups occurring.

I have also excited the band spectrum of iodine in the presence of high-pressure argon, but did not observe the relative intensity changes which Strutt and Fowler record as characteristic of the development in the afterglow.

It would appear, therefore, that while there remain several points of resemblance between the electrical conditions of the afterglow and those existing when a mild discharge is passed through high-pressure argon, there are many specific effects of the former which are incapable of reproduction in the latter case.

W. H. B. CAMERON.

The Queen's University, Belfast,
December 22, 1924.

Science and the Community.

THE article under this title in the issue of NATURE of January 3 refers to the small part played by scientific men in public affairs and in business life. I think that the explanation of this is simple. One man has a fixed amount of daily energy. If he makes a great effort in one direction his effort in another direction is correspondingly weak; and so, in general, one man cannot excel in more than one direction.

Now a successful business man, or, even more so, a politician, owes his success almost entirely to his powers of divining the wishes and thoughts of that strange creature—man. A man of science, however, is dealing with an inanimate world which cannot be influenced by tact, persuasive powers, or individuality. Consequently, in general, those personal qualities and mental characteristics which lead a man to success in business have no relationship at all to those which lead to success in scientific work. In fact, the inexactitudes and tactful misrepresentations characteristic of the business and political world are excessively distasteful to a man trained in the clear honesty and rigour of scientific thought, and put him at a positive disadvantage compared to his commercial fellow-man when engaged upon delicate negotiations of any sort.

In general, a man who has worked for years studying physics and higher mathematics will be much less tactful and much less persuasive, and will probably be a worse judge of character, than a man who has spent an equally strenuous number of years in persuading people to buy something which they do not really need.

GEOFFREY MARTIN.

Rosherville Court, Burch Road,
Gravesend, January 5.

The Propagation of Wireless Waves of Short Wave-length round the World.

By Dr. J. A. FLEMING, F.R.S.

QUITE the most important of the pronouncements of the past year in connexion with wireless telegraphy were the two addresses given by Senatore Marconi to the Royal Society of Arts, London, in July and December, and also a paper by Sir Joseph Larmor, in NATURE of November 1, and the *Philosophical Magazine* for December last, on the theory of wireless transmission round the world. Senatore Marconi gave details in July of his remarkable achievements with electric waves of relatively short wave-length, and in December of his discovery that waves of only 30 metres in length, or about 100 ft., can be used for reliable communication by day as well as by night over any distance, even to the antipodes, although entire continents and mountain ranges intervene (see NATURE, September 6, p. 359, and December 27, p. 939). In this most important advance, he has certainly priority of achievement, as he had in 1901, in long-wave transmission across the Atlantic. When in 1902 Senatore Marconi discovered the great difference in range between day and night transmission with long waves across the Atlantic, it at once became clear that wireless transmission involved not only the ether of space round the earth, but also that the atmosphere itself, and especially, its state as regards illumination by sunlight, had a great deal to do with the matter.

In the years that followed, radio engineers came to the conclusion that the best prescription for achieving regular commercial radiotelegraphy at all times of day and night over long world-distances was by increasing the wave-length and power. Hence between 1902 and 1922 the demand for long distance radiotelegraphy involved the erection of large high-power all-round stations with great aerials sending out electric waves 30,000 to 60,000 ft. in wave-length, and using power from 500 to 1500 horse-power or more. The latest example is the 1000-kilowatt British Government radio station now being erected at Rugby.

The inhabited land area of the world being chiefly confined to one-half of the terrestrial globe, and the useful long wave-lengths being included within somewhat narrow limits, it is clear there is not an unlimited possibility of putting up all-round super-power radio stations without risk of interference.

Accordingly, so far back as 1916, Senatore Marconi began to consider the alternative of exploring the utility of the other extremity of the wireless spectrum or gamut of wave-lengths, and using waves more nearly 100 to 300 ft. in wave-length projected as a beam by skeleton parabolic mirrors of vertical wires. It was well understood that when using such mirrors, the wave-length employed must be less than the aperture and height of the mirror, and constructive difficulties placed a limit on the mirror dimensions. Hence for beam projection short wave-lengths were essential. In 1916, experiments were conducted by Marconi in Italy with such short-wave beam radiotelegraphy for war purposes; and later in England, with the able assistance of Mr. C. S. Franklin, important results were obtained in radiotelephony by 15-metre waves between London and Birmingham. The achievements between 1916 and 1922 described in published papers by Senatore Marconi and Mr. Franklin in 1922, amply demonstrated the practical value of these short waves of 100-metre wave-length or less. In 1923, a series of tests by Marconi and his assistants on his yacht over long world-distances showed that communication could be established by these waves from Poldhu to Australia, but that the 100-metre wave had a markedly greater range by night than by day.

In October of 1924, Marconi discovered that the daylight range increased very rapidly as the wave-length was reduced from 100 to 32 metres, or say from 300 to 100 ft.; and that perfect communication could be established for all hours of the day and night between England and Australia by the 32-metre wave when using only 10 or 12 kilowatts (say 15 h.-p.) in the transmitter.

Apart altogether from the immense practical importance of this discovery, it raises scientific questions of high interest as to the mechanism by which these waves travel round the world. It is now quite clear that normal wave diffraction is not sufficient. The signal strengths at large world-distances are thousands of times greater than they could be by mere diffraction. It is generally agreed that the effect must be due in some way to ionisation of the high-level atmosphere, which descends to a lower level during the day-time. Although many theories have been put forward, the important paper by Sir Joseph Larmor, above mentioned, throws fresh light on the subject. When an electric wave passes through ionised air it sets the ions in vibration. If the ions collide at once with gas molecules, energy is dissipated and the wave is weakened.

If the mean free path of the ion is long (say 10 times) compared with the distance the ion is moved by the wave in the periodic time of the wave, then there will not be much dissipation of energy but the effective dielectric constant of the medium will be reduced and the wave velocity increased.

Larmor shows that at a certain height in the atmosphere, there is a region in which this accelerated and slightly dissipated wave energy can travel, and that a comparatively small ionic density will be effective. His equations show that the increase in wave speed depends on the ionic density and the square of the wave-length, and the modulus of absorption of the wave energy on the product of the ionic density and wave-length.

The increase in speed of the upper part of the wave front causes the wireless ray to curve round the earth, and Larmor specifies the conditions which must be fulfilled for the required curvature to be produced.

It appears, then, that for a given ionic density the long waves are more absorbed than the short, but the long waves have more energy at starting. Each wireless ray has its own proper path in the ionised air in travelling from the transmitter to any receiver. The shorter waves travel at a higher level in the atmosphere where the ionic density is greater and more constant, and this compensates for the smaller wave-length in giving the required ray curvature and makes them less affected by day and night variations. The

longer waves travel chiefly in a region in which the ionic density varies very much between day and night and are thus less absorbed by night.

In a general way, therefore, the theory fits in with facts, but there are an immense number of well-known wireless wave effects which will require consideration and discussion before we can say we can account for them all on any theory. Meanwhile, the practical consequences of the discovery of the properties of this 32-metre wave are very great.

Is there, for example, any justification for creating new high-power all-round radio stations by which the communication is, so to speak, bellowed over the world on 20,000-metre waves, when on the beam system perhaps a dozen stations could be erected for the same capital and annual working cost, which would whisper their message on 32-metre waves along limited paths, taking up much less room in the ether? Time, and perhaps expensive experience, will show whether the all-round high-power station is necessary. In any event, the short-wave system has the enormous advantage that the receiving appliances used in connexion with it are vastly more immune from atmospheric disturbances and render all-day and all-night intercommunication possible over long distances, even up to the antipodes.

The Oldest Fossil Fishes.

By Sir ARTHUR SMITH WOODWARD, F.R.S.

IT has long been known that the fishes of the Downtonian age—the earliest fishes of which we have any real knowledge—are very different from those which appeared in later times and persist in part to the present day. Prof. Johan Kiær, of the University of Christiania, discovered fossil fishes in the rocks of this period in southern Norway a few years ago, and the first part of his memoir describing them has recently been issued.[1] Prof. Kiær's remarkable specimens add greatly to our knowledge of these fishes, and some of his conclusions are so unexpected that they are of extreme interest to both zoologists and geologists.

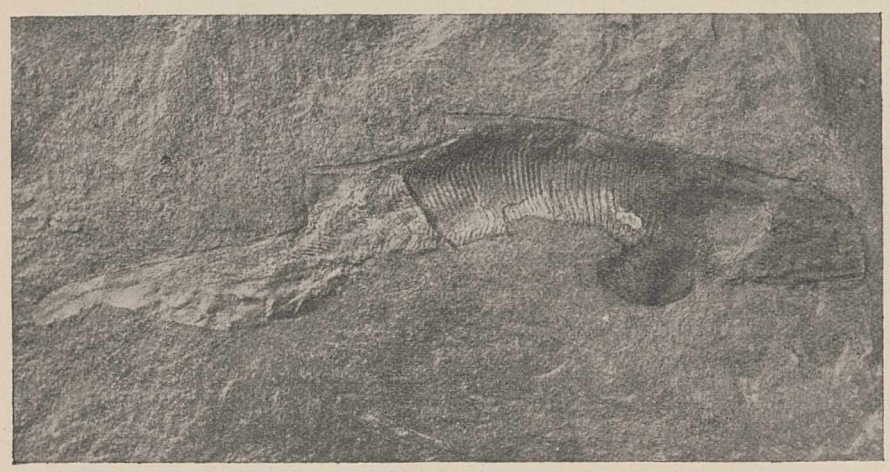


FIG. 1.—*Ceraspis robustus*, Kiær. Nearly complete specimen, nat. size. The foremost part of the head is incomplete. From "The Downtonian Fauna of Norway."

It appears that the Downtonian rocks of the Christiania region closely resemble those of Great Britain, and similarly contain the fishes in association with crustaceans and eurypterids in a good state of preservation. They are shallow water deposits, with frequent traces of ripple marks and sun cracks, and Prof. Kiær thinks they must have been formed in freshwater lakes on flood-plains. Some of the fishes are familiar, such as the beautiful Cephalaspidian reproduced in Fig. 1, which differs little from Cephalaspis itself except in having two dorsal fins instead of the single one. All, indeed, belong to known groups, and all are as usual small, none being more than two decimetres in length. The most striking novelties are referable to the Anaspida—laterally compressed fusiform fishes which were first described by the late Dr. R. H. Traquair from the Downtonian rocks of southern Scotland—and Prof. Kiær begins by devoting attention to the three new genera which he finds among these.

In the original Scottish specimens, Dr. Traquair was unable to make out any definite features in the head, and until he obtained examples with the heterocercal (or primitive unequal-lobed) tail, he felt uncertain as to which were the dorsal and ventral borders respectively. In the new Norwegian specimens Prof. Kiær has been more fortunate in finding both the head and the tail well preserved, and it now appears that the Anaspida differ from all other known heterocercal fishes in having the tapering end of the body bent downwards instead of upwards (see Fig. 2). Dr. Traquair indeed described all his specimens upside down. We have for the first time among fishes a form of tail which is known among the extinct marine reptiles, the ichthyosaurs, mosasaurs, and certain Jurassic crocodiles. Prof. Kiær, following Schmalhausen, supposes that this arrangement is correlated with the position of the centre of gravity of the fish.

The roof of the skull, which led to the discovery of the anomaly in the tail, is also very interesting. So far as it affords a clue to the underlying soft parts, it agrees with the cranial roof in the contemporary and allied cephalaspidians. As shown in Prof. Kiær's outline restorations (Fig. 3), the large orbits are distinct, not far apart, and each is surrounded by a hard rim. Between them is a plate pierced by a perforation doubtless for the pineal body; and immediately in front of this is a larger median perforation which may

[1] The Downtonian Fauna of Norway. I. Anaspida, with a Geological Introduction. By Johan Kiær. *Vidensk. Skrift. I. Mat.-naturv. Kl.* 1924, No. 6. Kristiania, 1924.

be rightly interpreted as an unpaired narial opening. The small dermal plates are symmetrically arranged and nearly on the same pattern in the three genera; but there is a tendency towards fusion into fewer and larger plates as shown in the three successive sketches *a*, *b*, *c*. In side view (Fig. 2) the cleft of the mouth is now seen for the first time in Anaspida, and it is bordered with large plates, at least in the genus here restored. In upper view (Fig. 3) the cranial dermal plates pass gradually backwards into the scales of the body, but on the side (Fig. 2) the limit of the head region is marked by a conspicuous oblique row of gill openings.

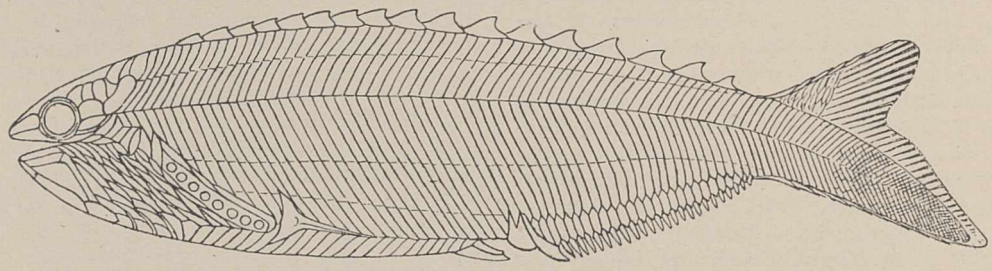
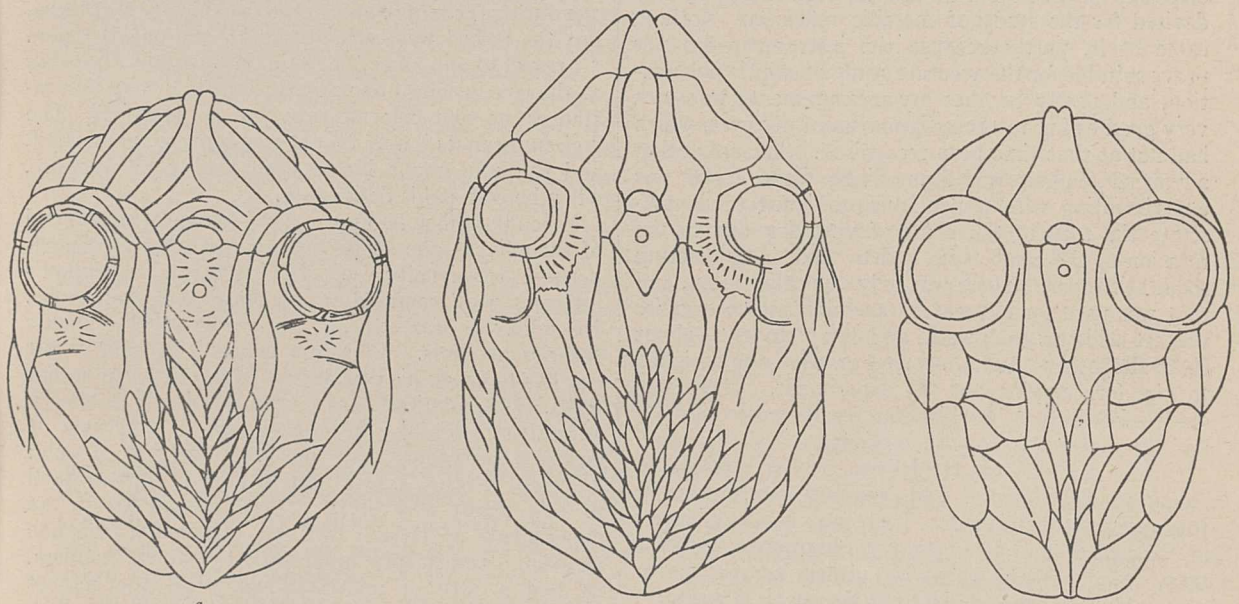


FIG. 2.—Reconstruction of *Rhyncholepis parvulus*, Kiær. ×2. From "The Downtonian Fauna of Norway."

No traces of paired fins have hitherto been observed in these lowly forerunners of the fishes, but Prof. Kiær finds in several specimens a small plate bounding the gill region behind, and a tapering spine which he considers to represent a pectoral fin (Fig. 2). Behind this spine there are apparently sometimes a few fin rays. Pelvic fins are entirely unrepresented. Enlarged scales only mark the cloacal opening and arm the front of the anal fin.

There are many more interesting details, for which it must suffice to refer to the memoir itself. Prof. Kiær not only describes them, but also concludes with an exhaustive discussion of the affinities of the Anaspida as they are now understood. Their anatomy, of course, can only be inferred from the hard dermal armature which is the sole part represented in the fossils. The single median nostril and the relative proportions of the parts of the brain suggest that the late Prof. E. D. Cope and others were right in regarding the earliest fishes as belonging to the same class as the existing lampreys and hag fishes. Even Prof. Kiær's discovery of evidence of ordinary jaws and rudiments of paired pectoral fins does not appear to him to invalidate this conclusion. The lampreys, which are obviously degenerate members of their race, may well have lost the structures in question since the early geological period to which the Norwegian fossils date back. The Downtonian genera indeed represent the heyday of the class, when the higher fishes were only just beginning to appear.

Prof. Kiær is led finally into even wider speculations as to the origin of the paired fins in fishes. He thinks the new discoveries indicate that a pair of pectoral fins appeared first, and then extended backwards as a paired fringe, of which eventually the pelvic fins were the sole persistent remnants. There may be differences of opinion on these and some other inferences, but Prof. Kiær's memoir is one of the most inspiring contributions to palæichthyology that has appeared in recent years, and we eagerly look forward to the promised continuation of it.



a *b* *c*

FIG. 3.—Cranial roof in schematic sketches of the Norwegian Anaspida. *a*, Pterolepis; *b*, Pharyngolepis; *c*, Rhyncholepis. From "The Downtonian Fauna of Norway."

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

4. KIRCHHOFF (1824–1887) AND BUNSEN (1811–1899).

IN the controversies that excited at one time a good deal of feeling with regard to the part played by different men of science in establishing the principles of spectrum analysis, some confusion was caused by the ambiguous meaning of the word "analysis." The term may apply to the separation of the spectrum into its constituent homogeneous radiations, or it may denote a method to identify the constituents of a chemical compound by the light it emits when raised to incandescence. To avoid the ambiguity, I introduced in 1882 the word "Spectroscopy," to indicate the physical side of this branch of science. With regard to the use of the prism as an instrument of chemical analysis, there can be little doubt that Kirchhoff and Bunsen first demonstrated its practical importance, though Wheatstone had clearly indicated its possibility.

I worked for one year with Kirchhoff at Heidelberg (1871–72). Those were not days of extensive and well-equipped laboratories. Next to Kirchhoff's private study, in the building which served as his residence, one room only was available for advanced work. Its chief occupant was Lippmann, who was working at his capillary electrometer. My table was by the side of his, and having placed myself entirely at Kirchhoff's disposal, he asked me to test an instrument he had devised for the study of metallic reflexion. Nothing came of it, partly because the instrument did not prove suitable for the accurate study of elliptic polarisation, and partly because my measurements were not very good owing to the astigmatism of my eyes, which had not at that time been recognised. The only other advanced student was Kamerlingh Onnes, who was experimenting with a pendulum designed to demonstrate the turn of the plane of vibration due to the rotation of the earth. He had to work in the lecture room next door. There was only one other room, and that was used for elementary exercises. One exercise was set aside for each week, and every student—about eight altogether—had a morning or afternoon assigned to him for carrying out the experiment. There was one weekly lecture in which the results were criticised and the succeeding exercise explained.

During my stay at Heidelberg, I was anxious to repeat an experiment I had previously performed on the spectrum of nitrogen. There was no glass-blower in Heidelberg and no means of obtaining a Geissler tube. Kirchhoff, to whom I appealed, advised me to consult Bunsen, who offered to let me use his laboratory, where I could find the necessary appliances. I had to confess that I was not sufficiently expert in glass-blowing to make the tube myself. He seemed rather amused, took me to a little room and spent the next half-hour at the blow-pipe. When the tube was ready, further difficulties arose. Bunsen gave me a very inefficient induction coil and insisted on my using a bichromate battery; but he would not allow the zinc plates to remain in the solution for more than two or three seconds, watching me all the time. I could not get a proper start and had to give up the experiment.

There are always innumerable stories about Bunsen illustrating his absent-mindedness and simplicity of character. Many of them will be found in Roscoe's "Reminiscences."

I attended Bunsen's elementary lecture course, which began at seven o'clock in the morning during the winter and at six in summer; but one had to be in the lecture theatre well in advance of the hour fixed, because the time was taken from a very erratic clock in this room. Whenever Bunsen was ready to start, he sent his assistant in to set the clock at six or seven as the case might be, beginning the lecture sometimes a quarter of an hour too early or too late by the real time.

There could be no greater contrast both in appearance and manner than that presented by the two men. Kirchhoff, sharp-featured and always correct and precise: Bunsen, with the appearance of a prosperous farmer, and a somewhat cynical but at the same time good-natured smile. New discoveries almost worried Kirchhoff: they amused Bunsen. The effect of light on selenium happened to be first published when I was at home on a holiday, and on returning to Heidelberg I mentioned it to Kirchhoff. His reply was: "I should not have believed that such a curious fact could have remained undiscovered until now." Kirchhoff's lectures were prepared with extreme care and delivered with precision. He is reported never to have missed one during the tenure of his professorship at Heidelberg, but the record was certainly broken on one occasion. "I regret to announce," he said on a certain Thursday at the conclusion of one of his lectures, "that circumstances prevent my meeting you to-morrow." The "circumstances" were that he was going to get married, and the honeymoon lasted from Friday till Monday, when he was at his desk again.

When both men had retired and were nearing the end of their lives—one at Berlin and the other at Heidelberg—I occasionally went to visit them. Kirchhoff's interests were confined to the days that were gone. He admired Maxwell for his work on the kinetic theories of gases. "He is a genius," he said, "but one has to check his calculations before one can accept them." He admired Lord Kelvin for his vortex theory of matter. "I like it," he remarked, "because it excludes everything else," and he added with a sigh: "If only it could explain gravitation." Bunsen liked to talk about new ideas. "Tell me all about the experiments of Hertz," was his first remark on one occasion; and in spite of his almost complete deafness, he had a way of understanding when the subject interested him.

It may be worth while to record the scepticism of Bunsen with regard to the chemical identity of diamond and carbon. He considered the evidence to be insufficient, depending in great part on a single reaction of the gas produced in the combustion of the two bodies. A more convincing test was the demonstration that equal weights of the two bodies produced equal weights of the products of combustion; but all depended here on the accuracy of the measurement, which probably was not very great. My information came from Sir Henry Roscoe, who repeatedly alluded to it in conversation. Engaged at the Cavendish

[1] Continued from p. 89.

laboratory on the spectrum of oxygen, I took the opportunity of placing a diamond inside a platinum spiral in an oxygen vacuum, and raising the spiral to a red heat by means of an electric current. The characteristic spectrum of an oxygen compound of carbon at once appeared, leaving no doubt as to the nature of diamond.

The examination for the doctor's degree at Heidelberg in those days was a purely oral one. The candidate was, in addition, supposed to send in a dissertation, but if this was not ready at the time of the *viva voce*, his degree was conferred on the latter alone, subject to the condition that he deposited a sum of money, which, so far as I recollect, amounted to 10*l*. This was returned if the dissertation was sent in and approved within one year. Three subjects had to be chosen; for example, physics, mathematics, and chemistry, of which one formed the principal and took up an hour. For the two others, half an hour was considered to be sufficient. The candidate, when ready, gave notice to the proper authority, and was in due course summoned to present himself on a certain day at seven or eight o'clock in the evening. No account was taken of attendances or period of study. Kirchhoff had the reputation of being a very strict examiner. When at the beginning of the year which I intended to spend at Heidelberg, I asked him how far I was expected to know the more mathematical branches of the subject, the only answer I got was: "I shall examine you in physics." All professors of the faculty received a fee for being present at the examinations, and the faculty of philosophy included all branches of arts as well as of science: this naturally secured a good attendance.

During my visit to Königsberger, the examiner in mathematics, he told me that Kirchhoff was very fond of asking questions about the potential. This reassured me, as I felt pretty safe in that subject, but it turned out that the examination was all on optics. The candidate sat at a long table, surrounded by about twelve severe-looking individuals, most of whom were perfectly ignorant of scientific subjects. As I had not passed the "Abiturienten Examen," which is the school-leaving test, I had to submit to an additional examination in Latin; but the examiner told me, during my visit to him, that he would pass me however badly I did, and indicated the particular book in Cæsar's "De Bello Gallico" out of which he would ask me to translate a passage. I have a vivid memory of the mournful shaking of heads that went round the table when I translated "frumentum" with "Korn," which in German means "rye," instead of with the proper word which is "Getreide." An hour's *viva voce* can, of course, cover a good deal of ground, for, as soon as the examiner is satisfied that the candidate can answer a question satisfactorily, he at once passes on to another. After the first hour, a quarter of an hour was spent on light refreshments consisting of wine and cakes, and then the examination in the two secondary subjects began. Finally, the candidate was asked to withdraw, and after a few minutes' interval the result was announced to him. If successful, he was summoned to present himself to the Pro-rector next day. The degree was actually conferred after he had delivered an oath in Latin promising many things, one being that he would not take a degree at another German university.

All through the examination it appeared to me that the examiners rather took the part of advocates of the candidates against the gallery of dummy professors who were paid to be present. When I got into a muddle with Kirchhoff over a question involving the wave surface and he had not spotted my mistake, he only said, "We both have been rather stupid over this," and then started another subject. When I could not answer one of Königsberger's questions he said: "There is no need for you to know this; I only asked you on the chance." As a matter of fact, I did know it, but failed to recognise the German expression which he used.

While I was considering the subject of my promised dissertation, I happened to meet the chief librarian of the university, who expressed the hope that I would default, for the reason that the forfeited deposits became the property of the University Library, which depended on this form of revenue.

Obituary.

Dr. G. D. Liveing, F.R.S.

BY the death of Dr. George Downing Liveing shortly after his ninety-seventh birthday, the University of Cambridge has lost the last of that small band of men who some sixty years ago set on foot the movement which proved the foundation of the present science school in that University. He was the eldest son of Edward Liveing, of Nayland, Suffolk; entering at St. John's College, Cambridge, in 1847, he was classed as eleventh wrangler in 1850, and as the first among the six who took the Natural Sciences Tripos in 1851, the year of its creation. After a short period of work under Rammelsberg in Berlin, he became a fellow and lecturer at St. John's College in 1853. In 1860 he married Catherine, daughter of the Rev. R. Ingram, of Little Ellingham, Norfolk, and thus automatically vacated his College fellowship in accordance with the old University statutes; in the same year he became professor of chemistry in the Military College at Sandhurst, but continued to teach in the St. John's Laboratory.

The Rev. James Cumming, F.R.S., occupied the chair of chemistry from 1815 to 1861, and Liveing, who had acted as deputy during the last two years of Prof. Cumming's life, was elected into the chair in the latter year. Liveing retired from the professorship in 1908; the University then conferred upon him the honorary degree of Sc.D. and appointed him an emeritus professor. He had been a professorial fellow of his College since 1880 and was elected into a fellowship again in 1908; in 1911 he became president of St. John's College. For many years he held the responsible and confidential office of Chancellor's secretary, an honorary official whose duty consisted in keeping the Chancellor of the University informed on all material happenings. In addition he served for long as a Borough and County Justice of the Peace, and was punctilious in the performance of his magisterial duties.

On his return from Germany in 1852, Liveing conceived the idea of providing instruction in practical chemistry for the medical students; no chemical laboratory existed in the University and one was equipped in a cottage on the west side of Corn Exchange Street, the fittings being improvised and oil and spirit lamps being used in default of gas. St. John's shortly afterwards built a small laboratory for Liveing, and this he used until long after he became professor in 1861. By this latter date, and largely as a result of the insistence of such progressive spirits as Liveing, the University had decided to build science laboratories; but the University was poverty-stricken, and for this and other reasons the oldest part of the present chemical laboratory was not built on the site of the old Botanic Garden until 1888. The difficulties which Liveing had to surmount in inaugurating a chemical school in Cambridge would have disheartened a man of less determination. His stipend was 100*l.* per annum, paid by the Government and subject to the deduction of Treasury fees amounting to four guineas. As he has himself said, men in those early days had to devote their means as well as their wits to the service of the University. Until his retirement in 1908, Liveing financed the chemical laboratory as a private venture, and he informed me that he declined to submit his accounts, when challenged in later years by the suggestion that he had been drawing a large revenue, because he was ashamed to disclose to his colleagues how large a sum he had thus contributed from his own resources.

Prof. Liveing lectured on heat as well as on chemistry, but in 1871 James Clerk Maxwell was appointed to the Cavendish professorship of experimental physics, a new chair established largely by the exercise of Liveing's influence. Maxwell commenced to deliver the lectures on heat in the chemical lecture-room in October 1871. Later, Liveing espoused the cause of other new subjects in Cambridge; thus, he housed the beginnings of the present flourishing school of agriculture in his own laboratory, and protected and encouraged it until it became independent under the auspices of the Drapers' Company. In a similar way he devoted his energies and money to the establishment of the Cavendish College, an institution for the accommodation of impecunious students. This enterprise soon stopped for lack of funds, and the building is now the Homerton Training College for teachers.

Prof. Liveing was elected into the Royal Society in 1878, and in 1901 received the Davy medal for his spectroscopic researches—"one of the most valuable contributions to this department of chemical physics yet made by British workers." He joined the Chemical Society in 1853, two years before Roscoe, and shortly after his first paper appeared—"On the transmutation of the elements"—in the "Cambridge Essays," first series, for 1855; this little note is characteristic in its breadth of knowledge, its elegance in phrasing, and its economy of words. A few short papers on geological and minor chemical subjects followed, and in 1878 began the great series of memoirs on spectroscopy in conjunction with the late Sir James Dewar, who had been appointed Jacksonian professor of natural philosophy in 1875. The close and intimate friendship which existed between Dewar and Liveing was very striking; both were men of strong personality, but no two men could have presented a greater contrast in outlook, tastes and all essential characteristics. Yet each held the other in profound esteem, and neither ever said a word in criticism of his colleague; without this absolute loyalty, the happy collaboration of Liveing and Dewar could not have persisted for nearly fifty years.

Liveing's scientific eminence will repose on these joint spectroscopic papers; the skill which he displayed in the development of experimental methods and his infinite patience as an observer resulted in the collection of an enormous mass of accurate data concerning the spectra of the elements which is still in course of interpretation. During his latter years Dr. Liveing occupied himself with the publication in book form of these researches; the "Collected Papers on Spectroscopy," by Dewar and Liveing, was issued by the University Press in 1915. He read his last paper, entitled "The Recuperation of Energy in the Universe," before the Cambridge Philosophical Society on May 7, 1923, and was engaged on experimental work connected with certain ideas put forward in that paper until but a few weeks before his death.

It is difficult to appraise the achievements of one, just passed away, who had left his student days behind him before Frankland had stated the doctrine of valency and before Kekulé had devised the structural formulæ of the chemist. Liveing had been the personal friend of Dr. Whewell, the great Master of Trinity, W. H. Miller, the founder of our present system of crystallographic nomenclature, Adam Sedgwick, Sir Joseph Hooker, Michael Foster, Sir Gabriel Stokes, Sir George Airy, de Morgan and Charles Darwin; he had studied under Rammelsberg, Mitscherlich, Rose and Magnus. He once mentioned to me that he and Hooker, after some preliminary discussion, walked over to see Darwin for the purpose of hastening the publication of the "Origin of Species," which appeared in 1859. In his conversation, always sprightly and vivacious, he seemed often trying to translate our later knowledge into terms of the science of seventy years ago; as befitted one who belonged to the age when the collection of facts was the main objective of science, he was apprehensive as concerned the vast theoretical flights of modern physics and chemistry. Indeed, in his presidential address to Section B of the British Association in 1882, he expressed his distrust of the graphic formulæ of the organic chemist in terms which must be considered as vigorous, coming from one temperamentally so cautious in judgment and so moderate in expression. In talking with Liveing and hearing his statement of long obsolete chemical views,

> "Told, when the man was no more than a voice
> In the white winter of his age, to those
> With whom he dwelt, new faces, other minds,"

one began to realise the difference between the science of seventy years ago and that of to-day, and to speculate as to what our survivors seventy years hence will think of the science of the future. At the same time, and although an authority on the older chemical knowledge, Liveing always maintained an excellent appreciation of recent progress.

Like many other men of robust habit and great vitality, Liveing found it difficult to understand why

his contemporaries dropped out and passed away; declining health seemed to him as due to lack of resolution. He was an enthusiastic gardener, and when well past his ninetieth birthday engaged in all the manual toil incidental to the care of a large garden; after this work had become too heavy he took his exercise by walking, and, in fact, his last illness resulted from a collision with a cyclist. His memory of long-past events was remarkably clear until quite recently, but he sometimes forgot that others could not reach so far back into the past; a few months ago, whilst still in full mental vigour, he expressed surprise that I had not noticed the splendour of Donati's comet—in 1858.

Liveing shirked publicity and rarely spoke in the Senate House because, as he said, he feared being betrayed by provocation into expressing his views—formed with care and then held tenaciously—in terms which might flavour of exaggeration. But whilst others wrangled, Liveing worked, and he will be remembered as the last of that small band of Victorians who possessed themselves of a secluded and conservative institution with splendid traditions and passed it to their successors as a great modern University. A further reason for the rarity of his public utterances lay in the meticulous conscientiousness with which he carried out any duty undertaken; he attended every meeting of the numerous committees and councils of which he was a member, and the sheer labour which he devoted to the study of the questions concerned left him with little leisure or desire to influence others by the spoken word. But the counsels of one so wise, so prudent and so experienced were often sought and were always given in careful and measured terms. With the death of Prof. Liveing, the University has lost one of its most devoted servants, science has lost a pioneer whose early work will long serve as a starting-point for fresh advances, and a great gentleman has passed away.

W. J. POPE.

MR. W. WHITAKER, F.R.S.

THE death of William Whitaker on January 15, though for some weeks it had been clearly imminent, will be felt none the less as a deep personal bereavement by his many friends. The picturesque figure so familiar at the meetings of the British Association, the alertness in body and mind, even after fourscore years and more had laid their burden upon him, but, above all, the geniality which endeared him to all he met, will long be remembered. As a geologist he was a pioneer in the elucidation of the Tertiary strata and the superficial deposits of the south and south-east of England, second only to Prestwick in that branch of the science.

Born in London on May 4, 1836, Whitaker was educated at St. Albans Grammar School and University College, London. At the age of twenty-one he was appointed to the Geological Survey, and continued in that service until 1896. His work lay almost wholly in the London Basin and in the neighbouring counties. The original one-inch geological maps were largely the work of his hands, but he was indefatigable also in collecting records of artificial sections, wells, boreholes, and the other openings which abound in and around London. His labours culminated in the production of the Geological Survey Memoirs on "The London Basin," "The Geology of London and Part of the Thames Valley," and other smaller works. These volumes form standard works of reference and provide the basis on which much of the later literature is founded.

Among other records collected by Whitaker were those relating to the first deep borings that reached Palæozoic rocks under the Tertiary and Secondary strata of the south of England. By their aid he was enabled to trace variations in the development of these strata and to sketch broadly the form of the Palæozoic floor and the distribution of the rocks forming it. The possible existence and situation of concealed coal-fields had come up for consideration, and so long ago as 1889 he wrote "that Coal Measures are likely to occur somewhere along the line of the Thames Valley, or in neighbouring tracts. . . . It is rash to attempt to foretell the future; but it seems to me that the day will come when coal will be worked in the south-east of England" ("Geology of London and Part of the Thames Valley," p. 46).

Whitaker retired from his official post at the age of sixty, in order to pursue economic geology. As a consulting geologist on sanitation generally, and on questions of water-supply especially, he attained a high reputation. But he still took pleasure in rendering service to the Geological Survey. A long series of memoirs on county water supplies from underground sources testifies to the diligence with which he collected records of wells and springs, and to the skill with which he interpreted them. This work he continued almost up to the last.

The history of the literature of geology occupied much of Whitaker's spare time. For some years he made "The Geological Record" his especial care, and he also compiled many lists of geological books and papers relating to counties, a task that might have proved tedious to one of less pronounced bibliographical tastes. Though much of his work was of this more or less statistical character, there stands to his credit a great record of original research. In addition to the many official memoirs of which he was author or part-author, his papers on Subaerial Denudation, on the Chesil Beach, and on Water Supply from the Chalk may be selected for mention. He was not given, however, to theorising and was never drawn into controversy.

The high esteem in which Whitaker was held by his fellow-workers is shown by the offices he was called upon to fill and the honours he received. Elected to the Geological Society in 1859, he served on the Council in 1873 and many years after, as president in 1898–1900, and as vice-president, 1901–2. In 1886 he was awarded the Murchison Medal, and in 1906 was the second recipient of the lately founded Prestwick Medal, a particularly appropriate recognition of his work in the field in which the founder of the medal had laboured. In 1923 he received the Wollaston Medal, the blue ribbon of British geology. He was elected to the Royal Society in 1887, and served on the Council in 1907–9. He presided over Section C of the British Association at Ipswich in 1895 and gave an illuminating address on the underground geology of that part of England. He was president also of the

Geologists' Association and of other societies. At the time of his death he was an honorary member of the Geologists' Association, of the Geological Societies of Liverpool, Manchester, and Yorkshire, of the Philosophical Society of York, of the Belgian Society of Geology, and correspondent of the Academy of Natural Science of Philadelphia.

Whitaker made many a friend, but never an enemy. Indeed, it is impossible to suppose that with so kindly a nature he could speak an unkind word. To the younger generations of geologists he never failed to lay open his stores of knowledge, or to impart the enthusiasm with which he had himself been inspired. The attainment of the truth was the dominant motive with him, and it gave him as much pleasure that it should be attained by others as by himself. Unselfishness, transparent honesty, and kindliness were the conspicuous features of his truly lovable character.

A. STRAHAN.

THE death on October 29 of Dr. Ernst König, of the famous dyeworks at Höchst-am-Main (formerly Meister, Lucius, and Brüning) at the early age of fifty-five, is recorded by the *Chemiker-Zeitung*. König's reputation rests securely upon his well-known researches in the field of photochemistry. Born at Flensburg in Schleswig, he graduated at the University of Leipzig, where for a very brief period he acted as assistant to Prof. Stohmann. In 1893 he entered the service of the dyeworks at Höchst, where he eventually attained a position of the highest responsibility. At first he undertook the investigation of new coal-tar colours, but his chief interest lay in their application to photographic processes. In 1902 a photographic department of the works was formed under his direction, and two years later a new kind of three-colour collodion process, the *pinachrome* process, was invented. This was followed by the application of dyes to chromate-gelatin emulsions and the development of the *pinatype* process. He also devoted much attention to the production of various light-filters and desensitisers. One of the most important of his discoveries was that of the panchromatic plate. The problem of extending the region of sensitiveness of the emulsion beyond the yellow into the red and even far down into the infra-red region was solved by employing as sensitisers derivatives of quinoline, containing auxochromic groups in the benzene nucleus. König was also the author of numerous scientific papers and books on photographic subjects.

WE regret to announce the following deaths:

Mr. G. Abbott, well known for his geological studies, and one of the founders of the South Eastern Union of Scientific Societies, on January 12, aged eighty.

Right Rev. L. C. Casartelli, Roman Catholic Bishop of Salford, and formerly president of the Manchester Egyptian Association, of the Manchester Egyptian and Oriental Society, and of the Manchester Statistical Society, and the author of numerous papers in oriental journals and in the proceedings of the Manchester Statistical and Geographical Societies, on January 18, aged seventy-two.

Dr. Clement Dukes, for thirty-seven years physician to Rugby School, and author of "Essentials of School Diet" and "School Health," on January 18, aged seventy-nine.

Dr. J. McT. E. McTaggart, fellow of Trinity College, Cambridge, since 1891, and the author of "The Nature of Existence," on January 18, aged fifty-eight.

Dr. Julius Morgenroth, a professor at the Robert Koch Institute for the study of infectious diseases in Berlin, and a former student and colleague of Paul Ehrlich, known for his work on immunity, on December 20, 1924, at the age of fifty-three.

Current Topics and Events.

GREAT encouragement for industrial research is contained in a notification just made to the chairman of the British Cotton Industry Research Association to the effect that 65,000*l.* is to be received by the Association as an addition to its present income—most welcome aid towards the maintenance of the laboratories at the Shirley Institute, Didsbury. The trustees of the Cotton Trade War Memorial Fund, acting on a recommendation from the Cotton Reconstruction Board, have decided, subject to the approval of the Board of Trade, to make this grant in instalments, 5000*l.* for the year ending June 30, 1926, and 20,000*l.* for each of the three years ending June 30, 1927, 1928, and 1929. Some four years ago the Cotton Reconstruction Board made a grant to the British Cotton Industry Research Association of 200,000*l.*, a sum from which a large part of its income has ever since been derived, and the fact that the trustees have now decided to continue their help shows their great confidence in the ultimate benefits that will accrue to the cotton trade as the result of scientific research. Nothing could more strongly signalise the value of science to the industry than a gift such as this; and their appreciation of what they describe as "the good work being carried out by the Shirley Institute" is bound to encourage not only the staff there but industrial research workers throughout Great Britain. Further, they feel that this work should be made even more widely known to the trade and to the workpeople themselves, showing that the real importance of applied science is now being more fully realised. Thus the labours of chemists, physicists, botanists, and engineers on the fundamental problems presented by cotton are being justified.

THE Dominion of Canada, which extends in an irregular way on a 3000-mile base line, with a scattered population and cities widely separated, will benefit largely by radio communication. In accordance with the agreement made between the Marconi Co. and the British Post Office, the Canadian Marconi Co. has begun to construct a "beam" station in Canada for communication with the stations which the Marconi Co. is to erect in England. The transmitting station is being erected at Drummondville, 50 miles east of Montreal, where the main office is situated, and the receiving station is at Yamachiche, which is about the same distance from headquarters. Both sections

will be operated from Montreal by a "remote control" method. The work was begun last November, and although the temperature has often been 20° below zero and the workmen have to wear gauntlets to prevent frost-bite by accidentally touching metal, good progress has been made. The transmitting aerials for communication to England are supported on five masts of steel lattice work and each is 300 ft. in height. For communicating with Australia, five 250-ft. masts are employed. The power required for each station per beam is 150 horse-power and is obtained from a local power supply company. The power delivered to the anode of the valve required for each beam, however, is only about 25 horse-power. Both the sending and receiving stations which are to be erected in England will be operated by remote control from the Central Telegraph Office in London. When the stations are completed, Canada will be brought into much closer contact with England and with Australia. It has been agreed to fix the rates so as to attract the largest volume of traffic. It is hoped that in this way the trade between the Dominions will be fostered to the advantage of the British Empire as a whole.

SIR WILLIAM BRAGG, in his Friday evening discourse at the Royal Institution on January 16, dealt with the investigation of the properties of thin films by means of X-rays. The reactions of bodies must generally depend upon the nature and condition of the surfaces at which they meet; therefore the thin surface film is of great importance. It may differ in structure, composition, or other condition from the internal portions of the body, and the fine vision of the X-rays may well help in its investigation. The X-rays cannot take notice of a single film or layer; their especial power lies in the measurement of the spacing of a set of layers. But the general laws of arrangement which are discovered in the crystal must be applicable to the thin film, and in some cases the thin film may be looked upon as one single layer of a crystal. Thus it has been possible to examine some elements of the structure of the fatty acids, alcohols, paraffins, and similar long-chain substances: to measure the thickness of the layers in which they lie, and to confirm with numerical amendments the previous measures of Langmuir, Hardy, Adam, Perrin, and other workers. It is found also that the fatty structure of these substances is shared by many more solid crystals, in which also the molecules lie more or less across the flake: bound together by side-to-side ties which are stronger than those at the ends. It is a general characteristic of crystalline structure, more particularly in the case of organic substances, that each molecule occurs in one or other of a small number of definite orientations: and that a molecule of one orientation binds together molecules of other orientations. The characteristics and probably the strength of the crystal depend upon the fact. It may explain the strength of the "black spot" of the soap film: the two layers of oleic acid on the two sides of the film are individually non-crystalline; but when they meet—the intermediate liquid being expelled—the full symmetry of the crystal can be realised, when all the orientations are present. The flaky substances are often greasy because of the toughness of each layer and the ease with which they slide on one another; pressure and rubbing tend to encourage the formation of the flakes in such substances as stearic acid.

SIR OLIVER LODGE delivered the second of his series of talks on the ether under the auspices of the British Broadcasting Company at 2LO on January 20, taking as his title "Vibrations and Waves and what they signify." Sir Oliver stated that the ether is so uniform that it as difficult for us to discover it as a deep-sea fish would find it difficult to discover water. All knowledge has to make its way slowly and painfully against a mass of prejudice and inertia: nevertheless it is better to be slow in accepting the truth than to be ready to accept falsehood: a certain amount of opposition may be salutary. Meanwhile our theories do not alter facts: the facts are there all the time, and are independent of what humanity thinks of them. Some things we have learnt which were unknown to the ancients; but in time we too shall be ancients, and our descendants will wonder at the blindness and stupidity, even of our learned men. We used to try to explain ether properties in terms of matter: we now perceive that we must explain matter in terms of ether. We now realise that the clue to the physical universe lies in electricity and magnetism. We had thought that the way towards the light must lie in the open country of ordinary mechanics; we are now plunging into the wood—the forest of ether-dynamics. But glimpses of illumination have been caught through the branches, and have heartened the younger generation of physicists with a great enthusiasm. Those who have insight and intuition know that through this strangely unpromising country lies the road to reality.

ATTENTION is directed, in a leading article in a recent number of the *Scottish Naturalist* (December 1924), to a modern development in the protection of wild life in the United States of America. The sportsman has entered into competition with the naturalist in the race for the creation of animal sanctuaries. The reason is obvious. The development of American legislation for the protection of wild animals shows very distinctly that a progressive disappearance of sporting mammals and birds has been proceeding for many years. The result is that, in the words of the Hon. John W. Davis: "Hunting is fast losing its character as one of the most democratic of sports. The really good shooting-grounds are rapidly being taken up by clubs too expensive to be patronised by the average sportsman. Drainage of great marsh and swamp areas, the natural breeding- and feeding-grounds of wild fowl, has threatened these with extinction. We must establish shooting-grounds so that the man of average means may enjoy the ancient, healthful, and democratic pastime of shooting, and *we must have the refuges if we are to continue to have the wild fowl.*" Accordingly a "Game Refuge Bill" has been introduced into Congress with the whole-

hearted support of the American Game Protective Association and of sportsmen generally. The combination of sportsmen and naturalists in an endeavour to protect wild life is a movement of great significance, for, as the *Scottish Naturalist* points out, "the sanctuary is the best solution of the problem of the preservation of the native fauna."

A REPORT on excavations at Ur by the Joint Expedition of the British Museum and the Museum of the University of Pennsylvania since November 1, when the season's work began, appeared in the *Times* of January 14. The main object of the work this year will be to discover whether the great ziggurat or tower was an isolated structure or formed part of a more considerable complex. Excavations to the north-west of the tower, between it and the enclosure wall, have brought to light living quarters and storerooms of the priests of the Persian period which overlie a courtyard laid out by Nabonidus. Beneath the latter was a range of buildings dating from the 16th century B.C., and beneath this again were the walls of shrines erected by the kings of Isin and Larsa (*c.* 1600 B.C.). Underneath this stratum was found the terrace wall of Ur-Ungur, the builder of the ziggurat. Inscribed nail-shaped cones of fired clay were found driven into the wall, this being the first indication ever found of the use of these objects. On the south-east side of the ziggurat a "Hall of Justice" has been brought to light, a structure originally a triple gateway, of which the back door had been blocked up by a later cross wall. Mud-brick chambers had been built alongside, in or on the ruins of the double wall in which the gate tower had originally stood. An inscription on a gate socket records the restoration of the fallen tower about 650 B.C. The original gate has yet to be discovered. It is known that it had been repaired by Ishme-dagan of Larsa by 2000 B.C.

AFTER an exhaustive inquiry by a commission which visited Europe, Japan resolved in 1921 to make the metric system of weights and measures compulsory throughout the Empire and took steps to secure a primary standard metre for the country. On the advice of Prof. Nagaoka, it was decided to obtain interference apparatus similar to that used by Benoit, Fabry, and Perot, who found that the red line emitted by cadmium vapour had the wave-length $0{\cdot}64384696 \times 10^{6}$ metre. According to a memorandum by Mr. F. Twyman on the measurement of standards of length in wave-lengths of light, the apparatus has been constructed by Messrs. Hilger, and in the course of his study of the literature on the subject of the metre, Mr. Twyman has noted how isolated the British are becoming in adhering to the yard as the standard of length, and how little is known about this standard to the degree of precision at present attainable. The British Empire, the United States, China, Paraguay, and Turkey appear to be the only countries in which the metric system is not now compulsory, and there appears every likelihood of China adopting the system in the near future.

KNUD RASMUSSEN, the Danish explorer, has been awarded the Charles P. Daly Gold Medal of the American Geographical Society for 1924 for his explorations in Greenland and northern North America. For twenty-five years he has studied the life of the Eskimo and explored northern lands. An account of his work and that of his assistants on the second *Thule* Expedition has appeared in the *Geographical Review* (vol. 8, 1919, pp. 116-125, 180-187). His latest expedition—the so-called fifth *Thule* Expedition—occupied three years, and the field of his work included the whole stretch of territory between Greenland and Siberia, as well as the study of the folklore, language, present distribution, migrations, and particularly the foci of migrations of all the known Eskimo tribes and families. The results will be issued in a series of volumes and maps. Among the most noteworthy of Rasmussen's earlier publications are "Greenland by the Polar Sea," "Eskimo Folk Tales," and "The People of the Polar North."

THE *Indian Antiquary*, which has been conducted by Sir Richard Temple as editor-proprietor for more than thirty years, has been transferred to the Royal Anthropological Institute and is being published by that body under the authority of its Council as from January 1. It will continue under the joint editorship of the present editors, Sir Richard Temple and Mr. S. M. Edwardes, with S. Krishnaswami Aiyangar as Indian editor. In policy and scope the *Indian Antiquary* will remain unchanged, and will continue to deal with the history, ethnology, archæology, linguistics and folklore of India. The Council of the Royal Anthropological Institute has authorised the formation of an Indian Section of the Institute the function of which will be to afford a meeting-place for discussion among those in Great Britain who are interested in the anthropology, archæology and history of India, to correlate the results of research in these subjects, and also to co-operate with workers in India. The *Indian Antiquary* will serve as the official publication of this Section and in it the proceedings of the Section will appear.

PROF. BOHUSLAV BRAUNER, professor of chemistry in the Charles' (Bohemian) University at Prague, has been awarded the cross of a chevalier of the French Légion d'Honneur for his scientific work in chemistry.

DR. ALEXANDER WETMORE, of the U.S. Biological Survey, has been appointed superintendent of the National Zoological Park, Smithsonian Institution, Washington, in succession to Mr. N. Hollister, who died on November 3.

THE Tokyo correspondent of the *Times* announces that Mr. Rockefeller has made an unconditional gift of four million yen (400,000*l.* at par) to the Imperial University Library. It will be remembered that in the fire which followed the earthquake of September 1, 1923, the Library of some 700,000 volumes was destroyed.

WE have received the annual report and statement of accounts for 1923–24 of Livingstone College,

Leyton. The College was founded thirty-two years ago for the purpose of training missionaries in the elements of medicine, and 810 students have taken its courses of instruction during that period. The deficit has been reduced by about 42*l.* during the year, but it still amounts to 1067*l.*, and further donations and subscriptions will be very welcome.

ON Tuesday next, January 27, at a quarter past five, Dr. H. R. Hall will deliver the first of two lectures at the Royal Institution on the relations of the prehistoric Greek and ancient Egyptian civilisations, and on Thursday, at the same hour, Sir William Bragg will begin a course of four lectures on the properties and structures of quartz. The Friday evening discourse on January 30 will be delivered by Prof. J. W. Gregory on the mountain structure and geographical relations of South-eastern Asia, and on February 6 by Prof. R. W. Chambers on the earliest recorded kings of the English.

THE first presentation of the Rivers Memorial Medal for anthropological work in the field, founded by the Council of the Royal Anthropological Institute in memory of the late Dr. W. R. Rivers, will be made at the anniversary meeting of the Institute to be held at the London School of Economics on January 27, at 8.30. As already announced, the first award of the medal has been made to Dr. A. C. Haddon, in recognition of his work in New Guinea, Torres Straits, and Borneo. After the presentation, Prof. C. G. Seligman, president of the Institute, will deliver his presidential address on "Some Little-known Tribes of the Southern Sudan."

IN connexion with the recent celebration of the bicentenary of Sir Christopher Wren, the Royal Institute of British Architects published a book on Wren and his work (including St. Paul's Cathedral), entitled "Sir Christopher Wren Memorial Volume: 1723–1923." The profits of the sale are devoted to the St. Paul's Preservation Fund. The sale of only one thousand copies of the five guineas edition would enable the Institute to hand over a sum of 2000 guineas, which would be acknowledged in the *Times* list in the name of each purchaser as a subscriber of two guineas. Orders, enclosing remittance, should be sent to the Librarian, R.I.B.A., 9 Conduit Street, London, W.1.

A PROCESS of direct colour photography is recorded by A. Hoffmann (*Photographic Abstracts*, iv. 139), who found that when photographing on a chloro-bromide transparency plate, objects reflected from the surface of a lake were rendered in their natural colours on prolonged development with pyrogallic acid. The angle of reflection proved to be the polarising angle. The author found that by using a grainless emulsion of Valenta's formula and exposing with a black glass reflector in front of the lens, on development with 0·1 per cent. pyrogallic acid with relatively large proportions of ammonia and potassium bromide, images in very good natural colours were produced.

AN investigator at the mines department testing station at Eskmeals, Cumberland, is shortly to be appointed, and applications for the post are invited. The duties of the person appointed will be to carry out, under the direction of the superintending testing officer, experimental work on problems arising in the testing of safety lamps (flame and electric), the analysis of mine air and mine dust, etc.; and to assist the testing officer generally in carrying on the scientific work of the station. Applicants must possess good scientific qualifications and have had experience in analytical and experimental work of this character. Forms of application, which must be returned not later than January 31, can be obtained from the Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1.

THE Scientific Expeditionary Research Association dispatched the *St. George* last April on a year's cruise to the Southern Pacific with the object of exploring many of the lesser-known islands and reporting on their natural history, ethnology, botany, marine life, etc. An account of the work which has been accomplished was given in our issue of November 8, 1924, p. 681, by Mr. J. Hornell, the scientific director of the expedition. It was intended to complete the cruise by studying the little-known islands south and east of Tahiti; but owing to unforeseeable circumstances, the funds are no longer available. Unless about 9000*l.* can be raised at once, it will be necessary to recall the *St. George* at what will be the most valuable and promising point of her voyage. An appeal has accordingly been issued, signed by ten members of the Advisory Council, representative of various branches of natural science, archæology, and so on, six of whom are fellows of the Royal Society. Subscriptions should be sent to the secretary of the Association at 50 Pall Mall, S.W.1.

THE work of the Smoke Abatement League of Great Britain, established in 1909, was dropped during the War and was not taken up again until 1923. Now the League is preparing a great campaign against the smoke nuisance and, with this object in view, is appealing for increased membership and support. We learn also that the valuable papers which were presented at the Manchester Smoke Abatement Conference held in November last under the auspices of the League, together with the discussions, are to be issued shortly in book form. Particulars of the League's activities can be obtained from the honorary secretary, Mr. C. Elliott, 33 Blackfriars Street, Manchester.

A VERY interesting and instructive catalogue (pp. iv + 24) of industrial sands has recently been issued from the Westmoor Laboratory, Chatteris, by Mr. A. L. Curtis, who for twenty years has specialised in supplying tested sands, and also clays and refractories, for technical and commercial use. It will be a revelation to many that the particular requirements of manufacturers and contractors can be met by so many different kinds of natural and artificially-prepared sands. The pamphlet describes more than fifty varieties used for widely different industrial purposes such as glass and pottery manufacture, sand-blast and other abrasive processes, moulding and casting, furnace lining, filtering, cement making

and testing, and less familiar applications in the soap and paint industries. Mr. Curtis has accumulated an enormous mass of data relating to the properties and uses of sands, and he undertakes to advise his clients on the problems that arise. Apart from his commercial enterprise, he is to be congratulated on issuing a pamphlet of unusual educational interest.

THE fourth Annual Report of the Animal Breeding Research Department of the University of Edinburgh is a record of research work actively pursued in many directions under the guidance of the director, Dr. F. A. E. Crew. The Department is engaged on the problem of wool improvement in Welsh sheep, with special reference to its kemp content, with the object eventually of eliminating this undesirable element from the fleece. Hybridisation experiments by crosses with Peruvian merino sheep are also being carried out with the object of improving British wools, and this has necessitated a detailed microbiological investigation of the fibres comprising the fleece of sheep. Parallel investigations on the fecundity, fertility, sterility, and general physiology of fertilisation in sheep are in progress and promise results of great importance. The list of twenty-one papers issued from the Department in the course of the nine months covered by the report is an eloquent witness to its widespread activities and to the value of the work being carried on there.

WE are informed that Messrs. Gurney and Jackson, 33 Paternoster Row, have been appointed official publishers to the Faraday Society, and in future they will deal with all business relating to the sale of Transactions and separate Reports of General Discussions.

WE have received from Messrs. Negretti and Zambra a specimen of an ingenious and simple pocket forecaster. The instrument consists of three concentric circular discs, the largest of which is two inches in diameter. The instrument is set by first rotating the middle disc so as to bring an arrow on it into coincidence with the appropriate point on a wind direction scale engraved on the outer disc, and then rotating the inner disc so as to set an arrow over the appropriate reading of a barometer scale in inches graduated on the middle disc. The inner disc has three windows, one each for rising, steady, and falling barometer, fitting over a series of code letters A to Z. Through the appropriate window a code letter is read, and this letter selects one of 26 forecasts given on the back of the outer disc. The instrument is ingeniously conceived, and can be recommended to those who desire to make the most of their barometer, with the proviso that no simple instrument can be expected to be infallible in dealing with so complex a phenomenon as the weather. On the whole, it may be expected to give good results.

Our Astronomical Column.

WOLF'S COMET.—A Copenhagen telegram announces that Prof. Wolf succeeded in photographing this very faint comet again on January 13, at $17^h\ 58{\cdot}5^m$ G.M.T. (new), its position for 1925·0 being R.A. $4^h\ 4^m\ 48{\cdot}0^s$, N. Decl. 20° 14′ 54″. The Right Ascension was about $1^m\ 27^s$ less than Kahrstedt's ephemeris, the Decl. 12′ greater. The orbit elements therefore need considerable modification, but there has not yet been time to do this. The magnitude had declined from 16 to 17, so it is to be feared that the object will not be visible for very long.

MINOR PLANETS.—*Astr. Nachr.*, No. 5341, contains a paper from the Berlin Recheninstitut describing the discovery of minor planets for the period July 1, 1923, to June 30, 1924. The number of discoveries is unusually large, 108, and shows that we are far from exhausting the zone. Only 29 of these were sufficiently observed for trustworthy orbits to be calculated and to receive permanent numbers. The numbers assigned are 996 to 1024, so that the 1000 mark is now well passed. No. 1023 is named Thomana ;- the others are still unnamed. The highest inclination among the new planets is 26° 58′ (No. 1019), the lowest 0° 41′ (No. 996). The greatest eccentricity is 0·454 (No. 1009), the smallest 0·009 (No. 1020). The periods range from 2·64 years (No. 1019) to 6·25 years (No. 1004). A new plan for the provisional numeration of planets is adopted in the new year. The lettering will begin afresh each year : planets discovered in the first half of January will be denoted by AA, AB, AC . . . ; in the second half BA, BB, BC . . ., in first half February CA, CB, CC . . ., the first letter changing twice a month. The system permits the insertion of planets afterwards detected on plates. The year must be prefixed to the letters, but in practice the last two digits of the year will suffice. This system will put an end to the present diversity, three independent systems having been in vogue since the War.

STELLAR SPECTROPHOTOMETRY.—*Bull. Astron.* tome iv. fasc. iii. contains an interesting research by M. Jules Baillaud on the distribution of energy in the spectra of stars of types A and B, also of Procyon (type F5). The observations were made at the observatory on the summit of the Pic du Midi (altitude 9384 feet). The curve for Procyon had a maximum at λ425, and resembled that of a black body at a temperature of 7000°. The curves for types A, B do not resemble those of a black body at any temperature. They fall off much more rapidly from their maximum. For type A this occurs in the neighbourhood of λ400, for type B it is at a wave-length even shorter than λ330, which is the limit to which the spectra were studied. The descent from this point is even more rapid than that indicated by Planck's formula for temperature 100,000°. The author concludes that the spectrum of stars of type B arises from the radiation of ionised atoms. He compares the continuous spectrum given by metallic vapours in an arc in vacuo, as observed by M. St. Procopiu.

α Cygni, though of type A, resembles β Orionis closely for the longer wave-lengths but not in the ultra-violet.

Two of the stars included here, γ Cassiopeiæ and α Cygni, were also studied by Plaskett. Baillaud's curve is much higher in the ultra-violet, perhaps owing to diminished atmospheric absorption. He determined the correction for this by observing the same star at different altitudes.

Research Items.

THE MOCK KING AT THE NEW YEAR IN EGYPT.—The December issue of *Ancient Egypt* has as a frontispiece a reproduction of the only illustration extant, fortunately preserved by Rifaud, showing the figure of the mock king degraded as *Abu Nerus*. The only account of this curious survival is given by Dr. Klunzinger in his book, "Upper Egypt: its People and its Products," published in 1878. On the tenth day of September, the first day of the Coptic solar year, each little town chooses from among its own members a king whose rule lasts through a festival of three days. During this period all official rule is abrogated and rigorous criminal investigations are held by the mock ruler, in which heavy penalties are inflicted even on the highest officials, and immense taxes are imposed. Both penalties and taxation are remitted for bakhshish. At the end of the three days the mock king is condemned to death and he (*i.e.* his clothes) is executed by burning. The illustration shows that this festival took place at the date harvest. Sir Flinders Petrie, in a note on the illustration and Klunzinger's account, refers to a title of the XIIth Dynasty, "New Year King of all the Nobles," which was borne by the highest nobles, and points out that this office, which the form of the title shows to have been annual, would indicate that the New Year King was a survival of an age much earlier than dynastic rule. It was a relic of an earlier kingship of prehistoric times and allowed a semblance of the ancient rule to the nobles of the old race, just as the king of the Saturnalia at Rome preserved among the enslaved aborigines a memory of their former liberty.

NEW CORBICULÆ FROM URUGUAY.—The genus Corbicula has a special interest for the student of post-Tertiary geology inasmuch as though now a southern form, it originally in both hemispheres ranged farther north, inhabiting Britain and Siberia in one, and attaining to Nebraska in the other. The American forms differ from the European in that the former have a slight palial sinus, which is wanting in the latter, and have been placed in a separate subgenus, Neocorbicula, by Fischer. Dall, however, has sought to revive Férussac's name of Cyanocyclas, which was only a synonym for Corbicula. Mr. W. B. Marshall in this respect has followed Dall when describing an interesting series of Corbiculæ from Uruguay (Proc. U.S. Nat. Mus., vol. lxvi. art. 15). Altogether eight new species are described and well illustrated, whilst a most useful list of the seventeen previously described American species, with the original references, is appended.

CINCHONA AND IPECACUANHA IN BURMA.—The Report of the Botanical Survey for India for 1923–24 contains further information as to the progress of the interesting experiment upon the planting of an experimental area (now at Mergui) in Burma with cinchona (see NATURE, April 21, 1923, p. 547, and January 5, 1924, p. 25). The conclusion of a brief description of progress is apparently "to confirm the optimism expressed earlier." With the more equable rainfall of Mergui, it appears that the period of nursery culture may be materially shortened, plants set out as quite small seedlings making such vigorous growth after rainfall that they have formed an area of young Cinchona already ahead of the older plants at the former station at Tavoy, now abandoned in favour of Mergui. So far the species to which this report refers is only *C. Ledgeriana*, but *C. succirubra* is also upon trial. Ipecacuanha is also under cultivation at Mergui, "where it is obviously much more at home than it ever can be in the Bengal plantations." Until now, however, no cropping has been attempted, but the policy of multiplication of stock continued.

BARK SCORCH OF WILLOWS.—A bark scorch of willows, caused by the fungus *Fusicladium saliciperdum* Tub., has been known as a troublesome disease of willow rods for some time on the Continent. The disease was noted on the rods of willows grown for cutting in a market garden in Lanarkshire, and specimens were sent to the Edinburgh Botanic Garden for diagnosis, where they were examined by Mrs. N. L. Alcock (Transactions of the Royal Scottish Arboricultural Society, vol. xxxviii. part ii. October 1924, p. 128). The disease first appears as patches on the leaves resembling those of "scab" *Fusicladium dendriticum*, Fuckel., on apple leaves. The disease causes later on striking black patches on the bark giving the rod a piebald appearance, and it may also cause a die-back, and the young rod then turns black from the tip downwards. Little is known as to control, but probably a winter wash of copper sulphate would be useful. Care should be taken when cutting out the rods to cut down to the stock, and not to leave long stubs. Affected rods should be cut out and burnt.

PALÆOZOIC ALGÆ.—Interesting plants from the Old Red Sandstone of Scotland, showing clear indications of algal organisation, are described by the late Dr. R. Kidston and Prof. W. H. Lang in the Transactions of the Royal Society of Edinburgh, vol. 53, part iii. (No. 29), pp. 603-614. *Cryptoxylon Forfarense* Kidston, described in 1897, is rediscussed in the light of a wider knowledge of Nematophyton, and as a result it is transferred to the genus as *N. Forfarense* Kidston, the pseudo-cellular structure of this species being no longer a bar to its transference to this genus. Two new species of Pachytheca are described, *P. media* and *P. fasciculata*. The genus includes a number of spherical forms about half a centimetre in diameter, which when split across show a central region or medulla surrounded by a radially striated cortex, composed of more or less evident tubes. In the newly described species, algal filaments can be clearly discerned on microscopic examination of favourable specimens; these run irregularly in the medullary region, and in groups of seven or more fine filaments through the cortical tubes, emerging from the ends of the tubes in a pencil-like group, in what is described as a peripheral "narrow clear zone." The authors suggest that where the algal organisation cannot be clearly made out, specific names should not be attached to specimens of this fossil, which are widely distributed and relatively abundant in certain formations in Britain. They conclude that the relatively frequent association of Nematophyton with Pachytheca raises interesting problems as to the condition of life of these contemporaneous organisms, and that the mode of occurrence of both of them and the nature of the beds in which they occur will repay further work and co-operation on the part of palæobotanists and geologists.

SUNSPOTS AND TEMPERATURES.—In a recent pamphlet under the title "Sunspots and Temperature, 1916," Mr. A. H. Wallis, of Kimberley, criticises the conclusion of Nordman and Köppen that there is a tendency in the tropics towards low temperatures at times of numerous sunspots, on the ground that the relationship is not invariably valid and is based on the discussion of smoothed means. He suggests for further investigation a law that sudden rises in the daily sunspot number are frequently associated with

rises of maximum temperature. He apparently has not had access to the variation curves for 25 regions of the earth's surface from 1820 to 1910 prepared by J. Mielke, or to the 97 correlation coefficients worked out by G. T. Walker; or he would realise that with a coefficient of only −0·2 or −0·3 in the tropics between the annual temperature and sunspot number, a perfect correspondence cannot be expected. Also a negative coefficient in annual means might be perfectly consistent with a positive coefficient over short periods such as a day. When, therefore, Mr. Wallis claims to find in the course of a single year 199 daily agreements of sign in the departures of spots and maximum temperatures and 155 disagreements, he does not upset existing beliefs; neither does he provide much support for belief in a parallel relationship by an agreement of only 56·2 per cent. of cases—his 79·4 per cent. appears to be in error. Also during the year in question, his tables appear to contain 27 occasions on which there was an increase of 24 or more between the sunspot number of one day and the next, and in only 16 of these was there a contemporary rise of temperature. All attempts to throw light on this interesting subject are welcome, but a further examination must be made before an addition to our knowledge can be claimed.

Investigations of Atmospherics.—All the various irregular noises which are heard in radiophones are classed together as "atmospherics." In long-distance working they are specially objectionable. As a large amount of research work, the results of which are not readily obtainable, has been done on the subject, the paper by Dr. R. L. Smith-Rose published in the January number of *World Power* will prove useful to many. The connexion between these noises and neighbouring thunderstorms was discovered at the end of last century by means of a coherer, and use was made of it in France, the owners of vineyards being warned of the approach of thunderstorms. During the War the forecasting of thunderstorms was of great value in aviation. It has been shown recently that all important atmospherics have their origin in mountainous regions and are due to electrical discharges. The range of a disturbance caused by a lightning flash is usually world wide, and there are always sufficient lightning flashes occurring in some part or other of the world to account for all the noises heard in a radiophone. The energy radiated is only a small fraction of the energy required for the local disturbance, and hence radio experts find it difficult to imagine that anything except a lightning flash could produce the observed effects. They also think that the disturbances travelling through the ether must have a high frequency. The methods used to eliminate these disturbances are to utilise the phenomena of directional reception, the beneficial effects being apparently more pronounced the shorter the wave-lengths used by the station.

Theodolite Observations without Field Illumination.—Difficulties are often experienced, especially by workers in remote regions, in obtaining suitable illumination of the field when observing stars with the theodolite. An ingenious attachment, which permits of observations being taken without any field illumination, is described by Mr. E. A. Reeves in the *Geographical Journal* for December last. A small semi-reflecting glass disc is placed in the focal plane of the telescope objective, taking the place of the ordinary diaphragm. Another similar reflector, which is capable of horizontal and vertical adjustment, is screwed over the eye-lens of the eyepiece. When an image of the star is formed on the semi-silvered face of the diaphragm, the transmitted light passes through the eyepiece and emerges as a parallel beam on the eye-lens reflector. Part of this beam is reflected backward on to the diaphragm and again reflected into the eye. Two images of the star are thus visible. These coincide only when the star is in the centre of the field. If the star is in any other position, the images part and move in opposite directions, the distance apart being double the error of pointing. The device can be readily fitted to, and conveniently used with, any theodolite if the object-glass is reasonably large. With a 5-in. theodolite, having a 1¼ in. aperture, coincidences can be made with 1st and 2nd magnitude and even smaller stars. The device should be of use also in mines and other underground works where lamps have to be used as marks upon which to sight the theodolite.

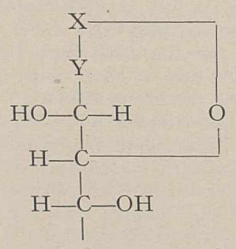
Physical Properties of Single Metallic Crystals.—Dr. P. W. Bridgman describes some physical properties of single crystals of zinc, cadmium, bismuth, antimony, tellurium, tin and tungsten in the Proceedings of the U.S. National Academy of Sciences for October 15, 1924. The properties listed include the elastic constants (which vary greatly with direction), linear compressibilities, linear thermal expansions, and electrical resistance. The compressibility of cadmium could not be obtained, owing to the existence of two new polymorphic forms under pressure, the transitions taking place at about 3000 and 6000 kg./cm.^{2} (20° C.). The electrical resistance also changes slightly at the transition. The properties of the new modifications are very similar to those of the ordinary modification. Tellurium exhibits negative thermal expansion along the crystal axis. The influence of pressure on the electrical resistance of antimony is anomalous; it tends to indicate that resistance is determined by something more specific than the distance apart of the atoms.

Harmonic Tidal Constants.—In a paper entitled "Perturbations of Harmonic Tidal Constants" (Proc. Roy. Soc., A, 106, pp. 513-526), Dr. A. T. Doodson, secretary of the Liverpool Tidal Institute, discusses some unusual features in the results of harmonic analysis of tidal observations at St. John (New Brunswick) and at Bombay. The principal lunar semidiurnal constituent M_2 at both stations shows three definite perturbations; one of these is of 19-year period, and arises from a failure of the ordinary method of allowing for the 19-yearly variation of M_2 (due to the varying longitude of the moon's node). The ordinary method assumes that two terms of closely similar period in the tide-generating potential will produce terms in M_2 of proportionate magnitude, and affected by the same phase lag. In actual fact this proves not to be the case, particularly at St. John, and the author states that, though the magnitude of the effect makes the explanation very difficult to believe, resonance is at present the only assignable cause. St. John is of course one of the stations where such a phenomenon is least improbable, since the very large tides in the Bay of Fundy are certainly due to resonance with a "sea seiche." But in addition there is another 19-year term in M_2 which can only be explained as due to frictional forces of considerable magnitude, depending on some higher power than the first (probably the second power) of the speed. This conclusion depends only on the forms of the expressions for the tidal elevations, and, while it is in general agreement with Dr. H. Jeffreys' calculation of frictional losses in the Bay of Fundy, it involves no numerical assumption as to the friction coefficient. Another perturbation of M_2 at St. John and at Bombay is a secular change of amplitude, ascribed to possible changes in the sand- and mud-banks near the ports.

Carbohydrate Metabolism.

THE breakdown of the carbohydrates found in the body, namely, glycogen and glucose, resulting in their final oxidation into carbon dioxide and water and the liberation of the energy stored in their molecules, takes place by stages, the details of which are still imperfectly known. It appears probable that a compound of glucose with phosphoric acid forms an intermediate stage in the conversion of glycogen into glucose, while lactic and pyruvic acids are intermediate products in the conversion of the glucose into carbon dioxide. In the case of striped muscle, the process, as far as the formation of lactic acid, is reversible (Emden, Meyerhof, etc.). Now although the monosaccharides formed in the course of digestion are absorbed and converted into glycogen in the liver, in the reverse process only glucose is produced, suggesting that this sugar has some peculiarity of structure which enables the cells of the body to utilise it, in preference to the others : enzymes are probably concerned in the process, and one of the characteristics of their action is their specificity.

Fresh light has been thrown on this subject by the work of Herring, Irvine and Macleod (*Biochem. Jour.*, 1924, vol. 18, p. 1023), who have used insulin as a key to the structure which the sugar must possess if it is to be utilised. The insulin was injected into mice, and the efficiency of various sugars and other closely related substances in curing the convulsions thus produced determined. Glucose and mannose cured the animals completely, but fructose and galactose produced only a temporary improvement. Maltose, however, was nearly as efficient as glucose, but somewhat slower in its action. None of the other substances tried, including substituted reducing sugars and glucosidic compounds, had any effect. Analysis of the results shows that the sugar must possess the following formula,



in which X or Y represents the reducing group. The cells of the body are, therefore, only fitted to deal with a sugar of this general type, all other carbohydrates being converted into it by their appropriate enzymes, either directly or after synthesis into glycogen.

Working on quite different lines, Kay and Robison and their co-workers have investigated the properties and functions of the compounds of glucose with phosphoric acid (*Biochem. Jour.*, 1924, vol. 18, pp. 1133, 1139, 1152, 1161). Two of these compounds are described, a hexosemonophosphate and a hexosediphosphate, the phosphoric acid being combined with a different group of the sugar in each case. Both compounds are probably present in the blood. An investigation of the distribution in the body of the ferments which act upon them shows that the diphosphate is hydrolysed by an enzyme present chiefly in muscle and blood, while the monophosphate is acted on by an enzyme which can be extracted from bone and ossifying cartilage. In fact, it is suggested that the latter compound is the form in which phosphorus is supplied to the bone in ossification. The injection of insulin increases the amount of the organic phosphoric esters in the blood and muscles, and it is extremely probable that it is the hexosephosphates which are thus affected. In this case the fall in the blood sugar after insulin may be connected with the formation of these esters, since it appears that the sugar disappearing is not all oxidised, nor is it converted into fat (*v.* Burn and Dale, *Jour. Physiol.*, 1924, vol. 59, p. 164). The formation of a phosphoric ester would, however, be probably only a step in the reversible reaction, glycogen $\rightleftarrows$ glucose. The actual direction in which the reaction proceeds depends in all probability on the amount of glycogen in the body : in the well-fed animal, the glycogen present is broken down; in the diabetic organism, the reverse process occurs and glycogen appears in the liver.

The phosphorus for the synthesis of the ester comes in the first place from the inorganic phosphate of the blood, with the result that less is left available for excretion by the kidney in the urine. Sokhey and Allan (*Biochem. Jour.*, 1924, vol. 18, p. 1170), confirming other investigators, have found that dogs after large doses of insulin excrete less inorganic phosphate in the urine during a period of six hours or so : the total output for the day is, however, definitely increased, suggesting that some of the newly formed esters are broken down later on. The nitrogen excretion is raised simultaneously with the fall in inorganic phosphate : possibly some of the phosphorus required comes from organic compounds which also contain nitrogen. Sugar *per os*, on the other hand, while diminishing the inorganic phosphorus of the blood and urine temporarily, does not cause any increased total output of this element in the 24 hours : at the same time it lowers the nitrogen excretion by taking the place of some of the protein previously oxidised. It appears then that, with excess of sugar in the blood, more of the esters are formed at the expense of the inorganic phosphorus, but that, although the subsequent oxidation is sufficient to reduce the nitrogen excretion by sparing the destruction of protein, it is not enough to raise appreciably the excretion of phosphorus in the urine ; the sugar is probably oxidised directly without previous synthesis to glycogen. Insulin, however, causes a great increase in the formation of the esters, the phosphorus coming both from inorganic phosphates and also from bodies which contain nitrogen as well as phosphorus in their molecules. The glucose necessary is obtained from that circulating in the body fluids, but in the normal animal an additional source is provided by the reserve glycogen of the liver and muscles ; the breakdown of the latter would produce an excess of free phosphorus, which would appear in the urine.

A somewhat different reaction is to be expected from feeding sugar and injecting insulin : glucose alone will not raise the total metabolism to any appreciable extent, while insulin, under certain conditions, will do so by increasing the carbohydrate oxidised, without at the same time reducing the protein broken down : in the normal animal, a limit is probably set to the amount of carbohydrate catabolised at any moment by the amount of insulin available. It seems justifiable to draw the general conclusion that insulin acts by assisting the reversible reaction glycogen $\rightleftarrows$ phosphoric ester $\rightleftarrows$ glucose, by causing the production of the ester ; the direction in which the reaction proceeds thereafter depends on the amounts of the various interacting substances present at the moment.

Nature and Origin of Coco-Nut Pearls.[1]

By Dr. F. W. T. HUNGER.

IN the endosperm cavity of the seed of *Cocos nucifera* a local calcareous formation is sometimes found to occur, to which the name of "cocos-pearl" has been given, and which must be looked upon as a highly remarkable and very rare occurrence.[2] Such a cocos-pearl has usually the form of a pear, or egg; sometimes it is almost spherical and has a smooth surface, as a rule of a milky-white colour. Its chemical composition corresponds somewhat to that of the oyster-pearl, from which it differs in appearance, however, by the lack of the pearly sheen.

Rumphius was the first to describe this calcareous formation as "calappites,"[3] and for more than a century after him nothing was heard of this condition, until at the meeting of the Boston Society of Natural History on February 1, 1860,[4] Mr. Fred. T. Bush presented a specimen of this cocos-pearl for chemical and microscopical examination. The research was entrusted to Dr. Bacon, who submitted his report on the subject at the meeting of the same Society on May 16, 1860.[5]

In 1866, Dr. Riedel, ex-Resident of Menado, reported having found a pearl in a coco-nut he opened.[6] This was the first report by an eye-witness who had actually seen such a thing, apart from the many stories told by natives about it.

Contrary to the statement of Bush to the effect that cocos-pearls "are said to be found free within the cavity of the coco-nut," Skeat[7] reported in 1900 that they are "usually, if not always, found in the open eye or orifice at the base of the cocoa-nut."

On my last voyage to the East Indies for purposes of study, I resolved to endeavour to find out something further about the cocos-pearl and if possible solve the problem of its formation. At the same time I realised the utter futility of going to look for cocos-pearls in the tropics, on account of their extremely rare occurrence. In proof of this it may be mentioned that on a coco-nut estate, where approximately three million nuts have been opened annually for years, no such pearl has ever been found, although stories about them have led to their existence being suspected.

I therefore directed my research to gathering as many authentic data as possible. On one of my voyages I met a native of British India who possessed a very fine cocos-pearl. According to his own account, he had seen with his own eyes this specimen inside an opened coco-nut which had been brought to him from Madras. He assured me that his pearl had been attached to the kernel of the coco-nut and exactly at the place where, in germination, the cotyledon forms a haustorium.

Later on I also met with an Arab on whose coco-nut plantation in South Borneo a coco-nut had been gathered which, on being opened, proved to contain a pearl attached to the inside of it. He had dislodged the pearl from the kernel of the nut with his own hand. In this case also the pearl had been attached at exactly the same place as in the case first mentioned.

These two corroborative declarations of eye-witnesses, who had both seen a cocos-pearl still attached inside an opened coco-nut, furnished me with a preliminary guiding-thread and led me to suppose that the spot which they indicated would probably be the normal point of attachment of such a cocos-pearl.

The normal germination process of the coco-nut begins by an enlargement of the embryo, whereby the cotyledon commences to grow inwards to an absorbing organ (haustorium), and thereby comes to protrude outside the endosperm and into the central cavity. Simultaneously with this, the plumule grows out and, breaking through the membranous operculum of the germinating pore, it pushes its way out through the hard shell.

Proceeding from the provisional determination of the place of attachment of the cocos-pearl, the following hypothesis could now be formed. Given that the germination, being in progress, is stopped by some cause or other, thus preventing the further development of the haustorium, it is conceivable that the haustorium in this state might become encrusted by the influence of the coco-nut milk, and that from this the completely petrified cocos-pearl would gradually be formed.

It was now necessary to find the reason for any such check in the process of germination and the accompanying solidification of the haustorium.

At the side where the coco-nut has been attached to the stalk, three thin spots, so-called germinating pores, or "eyes," can be seen in the hard inner shell of the fruit. As a rule one of these holes, the so-called "porus pervius," is closed by a membrane, whereas the two other, the so-called "pori cæci," are furnished with a hard tegument. In germination, the plumule pushes its way out through the porus pervius.

By way of exception there may be, instead of three, two germinating pores, namely, one porus pervius and one porus cæcus, and only very rarely will there be only a porus pervius with both pori cæci entirely absent. Nevertheless, a coco-nut of this description can germinate in the usual way. It is a different case, however, when there is not even a porus pervius, the base of the inner shell showing no germinating pore at all, as occurs in extremely rare cases. Such a coco-nut is known in the Malay language as a "kělapa boeta," or "klåpå boentĕt" in Javanese, which signifies a "blind coco-nut."

As remarked above, a coco-nut without germinating pores is a very great rarity, for which reason they are regarded by the Mohammedans as sacred. The "kělapa boeta" is a talisman (*tjimat*) *par excellence*, and consequently it is difficult to obtain a specimen.

This meeting with the *kělapa boeta* furnished me with an example of the way in which normal germination is rendered impossible in Nature, and I did my utmost to procure some specimens. I finally succeeded in collecting eight unopened "blind" coco-nuts from the East Indian Archipelago. Most of the specimens were very old nuts; some, according to their owners, had been preserved for scores of years as family heirlooms.

The first four "boetas" which I opened produced nothing, but in the fifth I found a really beautiful pearl still attached to the kernel; the next two produced negative results again, and the eighth specimen I have kept unopened.

The nut which had contained the pearl had been gathered but a short time before, and the endosperm in it was quite normal, whereas in the other nuts the kernel was either very much dried up or had even partly become a mass of brown powder. The

[1] Reprinted, by kind permission of the author, from the Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, vol. xxvi. Nos. 5 and 6.

[2] F. W. T. Hunger, "Cocos nucifera," 2nd ed. pp. 243-250, Pl. lxvii. (1920).

[3] E. Rumphius, "Herbarium Amboinense," vol. i. pp. 21-23 (1741); "D'Amboinsche Rariteitkamer," pp. 291-292 (1741).

[4] Proceedings of the Boston Soc. of Nat. Hist., vol. vii. p. 229 (1861).

[5] *Ibid.*, vol. vii. pp. 290-293 (1861).

[6] NATURE, vol. 36, p. 157 (June 16, 1887).

[7] W. W. Skeat, "Malay Magic, being an Introduction to the Folk-lore and Popular Religion on the Malay Peninsula," p. 196 (1900).

pearl was attached without the least trace of a stalk, being merely embedded in the endosperm, and was quite easy to remove from the kernel. It lay exactly at the base of the nut, just under the spot where the germinating pores ought to have been, and thus agreed completely with the indications as given above.

This discovery, in my opinion, warrants the inference that the cocos-pearl actually represents a calcified haustorium, which has been retained in the nut after the primary germination was checked, owing to the plumule not being able to get through the shell on account of the absence of the porus pervius. As the inner shell of the *kĕlapa boeta* remains hermetically closed, the newly formed haustorium becomes encrusted under the influence of the coco-nut milk with calcium salts, although it still remains unexplained why the cocos-pearl consists almost entirely of calcium carbonate, while neither the cocos-kernel nor the coco-nut milk contains this carbonate.

The belief that a *kĕlapa boeta* invariably contains a cocos-pearl was sufficiently disproved by my experience, that of seven specimens, only *one* such formation was found in a "blind" coco-nut. On the other hand, it is probable, in my opinion, that it will be principally (or exclusively ?) the *kĕlapa boeta* that contains the cocos-pearl.

Annual Meeting of the Mathematical Association.

THE annual meeting of the Mathematical Association was held at the London Day Training College on January 5 and 6. The report of the Council showed that the number of members has increased to 1019, in addition to about 500 associates connected with local branches.

The presidential address was delivered by Prof. G. H. Hardy, the subject being "What is Geometry ?" Prof. Hardy suggested that the time has come to consider what the subject taught in schools under the name of geometry really comprises. It appears to be a mixture; partly an investigation of actual space-relations, based on intuition, partly a system of pure geometry, based on axioms. But neither of these subjects is self-contained. Even the so-called projective geometry is not true projective geometry but is based on ideas of geometrical magnitude. While recognising that the early teaching of geometry must be a compromise, and that the Association has done very good work in improving it, he thought that an effort might now be made to introduce into schools a more logical study of modern systems of pure geometry.

Prof. H. Levy gave an address on "The Mathematical Laboratory; its Scope and Function." He said that mathematics is not merely the handmaid of science. Mathematical methods based on logical proof are not sufficient for modern needs: the methods must be developed so as to meet the requirements of technology—of aeronautics, of biology, of industry. He gave an account of the work done at the mathematical laboratory of the Imperial College of Science and Technology, S. Kensington. The work, fundamentally, is experimental. Any instruments available may be used, and the traditional restriction to rule and compasses is abolished. Absolute accuracy is not regarded as essential, and graphical methods, giving results within about 0·5 per cent., are found to be sufficient. The problems to be solved are engineers' problems, not the mathematician's conception of engineers' problems. Differential equations are solved by approximation, by differentiation, etc.; and their mathematical treatment in the lecture-room is followed by graphical treatment in the laboratory. The calculation of infinite series, and their differentiation, gives ideas of convergence and divergence of series, and a good deal that is of value can be derived from cases in which series obtained by graphical methods give incorrect numerical results in consequence of the series being divergent. Importance is attached to the study of cases in which different problems lead to the same mathematical equation. In the discussion on the paper, it was suggested that in a school the cost of equipment of a mathematical laboratory might be prohibitive; but Prof. Levy pointed out that, as great accuracy is not essential, second-hand instruments are usually quite good enough.

A discussion on the teaching of arithmetic in schools was opened by Prof. J. E. A. Steggall, who suggested that more attention might be given to the study of the properties of numbers, and that, in the earlier stages, children might concentrate on the study of some particular table, such as the table of measures of length. The discussion raised some interesting points as to method, and questions as to the psychology of the pupil. Prof. Steggall, in replying, expressed his disapproval of the teaching of anything that could not be understood.

There was some discussion of the recent report (of the Association) on "The Teaching of Geometry in Schools." Prof. M. J. M. Hill dealt with various methods of arriving at the properties of parallel lines.

Mr. A. Buxton communicated a note on the treatment of a certain problem in optics by means of Bessel functions.

Dr. H. B. Heywood contributed a thoughtful paper on the reform of university mathematics. In foreign universities, courses are given in subjects of which students in Great Britain have practically no knowledge. The whole of our mathematical teaching in universities, even more than in schools, is dominated by examination requirements; and no reform is possible until the examination system is modified. Some suggestions that Dr. Heywood made were that it is not necessary to examine over the whole field, but that an intensive study of some part should be allowed; that theses, followed by oral examination, should be encouraged; that more importance should be attached to reports by teachers; and that over the whole range the study should be less academic. There is no border-line between mathematics and physics, and there is no need for physics to be made fictitious when it becomes a subject for mathematical treatment. The extent of ground common to mathematics and physics should be investigated. The decision as to the content of a mathematical course must be made on the basis of vitality; and this requires a purposeful study of the whole domain of mathematics, to see what portions are alive and growing. Such a study would show what reforms are needed. In the discussion, Prof. E. W. Hobson agreed that reform must work downwards from the universities, but he was inclined to dissent, at any rate as regards Cambridge, from the view that the universities are more dominated than the schools by examination requirements. Prof. Hardy stated that he considered reform to be impossible without destruction, and said he would like to begin by destroying the mathematical tripos.

During the luncheon interval, on the second day, there was a very interesting exhibition of pieces of apparatus, designed by Mr. E. J. Atkinson, by Mr. C. V. Durell, and by Mr. D. F. Ferguson, for use in connexion with the teaching of mechanics.

University and Educational Intelligence.

CAMBRIDGE.—The Sedgwick Prize has been awarded to Mr. H. Hamshaw Thomas, fellow of Downing College.

Mr. C. T. R. Wilson, fellow of Sidney Sussex College, university reader in electrical meteorology, and observer in meteorological physics at the Solar Physics Observatory, has been elected to the Jacksonian professorship of natural philosophy.

OXFORD.—It is expected that in the course of the present term, which began on January 19, much progress will be made with the final settlement of College Statutes, which are now before the Universities Commission.

The Romanes Lecture for 1925 will be delivered by Sir William Bragg in the Sheldonian Theatre on Wednesday, May 20, at 5.30 P.M. Sir William's lecture will be on "The Crystalline State."

PROF. ANDREAS VON ANTROPOFF, of the Technische Hochschule, Karlsruhe, has been offered the chair of physical chemistry at the Chemical Institute in the University of Bonn.

ACCORDING to a message from the Toronto correspondent of the *Times*, the will of the late Mr. D. A. Dunlap includes bequests of 50,000*l.* to Victoria University, one of the constituent colleges of the University of Toronto, and 20,000*l.* to the University of Toronto for medical resources.

MR. F. J. HARLOW has been appointed principal of the Wigan and District Mining and Technical College, in succession to Mr. S. C. Laws, who has become principal of the Northampton Polytechnic Institute, London. Mr. Harlow has been, for the past four years, principal of the Blackburn Municipal Technical College. He is a B.Sc. (Physics, 1st class honours) of the University of London and an associate of the Royal College of Science, and he also holds the diploma (by research) of the Imperial College of Science and Technology.

PROF. H. E. ARMSTRONG, addressing the students of the Stoke-on-Trent evening schools on January 8, protested vigorously against the unpractical character of the teaching in English schools. "School, in the main, is but the means of keeping children occupied and ignorant up to a certain age: there is no conscious logical method behind it." Hence it is that our commercial men and leaders of industry are ill-informed, and manual dexterity is going from us owing to our slavish use of machinery. To prate of the value of the study of the humanities while we welter in ignorance of the world about us, and the public remains incapable of appreciating and using the vast achievement of scientific workers for its intellectual development, Prof. Armstrong stigmatised as "pure Pecksniffery." If the Potteries are to be capable of meeting the coming competition of Germany, the type of teacher required is the enthusiast for "Beauty in its many forms, one of which, and the greatest, is Truth," with power to kindle the imagination of pupils and other teachers. Thence will come capacity for producing work of beauty and value which will therefore attract. The number of students enrolled for the current session in the Stoke-on-Trent evening schools reaches the respectable total of 5700, including more than a thousand in the Art Schools and 600 in the Central School of Science and Technology, which, by the way, is extending its pottery course, for students who have completed a secondary school curriculum, from three to four years. It has a separately organised research department, with a staff of eight investigators.

Early Science at the Royal Society.

January 25, 1664/5. In order to see, whether the compression of the air caused the extinction of fire, there was put a lamp into the condensing engine; and a great quantity of air being crowded into it, it was found, that the lamp burnt in that compressed air about 15 minutes; whereas in the uncompressed air in the same engine, it burnt not above 3 minutes.—It was ordered that at the next meeting an experiment should be made, of filling a vessel with smoke, to see, whether a candle put into it would burn as long therein, as it would do in the same air without smoke.

1671/2. Mr. Oldenburg read a letter from Mr. Newton from Cambridge, of a way of preparing a fit metalline matter for reflecting concaves. "I desire," he says, "that in your next letter you would inform me, for what time the Society continue their weekly meetings; because if they continue them for any time, I am purposing them, to be considered of and examined, an account of a philosophical discovery, which induced me to the making of [my] telescope; and I doubt not but will prove much more grateful than the communication of that instrument, being, in my judgment, the oddest, if not the most considerable detection, which hath hitherto been made in the operations of nature."

January 26, 1670/1. Mr. Oldenburg produced some of the rock-salt lately digged up in Cheshire, mentioning that the workmen had bored three yards into it. That an hot fire makes the salt crack and fly like bags of kelp. That hot water dissolves it speedily, and cold slowly: that being pulverised it is a very strange salt, and the brown, that is free from mixture full as sharp as the white.

January 27, 1663/4. Ordered—That the president move this day the Society to appoint a committee of physicians, who are fellows of the Society, constantly to consider, what is necessary to be prosecuted in anatomy and surgery.—That the porter be allowed three pounds a year for his constant attendance, to be paid him quarterly.

1669/70. Mr. Oldenburg read the paper concerning Cassini's pretended new method, geometrical and direct, of finding the apogees and excentricities of the motion of the planets: after which he moved, that it might be inquired into, whether the like method had not been already found out in England. Whereupon Mr. Mercator, having considered this matter in private, produced a paper of his, which shewed, that this very thing was founded upon what Dr. Seth Ward, now lord bishop of Salisbury, had demonstrated in his "Astronomia geometrica" published in 1656. This paper was read, and being found to be the demonstration of this alleged invention of Cassini, printed as such in the French *Journal des Sçavans* of September 2, 1669, it was thought proper, that the narrative of the truth of this matter should be published in the *Philosophical Transactions*.

January 28, 1662/3. Mr. Hooke made the experiment of shutting up in an oblong glass a burning lamp and a chick; and the lamp went out within two minutes, the chick remaining alive, and lively enough.—Mr. Matthew Wren gave an account of a carp kept a whole week in a cellar out of the water, and fed with moistened bread, wetting the gills of it once or twice a day. Dr. Croune was put in mind to make this experiment, as he had formerly promised.

1668/9. The copies of Mons. Huygen's theory of motion were delivered, one to Dr. Wren, and another to Mr. Colwall.

January 30, 1660/1. Being the day of fast and humiliation for the death of King Charles I. there was no meeting of the Society.

Societies and Academies.

LONDON.

Royal Society, January 15.—Sir Charles **Sherrington** and E. G. T. **Liddell**: Further observations on myotatic reflexes. The myotatic reflex of the knee-extensor obtains after pre-collicular as well as after inter-collicular transection. The reflex retains tonic character after exclusion of the otic labyrinths. Stretch of the knee-flexors also yields a myotatic reflex, a main action of which is the depression by inhibition of the myotatic reflex of their antagonist, the knee-extensor. The reflex relaxation of the knee-extensor thus obtained is not changed into contraction by administration of strychnine.—A. V. **Hill**, C. N. H. **Long**, and H. **Lupton**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. An attempt is made to apply to the case of muscular exercise in man the principles discovered in the last seventeen years by the physical and chemical investigation of activity in the isolated frog's muscle. Part I. summarises the investigations, especially such as refer to the recovery process by which lactic acid, liberated during exercise, is removed in the presence of oxygen afterwards. In Part II. is described the method of estimating lactic acid in human blood. Part III. is a description of the lactic acid changes which occur in human blood, during and after exercise, with an account of their effect on the respiratory quotient. Part IV. describes methods of studying the respiratory exchanges in man, under the rapidly altering conditions which obtain at the beginning and end of exercise. Part V. is an account of the recovery process, in which oxygen is used and the lactic acid produced during activity is restored as the glycogen from which it arose. In Part VI. a discussion is given of the "oxygen debt" existing at the end of exercise, and of the muscle as an "accumulator of energy." Part VII. describes the relation between the rate of oxygen intake and the intensity of exercise. Considerably increased amounts of oxygen can be taken in when breathing gas mixtures rich in oxygen. In Part VIII. curves are given relating the "oxygen requirement" to the severity of various types of exertion.—A. P. **Chattock**: The physics of incubation. Daily cooling appears to be unnecessary, but an improvement in the hatching of more than 11 per cent. is indicated if the usual twice-a-day turning is increased to four times at equal intervals. By means of specially designed hygrometers, values of the humidity under hens have been obtained; very little improvement resulted from raising the humidity in incubators to the hen's nest value (20 mm. water-vapour pressure at the centre). On the principle that the water vapour and carbon dioxide which escape from the eggs during incubation must both leave the nest by the same paths, the ventilation in a hen's nest may be estimated. The value obtained is equivalent to the passage through the nest of 3·2 cubic feet of air per hour per 50 eggs; and is several times smaller than the ventilating air flow in typical "hot air" and "tank" incubators.—J. F. **Fulton**: (1) The influence of tension upon the electrical responses of muscle to repetitive stimuli. Simultaneous mechanical and electrical records of short, maximal, tetanic responses of intact skeletal muscle (gastrocnemius and sartorius; frog) have shown that the *size* of the successive electrical responses varies in isometric contraction with the tension developed, and in isotomic records with the work done. Tension *per se* rather than length of fibre controls the size of the action current. The mechanism which determines the size of the action current probably also controls the energy liberation within the fibre. (2) The relation between the durations of the isometric twitch and of the after-action of tetanus. The end of the plateau of short tetanic responses is characterised by an "angle" similar to that of the twitch. The duration of the after-action as measured from the beginning of the last electrical response of the tetanus to the "angle" is, in short tetani, invariably less than the duration of the twitch. The ratio of these two durations is approximately the same as that of the size of the corresponding action currents. The terminal "angle" of long tetani is less precise than in short, and is also less precise at high initial tensions than at low tensions. These modifications of the "angle" may be taken as evidence of slight fatigue—a less prompt "neutralisation" of the activating ions. (3) Some observations upon the electrical responses and shape of the isometric twitch of skeletal muscle. Isometric twitches of the intact gastrocnemius of frogs, when recorded with a myograph of high natural frequency, have a flat top which terminates with sufficient abruptness to form on the linear record a clearly defined "angle." Any factor tending to produce fatigue, obscures the "angle." From the shape of the isometric twitch it has been inferred that the "fundamental" process of contraction is rectangular in shape, the "angle" representing the point at which it ends, and the curve of relaxation representing the viscous return of the muscle to its resting shape.

PARIS.

Academy of Sciences, December 15.—M. Guillaume Bigourdan in the chair.—P. **Villard**: The construction of electro-magnets. Comparison of results obtained with differently shaped pole pieces, one cylindrical the other conical.—Ch. **Depéret**: The classification of the older Palæolithic from the historical and geological points of view. The palæolithic strata known as the Chellean consists of deposits of two different ages. One of these is older than the Chelles gravels, and for this the term pre-Chellean is proposed. The difference of age is shown both by the fauna and by the worked implements.—Ch. **Depéret**, Fabien **Arcelin**, and Lucien **Mayet**. New discoveries in the prehistoric deposit of Solutré (Saône-et-Loire). Following up the discoveries of human remains made in 1923, excavations near the same spot have revealed two more complete skeletons of Cro-Magnon type. The excavations of 1924 at Solutré have proved the existence, in regular superposition, of a series of levels containing graves, ranging from the Aurignacian epoch up to historic times.—Maurice **Lugeon**: River erosion. Example of the Rio Uruguay.—C. **Sauvageau**: The curious development of *Castagnea Zosteræ*.—Paul **Montel**: Some special complex families.—J. **Haag**: The combination of the results of observation.—René **Thiry**: Parallel displacement in Weyl's geometry.—B. **Galerkin**: The stability of a plate uniformly compressed parallel to its surface, limited by two arcs of concentric circles and by two radii.—P. **Laffitte**: The propagation of the explosive wave. C. Campbell has shown that if the diameter of the tube containing an explosive gas mixture increases suddenly, the explosive wave ceases to propagate itself, starting from the point of discontinuity. Experiments described by the author made with two gas mixtures ($CS_2 + 3O_2$ and $2H_2 + O_2$) show that although the explosive wave ceases to be propagated, starting from the point where the diameter changes suddenly, it reforms in the second tube after a period of combustion.—Léon and Eugène **Bloch**: The spark spectrum of iron in the Schumann region. The wave-lengths and intensities of 253 lines in the

region 1855 Å and 1505 Å are given: about half of these are new.—Alb. **Colson**: The displacement of the maximum of solubility and the existence of constant solubilities.—E. **Carrière** and E. **Vilon**: Experimental study of the action of sulphuric acid on calcium oxalate. After proof of the existence of an equilibrium, the influence of each of the variables, temperature, concentration of calcium oxalate and sulphuric acid, and excess of sulphuric acid was separately determined, the results being shown in the form of curves.—Claude **Fromageot**: Adsorption and cataphoresis.—P. **Lebeau** and P. **Marmasse**: The thermal fractionation of the gaseous products from the carbonisation of the structural constituents of bituminous coals. Fusain, durain, clairain, and vitrain from an English coal, and vitrain and durain from a French coal have been submitted to the method of fractional carbonisation described in an earlier paper (*Comptes rendus*, 177, p. 319). The results are shown graphically and analyses of the total gas obtained given. The composition of the gases obtained are very similar and they do not differ much from the gas obtained by the carbonisation of the original coal. The two vitrains, however, show a higher percentage of methane.—G. **Saurat**: The quaternary formation of Syrte minor.—Pierre **Lamare**: The presence of granites in the valleys of Baztan and Bertizarana (Haute-Bidassoa) and their tectonic significance.—G. **Mouret**: The geology of the Plateau of Aigurande and the dislocations of the neighbourhood of Neris (Allier).—Sabba **Stefanescu**: The presence of *Elephas planifrons* and of three mutations of *Elephas antiquus* in the geological layers of Roumania.—H. **Hérissey**: The presence of a glucoside in *Baillonia spicata* capable of being hydrolysed by emulsin, and the products of hydrolysis of this glucoside. The glucoside was not isolated, but from its hydrolysis by emulsin, *d*-glucose and a lactone, named baillonigenol, were isolated in a pure and crystallised condition.—P. **Freundler**: The conditions of the stabilisation of iodine in *L. flexicaulis*. The initial amount of iodine in these algæ may be preserved in three ways: increasing the saline concentration, heating in closed vessels at 110° C., or by complete desiccation at 105° C.—L. **Grigoraki**: Contribution to the study of Dermatophytes.—A. **Maige**: The evolution of amylogen excitability of the plastids in cells with starch reserves.—Maurice **Nicloux** and A. **Yovanovitch**: The fixation of chloroform by the central nervous system and the peripheral nerves. The method previously worked out for the determination of minute quantities (0·5 mgm. to 1 mgm.) of chloroform in blood and the tissues has been applied to the study of the amounts of chloroform fixed by the nerves after anæsthesia. The peripheral nerves, such as the central nervous system, fix the largest quantities of chloroform.—R. **Herpin**: The swarming and development of Eunice and Syllis.—Armand **Dehorne**: The histo-physiology of the intestinal cells of Ascaris of the horse and of the turtle.—Ch. **Pérard**: Researches on the destruction of the oocysts of Coccidia. The oocysts of *E. perforans* and *E. stiedæ* have been submitted to the actions of solution of various disinfectants, including formol, phenol, corrosive sublimate, and hypochlorites, and are not destroyed after 24 hours' exposure to these media, and in fact appear to develop better after such treatment. On the other hand, these organisms are very sensitive to drying or to heat and this is recommended for their destruction.—Henri **Stassano**: The mode of action of heat on the lactic ferments in the pasteurisation of milk. Three methods were tested: maintenance at 95° C. for two minutes, at 63° C. for 25 minutes, and in thin layers at 75° C. for 8 seconds. Some lactic ferments survive all three methods of pasteurisation, but the third method proved relatively the most efficient.—P. **Lemay** and L. **Jaloustre**: The comparative action of bismuth on staphylococcus, streptococcus, and the Coli bacillus. The staphylococcus is most sensitive to the action of bismuth salts.—H. **Labbé** and **Lavagna**: The action of acetoacetic acid on the nitrogen nutrition.—W. **Kopaczewski**: Surface tension and the cancer problem. It is proved by experiment that the development of cancer is accompanied by a diminution of the surface tension of the serum and blood plasma.—Jean **Saidman**: The absorption of ultra-violet rays by the skin and its therapeutical applications.—**Kohn-Abrest**: The index of toxicity and the utilisation of petrol in motor-cars. The ratio CO/CO_2 in the exhaust gases of a petrol motor is defined as the index of toxicity. Some determinations of this index are given, based on analyses of the exhaust gases of a motor-car working under different conditions.

CALCUTTA.

Asiatic Society of Bengal, December 3.—C. **Dover**: Further notes on the Indian diplopterous wasps. The subject is discussed from the faunistic point of view, and is based on a study of the Vespidæ in the British Museum; it is an attempt to settle the systematic position of various Indian forms.—Satya Churn **Law**: Kālidāsa and the migration of birds, No. 2. The migratory Hansas and Raj-hansas in Kālidāsa's works.—H. **Beveridge**: On Tamerlane. A review of the information in our possession about "the terrible Vulcan of Samarcand."—Maulavī 'Abdu'l **Wali**: Notes on the archæological remains in Bengal. The antiquities dealt with are situated in Burdwan, Murshidabad, Midnapur, Narayanganj, Birbhum, Aurangabad and other places.—Hirendra Lal Sen **Gupta**: A short history of the Madhyamika philosophy.—Harit Krishna **Deb**: "Ant-gold" and the Kautilīya Arthasāstra. The story of the so-called gold-digging "ants," in the sandy regions of Dardistan, related by Herodotus and later writers, is referred to in a passage in the Kautilīya. Cunningham's conjecture that these "ants" were some kind of marmots is confirmed. Incidentally, it is suggested that the "griffins" alleged to guard the gold dug up by "ants" may have been some variety of ant-eaters.—Harit Krishna **Deb**: (1) The Kautilīya Arthasāstra on the three classes of invaders. Invaders are classified in the Kautilīya as *dharma-vijayinah*, *lobha-vijayinah* and *asura-vijayinah*. The pre-Asokan date of this classification being shown, the inference is that India was already familiar with the Assyrian (asura) mode of invasion.—(2) The Kautilīya Arthasāstra on forms of government. The Kautilīya presents us with a threefold classification of forms of government, here analysed, namely, *rājya*, *dvairājya* and *vairājya*, corresponding respectively to government by one, by two or by the multitude. The Kautilīya's discussions contain helpful hints for a reconstruction of pre-Mauryan political and constitutional history.—Chhote Lal **Jain**: A bibliography of literature relating to Jainism, mainly from 1907 to 1924.

ROME.

Reale Accademia dei Lincei: Communications received during the vacation, 1924.—T. **Levi-Civita**: Exact determination of periodic irrotational waves in deep water.—E. **Carano**: Observations on the mechanism of division of the mother-cell of the embryo sac in apogamous plants.—Bonaparte **Colombo**: Study of the equations

$$\frac{\partial^3 z}{\partial x^2 \partial y} + \frac{\partial^3 z}{\partial x \partial y^2} = f(x, y, z, p, q, r, s, t)$$

and

$$\left(\frac{\partial}{dx} + \lambda_n \frac{\partial}{\partial y}\right)\left(\frac{\partial}{\partial x} + \lambda_{n-1}\frac{\partial}{y}\right) \cdots \left(\frac{\partial}{\partial x} + \lambda_2 \frac{\partial}{\partial y}\right)\left(\frac{\partial z}{\partial x} + \lambda_1 \frac{\partial z}{y}\right) = F(x, y).$$

—Francesco **Sbrana**: Certain integral equations.—Washington Del **Regno**: Photo-electric emission of selenium. No difference is detectable between the emission from selenium in the dark and in the light, the free electrons thus appearing to play no part in the phenomenon. The purely electronic character of the conductivity of selenium under the influence of light is upheld.—Bernardo **Oddo**: Diindylmethane.—Gaetano **Charrier** and Alessandro **Beretta**: Action of nitrosobenzene on *o*-nitroaniline. The product of this action is *o*-nitro-*p'*-nitrosodiphenylamine.—Gustavo **Cumin**: Geological notes on the Istrian mountain region. I.: Soils.—Enrico **Fossa-Mancini**: Tertiary strata in the neighbourhood of Orosei (Eastern Sardinia).—Ugo **Panichi**: The specific gravity of minerals and crystallised chemical compounds.—G. **Micatovich**: Experiments confirming the statolytic theory.—A. **Spartà**: Contribution to the knowledge of larval development in *Uraleptus Maraldii* Risso.—Livia **Garofolini**: Development of the chromaffine system and appearance of the chromoreaction in *Triton cristatus*.—Luisa **Volterra**: Variability of pelagic Dafnias in Lakes Albano and Nemi: *Daphnia longispina*.—Ugo **Banderati**: Action of alcohols on the sensory-motor cortical centres of the dog.—Mario **Ercole**: Contribution to the knowledge of the rhythm of renal secretion.—Carlo **Mannella**: Action of strychnine on the survival of the central preparation.—Carlo **Petacci**: Action of ethyl alcohol on the survival of the central preparation.—Palmira **Tavolaro**: Direct action of strychnine and various alcohols on the central preparation.—Oliviero **Olivo**: Commencement of the functional capacity of the contractile tissues in the embryo of the hen, in relation to their structural and morphological differentiation. I.: Functional and morphological differentiation of the cardiac embryo.—Gabriella **Armellini-Conti** and Giuseppe **Armellini**: Investigations on the variation of the luminous intensity of the moon during the total eclipse of August 14, 1924. From the moment at which the moon entered the earth's shadow until the eclipse became total, the total luminous intensity of the moon varied approximately according to a parabolic law. When the moon, entirely in the penumbra, began to enter the umbra, the intensity was nine-tenths of that exhibited by the full moon, whilst the intensity of the totally-eclipsed moon was about one-fortieth of that of the full moon.—F. **Zambonini** and G. **Carobbi**: Contribution to the study of the isomorphous relationships between compounds of beryllium and those of magnesium. In compounds of simple structure, beryllium and magnesium are probably not isomorphogenic except in very special cases, but mixed crystals of the double nitrate of magnesium and lanthanum with that of beryllium and lanthanum containing so much as 18 per cent. of the latter are obtainable.—L. **Sabbatani**: Pharmacological investigations on iron. VI.: Colloidal ferrous sulphide prepared in the presence of sugar. A preparation has been obtained which is much less toxic than that made in the presence of gelatin and is fixed more exactly and immediately, and almost exclusively in the liver and spleen. Such preparations produce pharmacological effects only as the result of chemical changes, which are rapid and profound with colloids of high degrees of dispersivity and stability, but slow and slight if the degrees of dispersivity and stability are low.—B. **Longo**: Further results on the sowing of the wild fig.—A. **Russo**: Different constitutions of the two pure gametes in *Cryptochilum echini* Maupas, resulting from the analysis of the nuclear successions, and the prevalence of the globuliform micronucleus.—Francesco **Sbrana**: Levi-Civita's parallelism for a surface of ordinary space.—Umberto **Crudeli**: Stationary motions in electronic dynamics.—Enrico **Fermi**: Theory of collisions between atoms and electric corpuscles.—G. **Carobbi**: Double nitrates of metals of the cerium group with copper and with cadmium.—G. **Sani** and V. **Grilli**: Practical notes on the conservation and transformation of nitrogen in stable manure.—Angelo **Bianchi**: Bismuthinite from Crodo, Val d'Ossola, and the crystallographic constants of bismuthinite.—E. **Onorato**: Celestine from Caramanico.—Emanuele **Quercigh**: Celestite from Pietraperzia and from Trabonella (Caltanissetta).—Carmela **Ruiz**: Celestite from Racalmuto (Girgenti).—Roberto **Savelli**: Genetic theory on the "electric mutations" obtained by Alberto Piròvano.—Cesare **Artom**: The species of *Gambusia* acclimatised in Italy (*Gambusia holbrooki* Grd.) in relation to the stability of the character of the gonopodium.—Giulio **Cotronei**: Dimensions reached by *Petromyzon fluviatilis* and the phenomenon of contraction. With this animal, the percentages of the two sexes may be considered identical. The female is larger than the male, and the form living in Southern Europe attains smaller dimensions than that of the north.—Boldrino **Boldrini**: Certain biological reactions encountered in the blood serum of women during and after the lacteal decline. I.: Demonstration of a precipitin of human milk serum.—Gaetano **Viale**: Variations of catalysis in the blood on high mountains.—Marcello **Boldrini**: Internal and external measures of certain long bones in man and in woman. I.: Volume of the medullary cavity and the phenomena of circulation and respiration.—Oliviero **Olivo**: Commencement of the functional capacity of contractile tissues in the embryo of the chicken in relation to their structural and morphological differentiation. II.: Functional and morphological differentiation of the myotome.

Official Publications Received.

Annual Report on the Working of the Museum Department during 1923-24. Pp. xi. (Malta: Government Printing Office.)

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 4: Plant and Animal Designs in the Mural Decoration of an Uriya Village, by Dr. N. Annandale; A Working Model of the Origin of the Ganges in a Temple in Ganjam, by Dr. N. Annandale, with Notes by Mahamahopadhyaya Haraprashad Shastri and Percy Brown. Pp. 239-256+6 plates. (Calcutta.) 4.8 rupees.

Union of South Africa. Journal of the Department of Agriculture, Vol. 9, No. 6, December: The Annual Report of the Department of Agriculture for the Year ended 30th June 1924. Pp. xviii+469-618. (Pretoria: Government Printing and Stationery Office.) 6*d*.

Department of Agriculture, Trinidad and Tobago. Administration Report of the Director of Agriculture for the Year 1923. Pp. 19. (Port-of-Spain: Government Printing Office.) 8*d*.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 8, No. 1: On the Fauna of the Anthracolithic Limestone of the Ômi-mura in the Western Part of Echigo. By Ichirô Hayasaka. Pp. 83+7 plates. (Tokyo and Sendai: Maruzen Co., Ltd.)

Empire Textile Conference. Official Report of Proceedings of Conference held at the British Empire Exhibition, Wembley Park, Whit-week 1924. Pp. v+267+109. (Manchester: The Textile Institute.) 5*s*.

United States Department of Agriculture. Department Bulletin No. 1217: Mixing Emulsified Mineral Lubricating Oils with Deep-well Waters and Lime-sulphur Solutions. By W. W. Yothers and J. R. Winston. Pp. 6. (Washington: Government Printing Office.) 5 cents.

Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March 1924. (M.O. 267.) Pp. 61. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 21 on Magmatic Nickel Deposits of the Bushveld Complex in the Rustenburg District, Transvaal. By Percy A. Wagner. Pp. 181+22 plates. (Pretoria: Government Printing and Stationery Office.) 7*s*. 6*d*.

Meddelanden från Statens Skogsförsöksanstalt. Hälfte 21, Nr. 7: Grankottmätarna (*Eupithecia abietaria* och *Strobilata*) och deras Skadegörelse. Av Paul Spessivtseff. Pp. 295-310. Hälfte 21, Nr. 8: Tragnagarestudier (Anobiiden-studien). Av Ivar Trägårdh. Pp. 311-338. Hälfte 21, Nr. 9 (Slutnummer): Redorgörelse för Verksamheten vid Statens Skogsförsöksanstalt under år 1924. Pp. 339-357. (Stockholm.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 517: Water Powers of the Great Salt Lake Basin. By Ralf R. Woolley. Pp. xvi+270+13 plates. 30 cents. Water-Supply Paper 521: Surface Water Supply of the United States, 1921. Part 1: North Atlantic Slope Drainage Basins. Pp. vi+294+2 plates. 25 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 750-D: New and Known Minerals from the Utah-Colorado Carnotite Region. By Frank L. Hess. Pp. 63-78+plates 4-11. Bulletin 750-E: Deposits of Magnesia Alum near Fallon, Nevada. By D. F. Hewett. Pp. 79-86. Bulletin 750-F: Molybdenite in the Rocky Bar District, Idaho. By Frank C. Schrader. Pp. 87-99. Bulletin 751-C: Geology and possible Oil and Gas Resources of the Faulted Area south of the Bearpaw Mountains, Montana. By Frank Reeves. Pp. iv+71-114+plates 10-14. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, JANUARY 24.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Miss E. M. Blackwell: An Outline of the Life History of *Phytophthora Cactorum*, Schroet.—H. R. Briton-Jones: The Diseases known as "Bark Canker" and "Die-back" of Fruit Trees.—J. Ramsbottom: Fragmenta Mycologica (II.).—Dr. M. C. Rayner: Sectoring in Cultures of *Phoma radicis-Callunæ* Rayn.—E. S. Salmon: The Epidemic Appearance in England in 1924 of a "Downy Mildew" of the Hop.

MONDAY, JANUARY 26.

ROYAL IRISH ACADEMY, at 4.15.

INSTITUTE OF ACTUARIES, at 5.—C. R. V. Coutts: Notes on Life Assurance Investment Policy.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (IV.). Neanderthal Man in Malta. A Review of the Racial Characters of the Inhabitants of Southern Europe in later Pleistocene Times.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—S. W. Melsom and others: Discussion on the National Physical Laboratory and its Work.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at the Great Northern Hotel, Leeds), at 7.15.—The Donnan Equilibrium in Chemical Industry:—Prof. H. M. Dawson: The Donnan Membrane Equilibrium Hypothesis.—W. R. Atkin: The Donnan Equilibrium in the Leather Industry.—J. B. Speakman: The Donnan Equilibrium in the Textile Industry.—Prof. N. M. Comber: The Donnan Equilibrium in Soil Phenomena.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—L. H. A. Carr: The Use of Induction Regulators in Feeder Circuits.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates Meeting) (at Institution of Mechanical Engineers), at 7.30.

ROYAL SOCIETY OF MEDICINE, at 8.—G. F. Cale Matthews: A Case of Long-standing Insomnia cured by the Extraction of Pulpless Teeth.—L. E. Claremont: The Problem of Pulpless Teeth.

ROYAL SOCIETY OF ARTS, at 8.—V. E. Pullen: Radiological Research—a History (II.) (Cantor Lectures).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Brig.-Gen. the Hon. C. G. Bruce and Major Northey: Nepal.

MEDICAL SOCIETY OF LONDON, at 8.30.—Prof. A. Castellani: Parenteric Fevers.

TUESDAY, JANUARY 27.

ROYAL DUBLIN SOCIETY (in Royal College of Surgeons, Dublin), at 4.15.—G. Brownlee: The Interpretation of certain Empirical Standards in their Application to Irish Butter.—Prof. E. A. Werner: The Decomposition of certain Amino-Acids by Alkaline Hypobromite.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—W. R. Dunlop: Economic Research in Tropical Development, with Special Reference to British Guiana and British Malaya.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. H. R. Hall: The Connexion and Relations of the Prehistoric Greek and Ancient Egyptian Civilisations (I.).

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. E. H. Salmon: The Southampton Floating Dock.—F. E. Wentworth-Sheilds: Southampton Floating Dock: Subsidiary Works.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.—A. E. Berriman: A Review of the Rating Question.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Alexander B. W. Kennedy: Petra.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Meeting) (at Broadgate Café, Coventry), at 7.15.—L. Jefferies: Gearing.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Leeds University), at 7.30.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—J. W. T. Walsh and others: Discussion on The Effect of Internal Obstructions on the Performance of a Lighting System.

WEDNESDAY, JANUARY 28.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (V.). France and Germany.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Section) (at 244 Deansgate, Manchester), at 6.30.—W. D. Williamson: The Respective Spheres of Petrol, Steam, and Electric Commercial Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at the Midland Institute, Birmingham), at 7.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—The Use of the Microscope in the Dairying Industry:—Prof. R. S. Williams: The Microscope of Fundamental Importance to the Industry.—N. Wright: The Structure of the Udder, Normal and Abnormal.—A. T. R. Mattick: The Differentiation of the various Cells found in Milk.—L. J. Meanwell: The Application of the Microscope to the Detection of Tuberculous Infection.—J. Golding: Fat Globules.—Miss E. R. Hiscox: The Separation and Identification of Micro-organisms causing Faults in Milk Products.—J. E. Barnard: The Elementary Principles of Microscopical Illumination (2). Self-luminous Objects (Lecture Demonstration).

ROYAL SOCIETY OF ARTS, at 8.—C. A. Baker: The Electrical Equipment of the London County Hall.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—B. W. Clarke, S. G. M. Ure, and Prof. J. W. Hinchley: Studies in Filtration.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. M. D. Eder: Substitution.

THURSDAY, JANUARY 29.

ROYAL SOCIETY, at 4.30.—P. M. S. Blackett: The Ejection of Protons from Nitrogen Nuclei, photographed by the Wilson Method.—R. E. Gibbs: The Variation with Temperature of the Intensity of Reflection of X-Rays from Quartz and its Bearing on the Crystal Structure.—R. W. Gurney: (1) Ionisation by Alpha Particles in Monatomic and Diatomic Gases; (2) The Stopping-Power of Gases for Alpha Particles of Different Velocities.—Dr. W. E. Curtis: The Fulcher Hydrogen Bands.—W. L. Webster: The Magnetic Properties of Iron Crystals.—*To be read in title only*:—A. E. Ingham and J. E. Jones: The Calculation of certain Crystal Potential Constants and on the Cubic Crystal of least Potential Energy—E. C. Stoner and L. H. Martin: The Absorption of X-Rays.—F. H. Schofield: The Thermal and Electrical Conductivities of some Pure Metals.—M. de Sélincourt: The Effect of Temperature on the Anomalous Reflection of Silver.—T. L. Ibbs: Thermal Diffusion Measurements.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (I.).

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Prof. C. H. Desch: Recent Developments in the Cement Industry.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 8.—Sir W. Peter Rylands: The Philosophy of Welding.

ROYAL SOCIETY OF MEDICINE, at 8.30.—Discussion: Radiotherapy and Electrotherapy in Diseases of the Bladder and Prostate.

FRIDAY, JANUARY 30.

ROYAL DUBLIN SOCIETY, at 4.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (VI.). Recent Discoveries of Fossil Man in England and their bearing on the Early Distribution of Racial Types in Europe.

INSTITUTION OF MECHANICAL ENGINEERS.—Discussion: Alternatives to the "Clash" Type of Change-Speed Gear for Motor Vehicles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—P. C. W. King: The Evolution of the Airship.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—A. J. Broughall: The Utilisation of Waste Steam.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.30.—F. D. Verrill: Shipyard Pneumatic Plant and Pneumatic Riveting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. Ambrose: Notes on High Voltage Electrical Transmission (Lecturette, Slides).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. W. Gregory: The Mountain Structure and Geographical Relations of South-Eastern Asia.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Section).

PUBLIC LECTURES.

SATURDAY, JANUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: Rough Stone Monuments and their Builders.

MONDAY, JANUARY 26.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: Constitution of International Labour Organisation.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 5.15.—Sir Richard Paget, Bart.: The Nature and Synthetic Production of Human Speech.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Some Results of the Excavations of Ur.

ROYAL SANITARY INSTITUTE, at 5.30.—Prof. H. R. Kenwood: Introductory Lecture to Students in the several Courses of the Institute.

TUESDAY, JANUARY 27.

KING'S COLLEGE, at 5.30.—Rev. Prof. W. R. Matthews: Philosophy and Religion.

UNIVERSITY COLLEGE, at 5.30.—Prof. G. Elliot Smith: The Evolution of Man.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 8.—Prof. A. Gilligan: The Geology of Yorkshire: The Effects of the Glacial Period.

WEDNESDAY, JANUARY 28.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—The Principles of Design as applied to Textiles.

THURSDAY, JANUARY 29.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. H. Hall: The Records of Famine in Mediæval England (as illustrated by the Manorial Rolls of the Bishopric of Winchester).

FRIDAY, JANUARY 30.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Philosophical Hall, Leeds), at 8.—Prof. J. Garstang: The Archæology of Palestine.

SATURDAY, JANUARY 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Empire of Egypt.