NATURE

SATURDAY, FEBRUARY 20, 1932

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET, LONDON, W.C.2

Editorial communications should be addressed to the Editor
Advertisements and business letters to the Publishers

Telephone Number: GERRARD 8830
Telegraphic Address: PHUSIS, WESTRAND, LONDON

The Supply of Biologists *

THE Committee of the Economic Advisory Council appointed in 1930 to " consider the obstacles which stand in the way of the education and supply of biologists for work in this country and overseas, and to submit recommendations for the removal of such obstacles ", has recently issued its Report. This is based on evidence obtained from an exhaustively diverse body of witnesses, and deals with every aspect of the problem, including even a brief appreciation of the value of natural history.

The general public undoubtedly as yet fails to realise that, other than in the medical profession, there exist in Government services, in industry, and in teaching a number of posts which are open only to biological workers. This failure is due to lack of information. There is no machinery for placing before potential candidates, their parents, and schoolmasters any comprehensive statement of the various classes of biological Government posts that are likely to be vacant at any given date, together with information as to salaries and prospects of promotion; nor is there co-ordination among the departments employing biologists in Great Britain.

A similar uncertainty with regard to biological posts in the Colonial Empire—the largest employer of biologists under the Crown—is a grave deterrent to men contemplating biological careers, there being no assurance as to the number of vacancies in any given year, nor uniformity of conditions in the terms of service offered by the several Colonial Governments. It is suggested that if there were introduced for Colonial biological appointments the same degree of certainty as already exists for candidates seeking employment in the Home and Indian Civil Services, parents, schoolmasters, and university tutors would then be in a position confidently to advise young capable biologists to compete for one of the guaranteed posts, and the supply of competent workers in biological fields would greatly increase.

Uncertainty, then, is the first obstacle. The second is the financially unattractive character of the careers offered to biologists in the Colonial Service, and the poor prospect of promotion. This deterrent would be greatly reduced if there were uniformity of conditions of service and scales of pay throughout the Colonial Dependencies, and if high administrative positions were attainable by

* Economic Advisory Council. Committee on Education and Supply of Biologists: Report. Pp. 68. (London: H.M. Stationery Office, 1932.) 1s. net.

biologists possessing the necessary administrative capacity.

The demolition of these two main obstacles will itself effect the reduction of the remainder. "Once it becomes generally recognised that there are careers in biology, the public will turn their attention to the opportunities offered for their boys, and parents will see to it that the schools provide the instruction; once the schools give the proper position to biology in the curriculum, boys will begin to become interested, and the attractions of careers offered by biology will be weighed against those offered by classics" and other subjects. The process must, however, be gradual; over-production of suitable candidates as a consequence of excessive stimulation would result in disappointment, and would discourage further supply. *Festina lente.*

Partly as a result of the foregoing obstacles, biology arrived in the curricula of schools long after chemistry and physics had become firmly established. Indeed, though its position has of late years much improved, it has not yet received universal recognition: biology should, as an indispensable cultural element, be brought to the notice of every boy, and none should leave school without some knowledge of it. The result of this late arrival is that relatively few boys, and especially too few of the most able, have proceeded to the universities with their minds still open to biology; and at the universities they have continued on the lines of their previous studies in chemistry and physics, particularly if they held scholarships awarded for those subjects. It can scarcely be doubted that among these were some who would have found in biology their *métier*, had the subject but been included in the course of their training.

The consolidated positions occupied by chemistry and physics have enhanced the difficulty of finding a place for biology in school curricula. It has inevitably followed that the number of candidates for scholarships at the universities in these older subjects has become very great; competition has thus become severe; the standard of the examinations has risen; the schools have been driven to excessive concentration on chemistry and physics; and biology has often gone to the wall. Moreover, the biology candidate must perforce have a good elementary knowledge of both chemistry and physics, and thus, from sheer lack of time, cannot attain in his own subject to a standard commensurate with that reached in their subjects by those offering chemistry and (or) physics.

It is recommended as a remedy for this over-specialisation (1) that in the scholarship examinations at the older universities the standard in all branches of science should be definitely lower than the present in chemistry and physics; (2) that in the award, proficiency in one modern language (preferably German) should carry due weight; and (3) that the faculties of science at these universities should discourage excessive specialisation in the schools by insisting that some knowledge of biology and some proficiency in a modern language be shown by all candidates offering science for their honours degree. The adoption of these recommendations will necessitate increase in the number of teachers of biology in schools; for, unless these are forthcoming, it is impossible to create the 'pool' from which the biological services are to be maintained. At the present time, after governments, research institutions, museums, the universities, and industry have extracted their toll, there is left, as is shown by the statistical appendix to the Report, only a small remainder to teach in the schools.

The type of teacher needed in the schools is not only the specialist in biology, but also those who have taken biology as a subsidiary subject in their examination for an honours degree in science, and who are therefore competent to teach biology as a cultural subject in the ordinary curriculum. The supply of such teachers would soon be assured if the regulations governing honours science degrees were modified in the manner suggested in the Report and already quoted.

To give effect to the conclusions at which this Committee has arrived, negotiations are required between a large number of authorities, often independent of one another and regarding the problems from different points of view. The Report therefore urges that, to bring these negotiations to a successful issue, the Economic Advisory Council should recommend His Majesty's Government to invite the President of the Board of Education, in consultation with those of his ministerial colleagues who are immediately concerned, to prepare for their consideration concrete plans for the initiation and conduct of the negotiations.

The Committee has succeeded in indicating clearly where the obstacles lie, and in formulating constructive suggestions for measures by which the flow of biologists may be augmented and cleared of existing impediments. It is to be hoped that the Government will not delay to act upon its final recommendation.

Faraday's Alloy Steels

Faraday and his Metallurgical Researches: with Special Reference to their Bearing on the Development of Alloy Steels. By Sir Robert A. Hadfield, Bt. Pp. xx + 329 + 58 plates. (London: Chapman and Hall, Ltd., 1931.) 21*s*. net.

THE two papers on Faraday's metallurgical researches presented last year by Sir Robert Hadfield to the Royal Society and the British Association respectively but whetted one's appetite for more. In the volume under review the full meal is provided. In essence it is divided into two fairly distinct portions, one of which is concerned with the man himself, the conditions under which he became what he ultimately was, and the people with whom he was brought into contact. To many of the latter, through their influence upon his work and outlook, real, if indirect, credit for Faraday's own achievements is due. Great care and industry have clearly been devoted to this section of the work, with so much success that readers who neither know, nor possibly even care, about Faraday's metallurgical work will come to know a really great man.

The present study is of the greater biographical interest in that Faraday carried out his work on steel during the very early years of his research career, at the very time, in fact, when the bookbinder's apprentice was being gradually transformed into one of the greatest of scientific workers. In a letter regarding his steels, written by Faraday in June 1820, he refers to "the two years that we have worked upon this subject", suggesting that this research may have been started so early as the middle of 1818. The rest of the book will be appreciated to the full only by those to whom metallurgical research, especially in the domain of special steels, is of immediate interest. To a wide circle of readers, however, some of the fascination will be felt even here.

We have already referred to the work described in Sir Robert Hadfield's papers on the samples of Faraday's steels discovered in the Royal Institution (NATURE, Jan. 9, 1932). From these, certain alloys which were known to have been made were missing, and since some, which contained large amounts of the very precious metals, were among the most interesting of all, the loss was the more deplorable. By almost incredible good fortune, the major portion of these have since been recovered and subjected to the same thorough examination as were the earlier materials. Two types alone of all the alloy steels which Faraday made are now lacking from the samples known, namely, that containing osmium and iridium and the one containing tin.

The ten specimens forming the subject of this continuation of the research had been deposited at the Science Museum by their owner, Mr. A. Evelyn Barnard, a nephew of Jane Barnard, Faraday's adopted daughter. These consisted of a razor made from one of Faraday's own platinum steels by his collaborator Stodart, six small 'buttons' of alloys which had been melted in the famous 'blast furnace', and three samples of platinum and steel which had been welded together. In Faraday's diary for Nov. 3, 1823, is the record of the production of nine metallurgical samples, with seven of which the present materials can definitely be identified. It would have appeared out of the question two or three years ago that we should ever have known more about Faraday's steels than he himself told us in his papers, and that we should ever have been able to identify the exact melts made after the last of the metallurgical papers had appeared, and even the day and the order in which the melts were carried out, would have seemed beyond the bounds of possibility.

The total quantity of these new materials which Sir Robert Hadfield has had for investigation was less that six ounces, and the number of tests which could be made was correspondingly restricted. The amount of information which has been gathered is, however, surprising. By comparison with 'buttons' of Swedish iron fashioned into a similar size and shape—obviously a very tedious business—approximate measurements of even the magnetic characteristics have been obtained. The more interesting samples consist of platinum and rhodium alloys, each containing nearly fifty per cent of the special metal, a palladium steel with half the quantity of that metal, and three samples of steel and platinum welded together in attempts to imitate Damascus steel. The properties of the rhodium alloy are probably the most interesting. The sample, which had a mirror polish over most of the upper surface, showed, despite the century since it was made, no sign of rust. It contained only 0·12 per cent of carbon with 48·8 per cent of rhodium. One of the most outstanding physical characteristics of this 'steel' is its high magnetic permeability, which is of the same order as that of the purest commercial iron. Its Brinell hardness of 350, too, is high for an untreated material. When exposed to the Sheffield atmosphere for two days, however, slight rusting occurred at one point, so that the most resistant of Faraday's alloys, as this was, is yet inferior to the stainless steels produced to-day.

The book is unique; in no other hands could more information regarding these steels have been obtained, and it is doubtful whether in any others nearly so much would have resulted. In one direction only can anything be added to what is here contained. To the writer of this review it appears that Faraday's Bakerian Lecture on the colour of thin metallic films is worthy of credit as great as that due to his work on steel. When discussing the effects of heat upon gold leaf, Faraday showed that at a certain temperature the latter lost its metallic lustre and became transparent. In discussing the reasons for this he says ("Experimental Researches", p. 397): "As already mentioned, it might be thought that the gold leaf had run up into separate particles. If it were so, the change of colour by division is not the less remarkable, and the case would fall into those brought together under the head of gold fluids." It would not have been a long step from this observation to the conclusion, reached much later by Beilby, that polished metallic surfaces are covered with a vitreous layer of the metal and to the well-known 'amorphous hypothesis'. F. C. T.

Epidemiology of Insect Pests

Die Forstinsekten Mitteleuropas: ein Lehr- und Handbuch. Von Prof. Dr. K. Escherich. Band 3, Spezieller Teil, Abteilung 2: *Lepidopteroidea: Die "Schnabelhafte" (Panorpatæ); die "Kocherfliegen" (Trichoptera); die "Schmetterlinge" I (Lepidoptera I); Allgemeines, Kleinschmetterlinge, Spanner und Eulen.* Pp. xi + 825 + 14 Tafeln. (Berlin: Paul Parey, 1931.) 57 gold marks.

IT is unfortunate that the title of this remarkable volume is misleading and may prevent the ideas put forward in it from becoming the property of general biology, to which they naturally belong.

Applied entomology is usually regarded as a purely descriptive and empirical science. Indeed, many biologists would not hesitate to consider it as not a science at all, but rather a craft. However, the last decade or two have witnessed profound changes in the methods of economic entomology, which is evolving rapidly into a real science, with its profound analysis of the causation of phenomena and the application of exact quantitative methods drawn from a wide range of other sciences. Economic entomologists of the present day study their insects against a background of the environment, and the study is not restricted to the external phenomena of bionomics, but special stress is laid on the physiological characteristics of the insect, its limits of toleration with regard to various environmental factors, and the influence of these factors on its development and propagation. An insect is conceived as a physiological system, developing and acting in a world of physico-chemical influences, which can and must be analysed and correlated with definite phenomena of insect life. Observations in the field and subjective deductions from them are giving way to experimental studies in a laboratory and to exact investigations of the environment.

The principal aim of these studies is the discovery of the causes underlying the well-known but still largely mysterious phenomenon of the fluctuations in the numbers of an insect, which make it a pest one year, while in the next it does not attract any attention. Modern economic entomology is, therefore, assuming the character of an epidemiology of insect pests, and quantitative studies of insect population as affected by fluctuations in environmental factors from year to year attract the chief attention of entomologists. This point of view and these methods of work have proved most fruitful, and there is every promise that economic entomology will soon rise to the rank of a science the results of which will be of direct interest and of great value to very wide circles. Indeed, injurious insects, appearing as they do in enormous numbers, present an exceptionally favourable material for analytical investigations of the factors regulating the numbers of individuals of a species. Thus, insect epidemiology opens a way to a scientific analysis of one of the most central points of the evolutionary process.

The book under review hides under its unpretentious title a masterly presentation of this new aspect of economic entomology. The methods and results of epidemiological research are discussed in its general part, while the special part contains a wealth of facts, all arranged according to the epidemiological conception of entomology. The chapter on the pine moth (*Panolis flammea*, L.) can be recommended for reading to every biologist interested in general evolutionary problems, because this pest has been recently studied epidemiologically by a number of outstanding entomologists, and the results, summarised by the author in a very concise way, represent a unique picture of the life of a species as a whole and in the actual, enormously complex environment.

It is interesting to note that the results of epidemiological work on various insects tend to stress the importance in the life of a species of the physical environment. Organic factors of control, such as predators, parasites, and diseases, in most of the cases sufficiently studied, play a definitely subordinate part, and the population of a pest is usually regulated by climatic factors, coupled with the surprisingly inadequate adaptation of insects to the vagaries of climate. It is only in some cases that the controlling influence of organic factors becomes significant, and this happens usually towards the end of an outbreak of the pest. The initial abnormal increase in numbers leading to an outbreak is always due, not to the reduced activities of natural enemies, but to the fluctuations in the course of weather, which constitutes an ever-present and continually active regulating factor. It is only fair to add, however, that the author himself is more conservative on this point than the majority of his followers in epidemiological studies.

A few minor faults may be mentioned, merely in order to stress the general excellence of the book. The problem of the selection of food plants by insects is discussed (p. 43) much too briefly for a problem of such outstanding practical and theoretical interest. The treatment of the literature has a definite bias towards German works. This is perhaps excusable so far as the special part, treating forest insects of central Europe, is concerned, but in the general chapters more attention could be directed to the valuable work of American physiologists and ecologists. For example, readers who may want to know more about the technique of physiological studies are referred to certain German books (Friedrichs, etc.), but Shelford's unique compendium is not mentioned. On p. 38, the investigations on the tarsal perception of taste by butterflies are credited to Frisch instead of Minnich; and on p. 84, an incorrect statement is made that aeroplane dusting against locusts has been developed in South Africa, while the actual paper by Mally, quoted in this connexion, refers only to experiments on dust poisons; no work with aeroplanes against locusts has ever been undertaken in South Africa, to the best knowledge of the reviewer.

A feature of the book are the numerous illustrations, including both text figures and coloured plates. Originals for most of the plates have been drawn by Herr von Kennel, a well-known authority on Microlepidoptera, and their exactitude and artistic quality of reproduction are in keeping with the generally high standard of the book.

Forest entomologists will find a mine of information on their subject in the book; workers in any other branch of economic entomology should certainly read it, in order to obtain a definite conception of their science; the general biologist who can be persuaded to read it would have no grounds to regret the time spent on it. Economic entomologists should feel now that their science is beginning to find its place amongst other branches of biology, and this is largely due to the life-work of Prof. Escherich and his numerous pupils.

B. P. UVAROV.

The Geochemistry of Igneous Rocks

The Chemical Analysis of Rocks. By Dr. Henry S. Washington. Fourth edition, rewritten and enlarged. Pp. xvi + 296. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 20*s* net.

DR. H. S. WASHINGTON is well known throughout the geological world as the most prolific of rock-analysts; as the author of a long series of petrographical papers; as the compiler of the records of analyses known familiarly as "Washington's Tables"; and, to chemists as well as geologists, as the author of this invaluable guide to the chemical analysis of igneous rocks. The present edition has been thoroughly revised and enlarged in order to incorporate descriptions of new methods and the uses of new reagents which have, in the author's experience, proved to be simple and reliable. Details of procedure are so fully and clearly given that the book can be used with complete confidence by any capable student. Apart from the descriptions of apparatus, operations, and methods, the general discussion of the value of rock analyses and of the occurrence of the rarer elements is of great interest. It is rightly pointed out that "an analysis complete as to the subsidiary constituents may be of great value in the future or to others, even if this degree of completeness is not necessary for the end immediately in view".

A plea for completeness is worthy of particular attention at the present time, when the importance of the geochemistry of igneous rocks is just beginning to be properly appreciated. It is commonly thought, for example, that all peridotites are derivatives from basaltic magmas, notwithstanding the fact that some, like the mica-peridotites, are quite clearly independent of basaltic associations and have a very different assemblage of the rarer elements from those of basaltic origin. This is particularly noteworthy in the case of P_2O_5, F, BaO, and SrO, and consequently it may well be that detailed analysis will provide in doubtful cases a criterion for discriminating between peridotites that come directly from the substratum and those that are merely accumulations of the early crystals of basaltic magma.

The work of Fersman shows that the nepheline-syenites and their relatives have associations of elements which differ considerably from those of both the granitic and basaltic families. This feature seems fatal to the general application of the Daly hypothesis of limestone assimilation, and consequently more detailed analyses are indispensable if the origin of the alkali rocks is to be intelligently discussed. It is disappointing to find in the majority of petrological papers analyses that are copious in number but deficient in detail. Petrologists should insist on all the detail they can get, for even the rarity or absence of a minor constituent is likely to be evidence of positive value. The high standard in this respect reached by the analysts of the Geological Survey of Great Britain, and particularly by Dr. H. F. Harwood, of the Imperial College of Science and Technology, is already directing attention to problems of fundamental importance that cannot as yet be adequately discussed on a world-wide scale for lack of the necessary data.

Dr. Washington's book is of particular value because of his insistence on a high ideal of accuracy and completeness. If time be a consideration, it is well that the petrologist and his chemical colleague should realise that a few detailed analyses are worth very much more than a large number that stop after twelve or fourteen constituents have been determined. ARTHUR HOLMES.

Language through the Looking Glass

Through Basque to Minoan: Transliterations and Translations of the Minoan Tablets. By F. G. Gordon. Pp. v + 83. (London: Oxford University Press, 1931.) 10*s.* 6*d.* net.

IN this book the experiment is tried of assigning modern Basque values to the Minoan characters on bronze age tablets from Crete. As Mr. Gordon says (p. 1), " such a method must obviously begin as pure guess-work ". It also ends there; for " not only did the system yield a language indistinguishable (at present) from Basque, but it revealed unmistakable references to Hellenic deities, several old Greek names, and three poems, one in hexameter verse, one in elegiac, and one in couplets . . ." etc. Basque is lovely for the purpose: "the language is highly fluid, the aspirate is uncertain, and inversions are common" (p. 2); and "it appears to make no distinction between B, P, and M, T and N, G and K, L and R, O and U ". It was also " an obvious convenience " that " the authors of the script were able to select signs with several meanings " (p. 3); and Mr. Gordon's " method ", as he frankly says (p. 4), " consists in applying a series of hypothetical values, and endeavouring to show that they fit everywhere ". For example (p. 9), with a sign which " appears to represent a conical eminence of some kind, and is provisionally rendered *iaq* or *iq*, Basque ik, 'height'", he thinks it "possible to write the plural, the agential suffix, the partitive suffix, the past participle, and the imperative singular, besides using the sign as a connecting link ". English itself has never attempted as much; and it is not surprising that "it would constantly occur, therefore, as in fact it does ". Another sign (for " a beard, *bizal*, Basque bizar ") " may also stand for a univalve of contorted type " (for which no Basque word is given), because it " stands as a decoration in a marine subject ", being in fact what the Germans call a " Füllenornament " of the commonest, in Late Minoan pot-painting.

The proof of the pudding is, however, in the eating. A well-known tablet (Hull, " Ægean Archæology ", pl. xxxiii.) not only " tells a connected story " (p. 4), but tells it "quite in the spirit of the Greek Anthology ". Scholars familiar with the Anthology must judge for themselves a composition which is " only what might have been expected from the Minoan genius ". Here is this " epigram ", an " elegiac Muiopotmos ", and " the work of a practised hand ", of which " the rhythm goes with a swing " (p. 16): *A spider in its web, holding thread in its mouth; a flesh-fly, round-headed, flower-skinned, the little wine-jar tapper. Take care, drinker, embracing a tomb with the mouth, drinking wine—alas! alas! He has spun round, dead!* As Mr. Gordon says (p. 14), it is " a little disconcerting at first "; but it is sober prose compared with the translation of the Phaestos Disc which he offers on pp. 55-67. This latter document, he thinks, is a metrical calendar, partly elegiac. Here is one of the pentameters: *Yasali dad bidiaq yadzua ulluedugi izal*; and it means (through Basque to Minoan) " the lord, smiter of the horse-hide (*or* the surface of the rock), the dog climbing the path, the dog emptying with the foot the water-pitchers ".

Indeed, only one question remains unanswered. Does the imprint " Oxford University Press " on the title page mean what it says or (into Basque through Minoan) something different? JOHN L. MYRES.

Short Reviews

Studies in the Literature of Natural Science. By Julian M. Drachman. Pp. xi + 487 + 6 plates. (New York: The Macmillan Co., 1931.) 17*s.* net.

As science becomes more and more popular, the man of science can no longer isolate himself in the laboratory; he must communicate his attainments to the general public in books which can be read without spending a lifetime in the mere learning of an alphabet. If it could be shown that the writers of scientific classics produced what in some cases were works of literary art, that might be a more convincing argument still. Such is the task which the author of this interesting book sets himself to do. He confines his research to the literature of natural science in the nineteenth century, which is dominated by men of genius like Darwin, Lyell, Owen, Huxley, and Tyndall, pointing out in each case how art and science are happily interconnected. The general conclusion of this historical investigation is that the writer of books on scientific subjects can vastly increase the number of his readers and the efficiency of his presentation by means of increased attention to the literary art.

Besides a number of interesting quotations from the sources, and the novel commentary presented by the author of several classical scientific works, there are two points in this book which should be mentioned. One is the new ‘ cyclical ’ classification of the sciences, which are divided into four groups—mental, human, natural, physical—each of which is further divided into sub-groups. The arrangement illustrates in a striking manner the mutual interdependence of the sciences. The other point is a questionnaire on the literature of science which was answered by various scientific workers and writers, and is intended to show that there is no essential contradiction between literature and science. Huxley's “ Essays ” have had more votes than any other as a “ particularly fine book of popular science ”. T. G.

A Manual of the Dragonflies of China: a Monographic Study of the Chinese Odonata. By Prof. James G. Needham. (Zoologia Sinica, Series A: Invertebrates of China, Vol. 11, Fascicle 1.) Pp. ii + 344 + 11 + 20 plates. (Peiping: The Fan Memorial Institute of Biology, 1930.) 5 dollars; 20*s.*

This bulky memoir is based upon researches that were supported by a grant from the Heckscher Foundation of Cornell University, and it forms a notable contribution to a knowledge of the little explored insect fauna of China. The material which rendered the work possible was obtained from many sources and includes that collected by Dr. Needham during a year's residence in China. Altogether 266 species of dragonflies are described, of which 58 are regarded as being new to science. They are included in 89 genera, of which the single genus *Simolestes* is new. The memoir is very fully illustrated by 20 plates which portray structural details of both adults and of the few nymphs that have yet been discovered. We congratulate the author, and those responsible for its publication, upon the production of a work that will be welcomed by students of the Odonata throughout the world.

Thought Transference (or What?) in Birds. By Edmund Selous. Pp. xi + 255. (London: Constable and Co., Ltd., 1931.) 7*s.* 6*d.* net.

Mr. Selous holds a high place as an observer of bird behaviour, and in the present small volume he gives much admirable description in support of his view that the concerted actions of flocks can be explained only by postulating some kind of ‘thought transference ’ between the members. The apparently simultaneous rising of a flock of rooks without obvious extraneous stimulus; the unanimity with which a party of dunlins wheel in their dashing flight; the sudden hush that stills the screaming of a colony of terns: these and many other examples of community behaviour the author observes over and over again with minute care.

The crux lies, of course, in the interpretation, and the reader may doubt whether the human eye is not deceived by an appearance of simultaneity that is in fact an extreme rapidity of imitative action: the author, indeed, seems to give part of his case away when he describes instances in which the movement could be seen spreading through the flock. Even so, there are difficulties, for why are some movements of individuals instantly conformed with by all the rest, while other movements—as the author points out—are ignored by the majority? The phenomenon is, at the least, a remarkable one, but Mr. Selous admits that his explanation would itself require to be explained. The author's method of presenting his matter in the raw, that is, wholly in the form of extracts from his diary embellished with footnotes, will probably appeal to some readers, but it will repel those who prefer a more orderly marshalling of evidence and argument.

The British Journal Photographic Almanac and Photographer's Daily Companion: with which is incorporated ‘ The Year Book of Photography and Amateurs' Guide’ and ‘The Photographic Annual’, 1932. Edited by George E. Brown. Pp. 684 + 64 plates. (London: Henry Greenwood and Co., Ltd., 1932.) Paper, 2*s.* net; cloth, 3*s.* net.

This well-known handbook for photographers needs no introduction to readers of Nature: it has been published annually for more than sixty years. This year there are five articles by well-known writers on photography. The latest advances in photography and photographic apparatus are discussed in a space of one hundred and sixteen pages. A further eighty-four pages gives a great mass of formulæ and other technical information. Not least in importance are the advertisements, which are very numerous and sufficiently descriptive to be of great use in a handbook of photography. The examples of pictorial photography cover a wide range of subjects and are well produced in photogravure. S. O. R.

Photo-Elasticity

Long ago it was remarked by Brewster that a transparent elastic solid such as glass ceases to be optically isotropic when it is bent or otherwise strained by external forces. It then shows chromatic effects in the polariscope, which vanish if the state of strain be relieved. That was the beginning of photo-elasticity, a science which, many years later, has become developed into a powerful means of investigating complex conditions of stress for the information of the engineer. It can readily be applied in cases which are too complicated for mathematical analysis; and even in less complex conditions photo-elastic experiments are often highly useful, providing short-cuts to the required results, or confirming the analysis of the mathematician. Whether the distribution of stress is simple or otherwise, the photo-elastic method makes the mode of distribution strikingly apparent. The polariscope is an incomparable showman, as entertaining as it is instructive. It appeals alike to the mathematical and the non-mathematical mind. The distribution of stress exhibited by the transparent solid applies to an engineering material such as steel, provided the elastic limit is not passed.

Lately, I saw in Prof. Coker's laboratory a transparent model of a locomotive driving-wheel revolving in contact with a loaded roller which pressed on the rim as the rail presses on the real wheel, the whole working in circularly polarised light and throwing its image on a screen. The chromatic effects, as each part of the rim and each spoke in turn took up its duty and then passed it on, made a brilliant spectacle—as fascinating a 'movie' as any engineer could wish to see, all the more as the spectator could control the speed or introduce a pause at any stage.

In modern developments of the subject the favourite medium for the study of stress is not glass but some form of celluloid. Xylonite, which engineers know as a material of which set-squares are often made, answers well. It is inexpensive, and is easily procured in transparent plates which are sufficiently uniform in thickness and quality, are free from internal stress, and come near enough to the ideal of perfect elasticity. It is not brittle, and is easily cut into strips or rings or flat pieces of any form, so that it may serve as a replica in miniature of the engineering article the behaviour of which under stress is to be studied—such, for example, as a plate weakened by rivet-holes. Readers of Nature who are unacquainted with the subject may like to be told briefly what is the process by which the polariscope is made to reveal the condition of stress in such a specimen.

Imagine, then, an optical bench with a source of light such as a pointolite lamp at one end and a projection screen at the other. The bench carries a pair of crossed Nicol prisms, between which the specimen is placed—a flat strip or plate of xylonite a quarter of an inch thick, or less, with its plane at right angles to the rays—so that light polarised by the first nicol passes through the specimen in the direction of the thickness. The piece is held in what is virtually a small testing-machine, in order that measured loads—pulls or pushes or both—may be readily applied in its own plane. Each of the nicols is furnished with a removable quarter-wave plate of mica, allowing either circularly polarised or plane polarised light to be used at pleasure, and the nicols may be rotated together in order that their crossed axes may be set at any angle to fixed axes in the specimen. The specimen is cut from a uniformly thick plate, so that the polarised light traverses the same thickness at all points of the material under examination.

So long as no load is applied, the material is isotropic, and has consequently no action on the polarised light. In that condition no light passes through, for the second nicol stops what has come through the first. But let stress be applied; the xylonite then develops a birefringent quality, causing a relative retardation of part of the polarised ray, with the result that colour effects appear on the screen. To take the simplest case, let the piece be a strip under uniform tensile stress in the direction of its length, then the image will have a definite uniform colour depending on the amount of that stress, and as the stress is increased the colour will change through a sequence of tints that correspond to Newton's colour scale for thin plates. Let uniform push be applied instead of pull, and gradually increased; the same sequence of colours is again seen, the colour for push being the same as for an equal intensity of pull. Or, to take another example, let the piece be stressed as a beam under uniform bending moment in its own plane; the image will then show a set of longitudinal colour bands. The neutral axis will appear as a black central band, since there is no stress there, and on either side of it—above and below—there will be a series of parallel colour bands grading into one another, which show how the intensity of longitudinal push or pull increases with the distance from the neutral axis towards one or the other edge.

In each of these examples there is only one principal stress P at any point, and the colour there directly exhibits the value of P. But in general, for less simple states of elastic strain in a loaded plate, there will be two principal stresses P and Q, at right angles to each other, and it is easy to show that what the colour really tells is the difference $P-Q$. At any point where Q happens to be equal to P no light gets through the polariscope. There the image has a dark spot: at all other places there is colour. As the magnitude of $P-Q$ increases from point to point of the plate the tint changes, following the Newton colour sequence, and the image on the screen accordingly exhibits strong colouring in the form of isochromatic curves, each such curve being a locus of points at which the value of $P-Q$ is constant. Incidentally, therefore, these isochromatic curves exhibit directly the amount of shearing stress at each point, for the shearing stress is everywhere proportional to $P-Q$.

The main object of the test, however, is to determine the principal stresses separately, and for that a further experimental analysis is required. We now change from circularly polarised light (which was best for exhibiting the isochromatic curves) to plane polarised light, by removing the quarter-wave plates, and set the crossed nicols at a particular azimuth or direction in the plane of the plate. The image now shows certain dark bands corresponding to places at which the two directions of principal stress are parallel to the axes of the two nicols. A locus of such points is called an isoclinic curve, for at these points the principal stresses have constant inclinations with respect to any arbitrarily chosen co-ordinate axes. Points on the isoclinic are recorded by marking the screen with little parallel crosses, the limbs of which lie in the directions of the principal stresses, these directions being given by the setting of the crossed nicols. Next, the setting is changed by turning the nicols through, say, 15°, and another isoclinic is then observed and is recorded in the same way. Proceeding thus, with progressive turning of the nicols through 15° at a time, we obtain a complete system of isoclinics for the whole plate, from which it is easy, by aid of the marked crosses, to sketch in the double system of lines of principal stress.

These lines give everywhere the directions of P and Q, but the magnitudes of P and Q have still to be determined. The colour bands, as we have seen, depend on $P-Q$, and the value of that quantity may be inferred by matching the colour at any point of the strained specimen with the colour shown by a strip of the same material and thickness strained by a known simple pull. But accurate colour matching is not easy, and a very much better way, due to Coker, is to superpose the auxiliary strained strip so that the polarised light passes in series through it as well as through the main specimen. The auxiliary strip is set so that the direction of pull in it is at right angles to the principal stress P at the place under examination. Then by adjusting the stress P' in it until a black spot appears in the image, we know that $P=Q+P'$, and hence P' gives a direct measure of $P-Q$.

To find the value of $P-Q$ is not enough when we want separate values of P and of Q; so, following Mesnager, Coker carries out a supplementary observation. By means of a delicate lateral extensometer, which measures the elastic change of thickness of the plate at any point, he infers $P+Q$ from the observed amount of lateral contraction. Then, combining this information with the results of the optical tests, the whole problem is solved; P and Q are each determined, in magnitude and direction at every point. The process is laborious, but the final results are complete and convincing: in many cases they can be usefully checked by integrating graphically over a section on which the whole stress is known from the conditions of loading. Often the process may be simplified by starting from a free edge, where one of the principal stresses is necessarily zero.

All this, and much more, is fully discussed by Profs. Coker and Filon in their recently issued treatise,* along with an account of how the method has been applied to a host of important practical examples. This fine volume, with its 720 large pages of print, its numerous colour plates, and its many hundreds of admirably drawn illustrations, is a monument not only to the ability and industry of the joint authors, but also to the enterprise and technical skill of the producers, the Cambridge University Press. The typographic form is worthy of the matter, and to say that is high praise. The authors here treat with affectionate completeness a subject they have made peculiarly their own. They have spent many years in perfecting it and demonstrating its uses. Much of their original work has been done in close association. Now they present us with the fruits of a happy collaboration in authorship, where the critical insight of the mathematician and the practical flair of the engineer combine to provide a comprehensive, systematic, and extremely lucid treatise. Readers who know both authors may find material in the book for an interesting guessing game, as to which parts, so to speak, are Sullivan's and which are Gilbert's. But the main point is that the whole is a good blend. The authors make an exceedingly strong team; they pull well together and each supplements the many virtues of the other.

After a short introduction, we have several chapters of general theory. The relevant optics are discussed on the basis of Maxwell's electromagnetic waves, and this is followed by a chapter on the theory of elasticity, before the theory of artificial double refraction is attacked, on which the whole process depends. The first half or so of the work will be of general interest to physicists, apart from the solution of special problems of engineering with which the later sections abound. These comprise many detailed applications of the method, to tension and compression test-pieces and pieces under shear, to beams and bridges, to thick cylinders, to plates with holes and notches and cracks, to eye-bolts and fastenings, to rings, chains, hooks, wheels, to the action of cutting tools, and to other examples too numerous for mention here. Some of them are very recent: they include studies undertaken by Coker for a special committee of the Department of Scientific and Industrial Research, which has not yet reported, in critical examination of certain customary types of test. All of them illustrate the wide sweep of the method, its power to illuminate obscure matters, and its great value as a guide in design. To have produced such a work is a professional service for which engineers—contemporary and future—cannot fail to be deeply grateful.

Such a treatise was, in fact, greatly needed. It is a new departure: no book has hitherto been available that covers anything like the same ground. Students of the subject have had to refer to scattered papers or lectures, many of them by Coker and Filon themselves. The book will be welcomed as filling a definite gap in the literature

* A Treatise on Photo-Elasticity. By Prof. E. G. Coker and Prof. L. N. G. Filon. Pp. xviii+720+14 plates. (Cambridge: At the University Press, 1931.) 50s. net.

of scientific engineering. Engineers know that the methods of photo-elasticity—methods of experiment with which they are still for the most part unfamiliar—have already become important auxiliaries in design. Such a treatise will, I believe, be no less attractive to the physicist, to whom it will appeal in the rare moments which find him willing to turn aside from the atom and the photon to revise, and perhaps enlarge, his ideas of what happens to the 'classical' Maxwellian waves when they traverse solid aggregates. If he discovers how to harmonise the two modes of thought, so much the better.

There is, paradoxically enough, one defect. The book is so big, so full, so thorough, that it must fail of one important purpose: it is not a textbook for the ordinary student of engineering. He needs something much more brief, direct, and simple—something that will show him the optical bench and tell him plainly how to use it. So many elementary accounts have already appeared in lectures and addresses to learned societies that the authors must be tired of that kind of exposition: but it still needs to be embodied in a handbook that will be a really handy book. Such a task is well worth doing. This excellent voluminous treatise will always be there for more advanced study and as an encyclopædia of reference: the small book, which has yet to be written, would introduce readers to it and would spread knowledge, in a way the treatise cannot be expected to do, of a subject which should be taught in every engineering laboratory, and should become, at least in its elements, part of the mental equipment of every educated engineer.

To me the book brings a personal pleasure, for it happens that both Coker and Filon were at one time my pupils. It was in the engineering laboratory at Cambridge, more than thirty years ago, that Filon carried out his earliest photo-elastic research on a loaded beam of glass. For that, however, I can claim no credit, not even the credit of suggestion. His experiments were initiated and pursued in a fine spirit of independence, a virtue only too rare among research students. Nor had I any hand in the subsequent efforts, successful and long sustained, to which this book bears witness. But even so, it gives an old teacher some satisfaction to see original work of high quality proceed from those whose early notions he may have had some small share in shaping, and to sit, as I now do, a learner at their feet. J. A. EWING.

Albertus Magnus

HIS SCIENTIFIC VIEWS

"EVERYTHING there was to be known, he knew." Thus is the genius of Albert the Great characterised by the Pope in the remarkable Bull "In Thesauris Sapientiæ" declaring the blessed Bishop of Regensburg a saint and a doctor of the Church. In this "Decretal Letter", dated Dec. 16, 1931, but published on Jan. 14, 1932, Pope Pius XI. points out that Albert the Great (1206–1280) was not only a lover of God, a pastor of souls, and a master of the sacred sciences, but also a pioneer in secular knowledge. He wrote about astronomy, physics, mechanics, chemistry, mineralogy, anthropology, zoology, botany, architecture, and the applied arts; and the modern edition of his writings makes thirty-eight thick quarto volumes (ed. Jammy O.P. repr. Vivès, Paris, 1890 *sq.*). Indeed, Albert the Great broke the chains that kept natural science in the hands of unbelievers, and vindicated it against the more timid pious persons of his time who were afraid of it for fear of its abuse. For, says the Pope, "no real theologian is afraid of any damage from the operations of nature or of natural reason rightly investigated, for these very things bear upon them the light of the Creator himself".

We do not propose here to give any account of the edifying and active life of St. Albert the Great, or to report on the various causes which led to his canonisation by the Church. Nor do we intend to give an outline of the theological and philosophical views of a master mind who is now honoured as one of the twenty-eight doctors of the Church, together with Gregory, Basil, Ambrose, Augustine, Jerome, Thomas Aquinas, Anselm, Bernard, Beda, Ephraem, John of the Cross, and Bellarmine. We shall endeavour, however, to give a short sketch of the scientific views of Albert the Great, which are of the greatest interest for the history of science, especially as they represent the state of scientific knowledge in the Middle Ages.

Though Albert seems to be less original and forceful as a scientific thinker than his contemporary Roger Bacon, yet he was far more influential on the age in which he lived. The peculiarity of his encyclopædic teaching was that it was based entirely on the writings of Aristotle. This was remarkable because the Aristotelian principles were resisted by the Church at the time; the provincial council at Siena in 1210 going so far as to forbid the use of Aristotle's books on natural philosophy. But though no professor was permitted to lecture on them, and in spite of the fact that in 1215 the "Physics" and the "Metaphysics" were banned by the statutes of the University of Paris, Albert the Great was actively promoting the new philosophy, probably with the connivance of the Church authorities, who allowed a responsible theologian to sift the true from the false the while they acted as the stern guardians of orthodoxy. He soon joined hands with his pupil Thomas Aquinas, who, if he surpassed his master in the theological and philosophical interpretations of the Stagyrite's system, does not, however, compare favourably with Albert in his scientific studies.

The astronomical beliefs of Albert, though partly inspired by Aristotle, differ widely on many important points from the views of the Stagyrite. Albert taught that the heavens move from east to west carrying along with them their particular stars which move from west to east, " something like the motion of an ant on a wheel rotating in a contrary direction ". The whole world is like a huge machine moved by God according to secret principles which the human intellect, however, can partly discover. Each star, in turn, is moved by a pure intellect, each having its own heavens with its particular motion ; so that the circles of the stars are not concentric, as Aristotle on the authority of Eudoxus taught, but eccentric as in Ptolemy's system. Yet the earth is at the centre of the world, the heavens of the Moon, Venus, Mercury, the Sun, Mars, Jupiter, Saturn, the fixed stars, the aqueous, the crystalline and the empyreal heavens, coming in succession, the last-named being the dwelling-place of the blessed. It is this system which must have inspired Dante's cosmology ; and we find in the "Paradiso" (x. 98-99) this reference to Albert the Great:

> Questi, che m' è a destra più vicino
> Frate e maestro fummi, ed esso Alberto
> È di Cologna.

Albert was not entirely satisfied with his cosmological theories, which are sometimes very difficult to follow (see Duhem, " Le Système du Monde ", t. 3, p. 327 *sq.*). He knew that his opinion could not be final when he wrote that " celestial phenomena are so far away from anything we know that we have no means of understanding them perfectly. All we know for certain is that the heavenly bodies are moved by a soul, that is, by a separate substance, an intellectual mover, a unit of intellectual life " (" De Coelo et Mundo ", 2, 13).

The belief in the existence of a pure intellect in each heavenly body led Albert to share the current opinion of his time about the influence of the stars on human beings, each intellect having a direct influence over the one immediately following it in the hierarchy of spirits. At the top of the scale, the omniscient and omnipotent mind of God controls the whole of the world, right down to the elements, the compound and the simple bodies. Parallel with this hierarchy of creatures there is a hierarchy of light and a hierarchy of weight : the four traditional elements, earth, water, air, and fire, are thus drawn up in echelons from the heaviest, earth, which is at the bottom or in the middle of things, to water, then air, and finally fire which rejoins the celestial bodies—a conception which reminds one of Anaximander's cosmogony. These considerations on the order in the realm of matter have their equivalent in the realm of spirit : the simplest intellect gives the most perfect motion to the star to which it is attached ; and again, the simplest and most perfect intellect has the most adequate knowledge of things, the intrinsic and epistemological power of the various creatures being thus echeloned from the Highest God to the humblest of His creatures. The detailed development of this powerful vision of the nature of reality allows Albert the Great to state and explain his views about the various provinces of our knowledge : the part played by each natural or spiritual being is thus accounted for according to its place in the hierarchy of God's creatures.

Details about the particular sciences are interesting. In alchemy, for example, Albert himself tried several reactions, describing accurately enough the preparation of nitric acid or, as he called it, ' prime water ' or philosophical water to the first degree of perfection, and giving at the same time its principal properties, such as the oxidation of metals and the separation of gold from silver. By combining three parts of prime water with one part of sal ammoniac he obtained the secondary water ; the tertiary water is obtained by treating mercury with the secondary water, and the fourth water is the result of the distillation of the tertiary water after it has been left for four days in a vessel covered with manure. This fourth water was very popular among the alchemists of the time, who called it ' philosophers' vinegar ', ' mineral water ', and ' celestial dew '.

Albert distinguished four ' metallic spirits ', mercury, sulphur, orpiment, and sal ammoniac, which could all be used to stain metals in gold or silver. But he warned us that the gold or the silver of the alchemists is not pure gold or silver. In fact, though the theory of a ' materia prima ' and the conception of transmutation made chiefly an intellectual and philosophical appeal to him, Albert did not believe in the actuality of transmutation. Thus he wrote in " De Mineralibus " (Bk. 3, 9) : " Alchemy cannot change metals, but can only imitate them. I have tested alchemistic gold ; but after six or seven heatings, it is burned and reduced to ashes." He was the first to use the word " affinitas ", in his treatise " De Rebus Metallicis ", which was no doubt suggested to him by the views of ancient Greek philosophers current at the time, that chemical reaction is due to a similarity or kinship between the reacting substances, or, as maintained by Hippocrates, that like unites only with like. Thus, said Albert, " sulphur blackens silver and generally burns all metals, because of its natural affinity with them " (propter affinitatem naturæ metalla adurit). It seems also that Albert was the first to call sulphate of iron " vitreolum ". His small treatise " De Alchimia " gives a vivid picture of the state of alchemy and alchemists in the Middle Ages, a picture which has been confirmed since by the descriptions of Paracelsus.

In his biological works Albert follows very closely Aristotle's text, given a sentence or two of the Stagyrite and adding his own remarks by way of commentary ; in sifting what is Aristotle's from Albert's additions, it has been found that the remarks of the Dominican monk contain a considerable amount of personal observations which prove that he was a naturalist of great ability. In his " Short History of Biology " (pp. 73-74), Prof. Charles Singer quotes a long passage of Albert's treatise " De Animalibus " in which there are some striking remarks about embryos of birds and of fishes; while he considers Albert's book "De Plantis" as the best work on natural history produced during the Middle Ages. Albert seems to be at a loss, however, in his attempt to draw up any general account of plants, since he reaches no satisfactory basis of classification, and is equally ignorant both of their minute structure and their true mode of reproduction. Yet his descriptions are fairly accurate, and show that he had a remarkable gift of observation.

These general remarks illustrate the range of Albert's knowledge and scientific interests. He probably wrote also on mathematics, as he often refers to his mathematical works, especially the 15th and 16th books of his geometry (iii. Met. 2, 1); but these works have not reached us. We know, however, that Albert placed mathematics between metaphysics and natural science, the object of mathematics being defined as the motion and material extension of natural objects independently of their essence and their fundamental causes. The mathematician studies the straight line, for example, as it is materially illustrated in Nature, but he does not consider the cause of the straight line or the particular matter which illustrates it. Such considerations were possible, of course, at a time when Euclidean geometry was the only known system in terms of which Nature could be interpreted.

To-day these and the other scientific views of Albert the Great could scarcely bear the strain of a searching criticism. It would be unfair, however, to dismiss Albert's claims to consideration because they do not correspond to the extraordinary developments of modern science. Should one ignore Aristotle or Plato because his biology or his cosmology is behind the present state of science? Every system of philosophy has to give some account of Nature, with reference to the scientific beliefs of the time. None of the great thinkers of the past could have possibly established his doctrines in terms of the science of the future; nevertheless, one studies them as they are and often uses them in the interpretation of modern scientific conceptions. The scientific doctrines of Albert the Great are entitled to a similar consideration; and the historian who devotes his patient efforts to the study of the "doctor universalis" will be repaid to the full by the discovery of the valuable indications contained in his writings. Thomas Greenwood.

The Iron and Steel Industry

Mr. Boffin, it may be remembered, introduced Mr. Weg to Mrs. Boffin as "the gentleman that's a going to decline and fall off the Rooshan Empire". Prof. W. A. Bone may be introduced as the gentleman who has taken the opportunity, as Melchett medallist of the Institute of Fuel, to decline and fall off our coal and iron industry. Behind the subject he discussed, "A Century of Fuel Economy"—in (1) the manufacture of iron and steel, (2) of gas and coke and (3) in the production of power—lies the gradual decay of our iron industry. If European nations agree to disarm, if we continue to develop the use of the road engine, the interest in iron must pass over to nations like Japan and China—to the unsettled East. The topic is, therefore, one of extreme public importance.

Born in a region of coal and raised in the reek of coke-oven, gas-producer and blast-furnace, a life-long student of the processes, Prof. Bone is a man of fuel by instinct, able to envisage and discuss the problems, both of coal and of iron, with detachment and a fullness of ripened knowledge which no other worker, either industrial or academic, has at his command. He is the recognised master artificer in the field of high temperature change, especially in gases. By his recent systematic studies of coal he has revolutionised our conception of its nature. The special department he has developed at South Kensington stands alone and unrivalled in the completeness of its equipment and the accuracy of its apposite inquiries. The Institute of Fuel could not have paid a greater compliment to the man whose memory the medal commemorates, nor have done a greater service to industrial interests, than it has in making him its medallist and so forcing him to display his knowledge of the subject, which is probably, at the moment, the most important to be considered in the whole range of industrial activity.

The story opens with the downfall, as politician, of the Duke of Wellington, in 1832, and the coincident introduction, by the Scot, J. B. Neilson, of the hot blast, the first great step in the modern development of the iron industry, signalling the dawn of fuel economy. Neilson appears to have been a most remarkable man and a pioneer in technical education. He had intuitively guessed that the expenditure of a given quantity of fuel (small coal) outside the furnace for the purpose of preheating the ingoing blast would save many times more fuel (coke) inside the furnace. Paradoxical though it seemed at first, trial soon proved him to be right.

The output of Scottish pig-iron rose from 37,500 tons in 1830 to 196,960 in 1839 and to 475,000 tons in 1845. Next came the utilisation of the furnace gases but not until after 1845, when the great Bunsen and his pupil Lyon Playfair reported to the British Association the result of their analyses of the gases, taken at various levels, from a coal-fired blast furnace, pointing out that 81·54 per cent of the fuel was lost in the form of combustible matter, only 18·46 of the whole fuel being realised in carrying out the processes in the furnace. The second invasion of the chemist into the industry was Lowthian Bell's great inquiry (1868–72) into the complex chemical interactions within the blast furnace. Lowthian Bell stands alone as the colossus of the industry: he has yet to be monumentised.

Steel was also advancing. Coincidently, strange to say, with Perkin's discovery of the first coal tar colour, came Henry Bessemer's invention (1856) of his process, in which iron, taken directly from the blast furnace, was converted into steel by merely blowing air through the molten metal. A great further advance was made, in 1880, when Thomas and Gilchrist substituted a basic for the acid lining of the Bessemer furnace. This, however, threw open the production of iron to the world, as it made possible the use of low grade phosphatic ores, which were previously unworkable. It also greatly aided agriculture, by the introduction of basic slag. It is noteworthy that this advance was practically coincident with that caused by the introduction of azo dyestuffs, which threw the colour industry open to the world. Great Britain's hold upon the colour industry and upon the pig-iron industry waned at about the same time, by no mere coincidence but for similar reasons. Just as we had no second set of workers to compare with the Perkin-Nicholson-Hofmann triumvirate, so we had no second iron and steel triumvirate to compare with the Lowthian Bell-Bessemer-Snelus cum Thomas and Gilchrist combine. Those in commercial charge of both industries were too short sighted to secure the necessary succession of scientific workers: the trained chemist has scarcely been known in the blast furnace industry. Only steel has attracted academic attention. We have recovered our hold upon colour but the blast furnace industry is still lacking in vision and has not put its house in order up to the present day; labour difficulties have been an additional drawback. Prof. Bone holds out science as still a key of promise to some further economy in the use of fuel. Users of coal may rejoice at his conclusion but it is one that brings cold comfort to owners and producers. It is imperative, however, that false hopes should not be held out in public in this connexion.

The century of invention Prof. Bone discusses is only about fifty years in advance of the beginning of the steel age. Children are taught something of the flint, the iron and the bronze ages; archæologists gloat over rusty bits of iron found in old Roman foundations: yet we look complacently, without wonder, at modern steel defiance of the Tower of Babel legend; this too when our ores are on the verge of exhaustion. Of the many great names mentioned in the course of the address, excepting that of Lord Playfair, scarce one of them is to be found in current literature or the histories—yet they are the men who have made our world what it is. The ministers who figure, for example, in Queen Victoria's "Letters" have been largely automata, owing their importance almost entirely to the backing they have had in coal and steel. Politicians may trumpet their messages from Geneva and Washington but, as Shanghai shows, steel bombs are the messengers which eventually tell in forcing order. The East is too ignorant and too human ever to be reformed by mere talk: the work will needs be helped on by steel in some form.

It is because the story of steel is so ill-told in our schools, so little understood by politicians, that the public to-day has no suspicion of the way in which the world is under ferrous control. If the Highgate Hexaphilites were to name us, we should not be called Calciferites—though we have much lime in our bodies—but Ferrosoferites: iron is the great social advitant, not merely in our blood. Having gone so far in laying bare the statistics of the industry, Prof. Bone might with great advantage now prepare the way for a future Mr. Weg to decline and fall off the Empire of Coal and Steel, to which the nations, during a century past, have far too exclusively directed their attention. Everything points to a more superficial cultivation of the soil than that involved in mining for iron. Maybe the farmer will yet have his revenge and see iron put in its place, if not in Queer Street—if we no longer build warships, big guns and tanks; if the railways cease to pay because we have taken to the roads and run upon slag rather than upon steel.

The present unhappy state of the British blast furnace industry is deplorable. It was inevitable that we should lose the supremacy we once had and that countries with full command of ore and coal supplies—Belgium, France, Germany, the United States—would both satisfy their own demands and seek to be exporters. It is very doubtful if it will pay us, as long as competition is unrestricted, to supply our own needs, let alone export at a profit. Whether, under a system of regulated fair trade, we shall do so is another question. The art is not one to be lost, as we have no guarantee that the accident of war may not come upon us; moreover, much phosphate is to be gained from our low grade ores. Germany, beyond question, has greatly overbuilt her ironworks—definitely with the object of capturing outside markets. To stop armaments and yet carry on a merciless commercial war in iron will be to create a purely Gilbertian situation.

The rapid development of the American iron and steel industry has been a necessary consequence of the vastness of the continent; the great demand being over, it is unreasonable for the industry to expect that it can be run at full blast at the expense of other countries. The sky-scraper in New York is a logical outcome of the conditions prevailing there—of the limited area at disposal and the existence of Silurian foundations. New York, however, is no excuse for towns in the Far West out on the open prairie. The sky-scraper is simply an American habit. Is it to become one here? We are learning every day more and more to value light—why, then, should we shut it out? We know our English heating system to be more healthy than the Continental and American plan. Everyone who lives in them is beginning to complain of the bee-hived, graceless constructions now coming into being at the instance of speculative builders. Might we not pause to think if iron after all be worth what it is going to cost us, indirectly perhaps more than directly, in convenience, comfort and health. It has probably too long been our master.

Henry E. Armstrong.

Obituary

MR. GEORGE FORREST

BOTANISTS and horticulturists have received with the greatest regret the news of the death of Mr. George Forrest from heart-failure, at Tengyueh, in West China, on Jan. 5. He was one of the greatest of botanical collectors, and had the good fortune to find the richest of fields for his explorations.

Forrest was born at Falkirk on March 13, 1873, and was educated at Kilmarnock Academy. As a young man he spent some years in Australia and South Africa. Returning to Scotland, he was engaged for a time on herbarium work at the Royal Botanic Garden, Edinburgh. In 1904 came his opportunity. On behalf of Mr. A. K. Bulley, of Neston, he made the first of his journeys to western Yunnan to collect plants and seeds. From that time onwards he devoted himself, with but brief vacations, to exploration in Yunnan and the adjoining regions.

The floral richness of the provinces of western China and of eastern Tibet was long unsuspected. A foreshadowing of the botanical wealth of the area came first from the dried collections of Prof. A. Henry and from the material sent to Paris by the French missionaries such as David, Delavay, and Soulié. These noteworthy collectors did not, however, explore in any detail the higher alps of the Tibeto-Chinese frontier, nor did they forward much to Europe in the way of seeds. Consequently, the area was almost virgin country for the horticultural explorer. It was now that Wilson and Forrest, and later Kingdon Ward, Schneider, Handel-Mazzetti, and Rock, entered such a promising field. Wilson had Hupeh and Szechwan for his domain, and "Plantæ Wilsonianæ" is testimony to their botanical riches. Forrest was but a year or so later, and chose western Yunnan and the adjoining parts of Tibet and south-west Szechwan. For multiplicity of species this is the richest area in China, and has good claims to possess the finest alpine flora in the world. Forrest made no fewer than eight expeditions into these regions. The number of his dried botanical specimens exceeded 30,000. Many of the species had been found before by the French missionaries and described by Franchet at Paris ; but many hundreds were new, and these specially natives of the higher altitudes between 10,000 ft. and 15,000 ft.

Forrest kept an even balance between the claims of botany and horticulture. He made it his endeavour to secure seed of all plants of horticultural merit and also of any botanical interest. His dried material forms one of the great collections, worthy of comparison with that of any previous explorer in any country. Apart from copious field notes, the material is of the very highest standard ; witness the statement of a Japanese botanist, Prof. Kudo, who has just published, after fifteen years' study, a monograph on the Labiatæ of eastern Asia. For that purpose he visited some forty of the chief herbaria in Europe, Asia, and America, and records of his examination of Forrest's specimens that his collection of Chinese plants is "die beste in der Welt" (*Mem. Fac. Sc. Tôhoku Imp. Univ.*, vol. 2, No. 2).

Much of Forrest's success in this respect was due to his capacity for management of the hillmen whom he employed in his travels. These tribesmen were taught by him and became expert in the drying of herbarium material, in the collection of seeds in autumn (implying recognition of what was previously collected in flower—no easy task), and in the skinning of birds and mammals. The hillmen were particularly loyal to him, sometimes travelling six weeks to meet him when they heard he was arriving at Bhamo *en route* for the Chinese Alps. This influence extended to the tribesmen generally, as well as to all classes of Chinese in the towns and villages at lower elevations. Among other kindnesses, he was welcomed for his attempts to do what he could for them in the way of rough-and-ready 'doctoring'. He felt their needs so much that he was in the habit of procuring lymph from Burma, and in his time inoculated many thousands against smallpox. It was only on his first expedition, when feelings between Tibetans and Chinese were exacerbated, that Forrest had serious conflict. That first expedition ended in a tragedy. A large party, some eighty in all, including Forrest and two French missionaries (Père Dubernard and another), were assailed by the Tibetans, and only a bare dozen escaped massacre. Père Dubernard was brutally tortured before death, and his companion was killed on the spot. Forrest was hotly pursued for some ten days, without shelter and without food. Of his personal following of seventeen, there was only one survivor.

Though somewhat short of stature, Forrest was of very robust build and was able to endure the roughest of travelling. Unfortunately, he never gave to the world a written record of his experiences in central Asia. Few explorers could have had a more fascinating story to tell, but the task of writing it was always postponed until his days of retirement—and that time did not come. In any event, the task did not appeal to him, and it was only rarely that he could be persuaded to write for publication. His interests lay wholly in the field ; his collections of the flora and fauna of the area, supplemented by accurate and very complete notes, have formed the basis of a very large number of scientific papers, while European gardens have been much enriched by the numerous plants raised from the seed secured on his various journeys.

WE regret to announce the following deaths :

Prof. W. Billington, professor of surgery in the University of Birmingham, aged fifty-six years.

Sir Arthur Duckham, president-elect of the Federation of British Industries and one of the founders of the Institution of Chemical Engineers, on Feb. 14, aged fifty-one years.

News and Views

Tariff Commission and a Scientific Policy

THE creation of a Tariff Commission, or, as it is called, Import Duties Advisory Committee, as part of the Government's general tariff plan has implications which go far beyond the theoretical merits of 'free trade' or 'protection', and are of special interest to scientific workers. As Capt. Harold Macmillan, M.P., points out in recent articles (cf. *Week-End Review*, Jan. 30, and *Sunday Times*, Feb. 14), Britain suffers particularly from the chaotic market conditions which affect all countries, because not only is a large proportion of its production for export, but also because alone among nations it has a home market open to unrestricted competition. In the absence of any protective device, British economic development is being determined not by our own decisions but by the fluctuating disorder of world trade. The old fiscal controversy having now been resolved in principle by the Government decision to apply tariffs to a wide range of manufactures, the question of practice and of the purpose for which tariffs are to be applied becomes of primary importance. It is clear that both ministers and other members of Parliament are now prepared to consider the economic and financial aspects of a tariff policy in relation to the reorganisation, modernisation, and re-adjustment of industry as part of a definite plan of national and imperial policy. The execution of any such constructive policy, involving the application of scientific methods in this difficult and contentious field, requires a wealth of detailed information regarding the relations between different industries, their productive capacity, efficiency, their importance in the general national economy, the merits of their plans of reconstruction, and so forth.

Scientific and Industrial Development

THIS information and the essential co-operation of industry can probably only be secured by the creation of representative councils for each of the great national industries, and in this way the Tariff Commission will be brought face to face with rationalisation problems, technical questions of scientific development, industrial organisation, and management. In addition to the technical advice of industrial representatives, the co-operation of the banks, co-ordinated, for example, through some such body as the Bankers' Industrial Development Trust, will be required, since intelligent use of the powers of the Committee involves the complete supervision of every question relating to industrial and commercial development. If the Government proposals are indeed directed towards the evolution of such a deliberately planned national economy, there will undoubtedly occur opportunities of making representations to the Commission upon the scientific position of many of our great industries the development of which is dependent upon technical control and scientific research. It is desirable that the Commission should be aware of what scientific opinion is on such great industries as the textile industry, the iron and steel industry, etc., and it is incumbent upon representatives of science to follow these developments with the closest attention and to seize the earliest opportunity of making representations or affording other assistance towards the evolution of a creative and scientific national policy.

Tariffs and Imported Scientific Books

THE text of the Import Duties Bill, whereby an *ad valorem* duty of 10 per cent is to be charged on goods imported into Great Britain, has been issued, and we are glad to see that newspapers, periodicals, and printed books, and radium compounds and ores are among the articles exempted from the impost. As was pointed out in our issue of Feb. 6, p. 195, the revenue to be expected from a tax on imported scientific literature is negligible; the only effect of such a duty would be to increase the cost of scientific research. It is encouraging to find that this aspect of the matter is appreciated in Government circles, and that, amid the many claims for exemption which have, no doubt, been put forward, consideration has been given to the needs of scientific workers. Affairs do not seem to be so well ordered in Australia. It will be recalled (NATURE, Nov. 28, 1931, p. 900) that the Commonwealth has in force a duty of 10 per cent on imported books and a sales tax of 6 per cent; this, with the depreciation in Australian money, has proved a serious handicap. Incidentally, it has demonstrated our contention that, as a source of revenue, an import tax on books is not worth consideration. However, it is stated by the Canberra correspondent of the *Times*, in a message dated Feb. 11, that a deputation including Sir George Julius, chairman of the Council for Scientific and Industrial Research, has waited on the Prime Minister, Mr. Lyons, who has promised to consider the exemption of historical records and scientific periodicals, although he will not consider the early and total remission of the sales tax.

Discovery and Uses of X-Rays

SEVERAL letters have appeared recently in the *Times* on Prof. W. C. Röntgen's discovery of X-rays and their early use in surgery. As NATURE is mentioned by three of the correspondents, it may be worth while to recall the association of this journal with the notices of the discovery. General announcements appeared in the daily Press on Jan. 7, 1896, to the effect that Röntgen, who was then professor of physics in the University of Würzburg, had discovered that a number of substances which are opaque to visible rays of light are transparent to waves capable of affecting a photographic plate. A note upon these reports appeared in NATURE of Jan. 16, 1896 (vol. 53, p. 253). In the issue of the following week, Jan. 23, we published a letter from Sir Arthur Schuster on the physical significance of Röntgen's observations, and Sir Arthur himself arranged for the translation into English of Röntgen's paper "On a New Kind of Rays" from the *Sitzungsberichte der Würzburger Gesellschaft*, 1895, which appeared in the same issue. This, we believe, was the first complete account of Röntgen's work published in England. To the same issue (Jan. 23, p. 276) the late Mr. A. A. Campbell Swinton contributed an article describing how, "Working upon the lines indicated in the telegrams from Vienna, recently published in the daily papers, I have, with the assistance of Mr. J. C. M. Stanton, repeated many of Prof. Röntgen's experiments with entire success"; and his article was illustrated by an X-ray photograph of a human hand taken by him with a Crookes tube. In the following three months as many as one hundred and fifty-five notes and original communications upon X-rays and their applications appeared in our columns.

Gold Medal for Astronomy

The award of the gold medal of the Royal Astronomical Society to Dr. R. G. Aitken, director of the Lick Observatory, Mount Hamilton, California, was the subject of the presidential address given by Dr. Knox-Shaw, Radcliffe Observer, Oxford, at the annual general meeting of the Society on Feb. 12. The actual presentation of the medal is deferred until May 13, when the medallist is coming to London to deliver the George Darwin lecture; the subject of this has not yet been announced, but it will probably be connected with double stars. Dr. Knox-Shaw began his address by giving a description of the state of double-star astronomy in the middle of the last century; it was taken for granted that the work of the two Herschels and the two Struves had exhausted the mine of possible discoveries, at least in the northern hemisphere, and that it only remained to continue the observation of the known pairs, with a view of obtaining better orbits.

Dr. Aitken and other Double-Star Observers

With the advent of the great American telescopes a new era began. It became possible to detect much closer pairs than before; these offered such a large field that for the first time a distance limit was fixed, beyond which stars should not rank as doubles. This was taken as 5″ for stars of the ninth magnitude, but was made wider for brighter stars and for stars of large common proper motion. S. W. Burnham was the first to make a great advance in this direction; in 1906 he brought out a great catalogue of 13,665 pairs, more than two thousand of these being his own discoveries. Dr. Aitken has been a worthy successor. With the aid of Dr. Hussey, who was his fellow-worker for many years, about four thousand new pairs have been found, and a new general catalogue is in course of formation. An important point is that many of the new pairs are extremely close (separation less than half a second). As was to be expected, many of these close pairs showed fairly rapid motion; in fact, one of them has completed a revolution since discovery; Dr. Aitken enjoys the distinction of having made all the observations upon it, and also of computing its orbit. From a physical point of view, the chief importance of double-star astronomy is the information that it leads to on the masses of the stars. At the beginning of this century not more than a dozen star-masses were known with any accuracy; the number has now been greatly increased, the study of eclipsing binaries having added to it. As a result, Sir Arthur Eddington was able to deduce the law correlating mass with absolute magnitude. This important law rests largely on such work as that carried on by Dr. Aitken.

Gold Medal of the Hunterian Society

The Hunterian Society, the oldest medical society in London, offers annually or periodically for competition a medal bearing the profile of John Hunter. It is open to all general medical practitioners resident in Great Britain, Ireland, and the Channel Islands, and is awarded for an essay. The subject of the essay is chosen by the writers from any subject in the medical sciences, and each essay has to be written under a motto or device and is accompanied by a sealed envelope containing the writer's name. In 1931 the Council recommended that the medal should be of gold instead of silver as heretofore, and that a new design should be struck. Accordingly, Mr. Thornton Shiells, with Mr. H. Youngman, engraver, produced a gold medal the size of a crown piece. The original designs and the plaster medallion made for the purpose are now preserved in the Library of the Society. For the first competition under the new régime a number of essays of high order were received, and the medal has been awarded to Dr. Griffith Ifor Evans, 37 Castle Square, Caernarvon, for an essay on "Chronic Familial Syphilis". Dr. Gwladys Victoria Smallpiece, of 365 Woodstock Road, Oxford, was declared "proxime accessit". The medal was presented to Dr. Griffith Evans at the annual dinner on Feb. 11. The next award of the gold medal will be made in 1933 for essays received on or before Dec. 31, 1932. The rules governing the award may be obtained on application to the honorary secretary of the Society, Mr. Andrew McAllister, 79 Wimpole Street, London, W.1.

Extension of University College, London

University College, London, has acquired by purchase a site of two acres, formerly occupied by Messrs. Shoolbred, immediately south of the buildings of the Faculty of Medical Sciences of the College. This is the largest addition to the site of the College made since its foundation more than one hundred years ago. The site acquired by the founders was some eight acres in extent, and most of the previous additions to the College have been confined to this area. So long as fifty years ago attempts were made by the College to buy the site, on which, eventually, were erected warehouses, depositories, and stables for Messrs. Shoolbred. The site was too large for University College to buy or to occupy as a whole. The problem was solved by the Carnegie United Kingdom Trustees, who acquired part of the property as permanent headquarters for the National Central Library and the Library Association. In the College part of the territory there will be housed the Departments of

Zoology and Comparative Anatomy, Botany, Geology, Geography, and Political Economy, and certain other needs will be served there. The Departments moving out of the old buildings of the College will set free accommodation much needed by the Faculty of Arts and by the Libraries. The College has also received a great benefaction for the endowment of the Department of Zoology and Comparative Anatomy from the Rockefeller Foundation. The benefaction amounts to £88,000, and must be devoted to the advancement of research. This gift follows other benefactions by the Rockefeller Foundation, which have made possible the building of the new Department of Anatomy and Embryology and the provision of endowments for that Department and the Departments of Physiology and Pharmacology.

British Industries Fair

THE eighteenth British Industries Fair, which will open in London and Birmingham on Feb. 22, will be the largest and most representative display of British manufactured goods that has yet been organised. Last year exceeded all previous efforts, and this year marks a further advance. Following the practice of last year, the Fair will consist of two sections, the London Section and the Birmingham Section. In London the exhibits of the lighter trades and the specifically Empire exhibits will be held at Olympia ; the White City will accommodate the display of textiles and clothing, which for the first time will represent all branches of the textile industry. At Castle Bromwich, Birmingham, there will be exhibits mainly of hardware, house equipment, and engineering, and, out-of-doors, an exhibition of agricultural implements and of plant for light railways, quarrying, and roadmaking. The total frontage of the stands in all sections of the Fair will amount to approximately 16 miles. The total number of exhibitors will be 2305, of which 1150 will exhibit their products at Olympia, 130 at the White City, and 1025 at Castle Bromwich. Of the new trade groups that have co-operated in this organised effort to exhibit the variety and extent of British manufactures, mention may be made of the oil section, and of the section for mining, quarrying, and roadmaking plant. The former will provide working exhibits of the latest oil-fired plant, and the latter will give a demonstration of the actual construction of a road. We hope to give, in a subsequent issue, a review of some of the chief features of the Fair.

Second Dynasty Burial Rites at Ur

MR. LEONARD WOOLLEY'S first report on the current season's work at Ur, which appeared in the *Times* for Feb. 12, chronicles *inter alia* the discovery of a burial of a type " quite out of the ordinary ". It has the additional interest that it belongs to the Second Dynasty of Ur, about 2800 B.C., a period and dynasty about which at present nothing is known. The Joint Expedition of the British Museum and the Museum of the University of Pennsylvania is now engaged in endeavouring to trace the earlier history of the sacred area on which stands the famous ziggurat of the Third Dynasty. In the first month's work the complete ground plan of a range of buildings on the north-west side has been brought to light. The buildings belong to the First Dynasty. The burial to which reference has been made was not discovered here, but in the course of excavating a patch of ground between the predynastic cemetery and the mausoleum of Bur Sin. Eighteen people were found buried at the foot of a rectangular shaft originally at least 20 ft. deep, but of which the bottom is now 30 ft. below the surface. All the bodies, which were bedecked with gold ornaments and beads, had been buried independently, although the burials were contemporary, and the same elaborate ritual had served them all. Above the graves a clay floor had been spread, and on this were fireplaces and a brick-walled enclosure containing traces of food. Above this were two floors, at different levels, with altars, and the shaft was closed finally with rubble and brick packing. Evidently, Mr. Woolley notes, the burial had been by stages, each marked by ceremonies of fire and sacrifice.

Co-operation in Archæological Research in France

THE Smithsonian Institution announces the completion of an agreement with the University of Toulouse, whereby the two bodies will co-operate for a period of ten years in the excavation of the cave of Marsoulas in the Haute-Garonne among the foothills of the Pyrenees, The cave is the property of the University, and is already well known to archæologists for its polychrome paintings and wall engravings of palæolithic age. It was first investigated by archæologists in 1886–87, but after that it was comparatively neglected until recent excavation by Mr. J. Townsend Russell of the Division of Old World Archæology of the Smithsonian Institution. The cavern is about thirty metres in extent, but galleries now closed by clay infiltration suggest that at the time of its occupation by palæolithic man it may have afforded more extensive accommodation than at present. It is hoped that it may be possible to open up these galleries. By the time the agreement expires, the cave should be cleared completely. In the meantime the terms of the agreement may be extended to cover other investigations, possibly so far afield as the French Near East and Africa.

Recent Excavation in the Marsoulas Cave

EXCAVATION in the Marsoulas Cave during the past season by Mr. Russell on behalf of the Smithsonian Institution has already produced results of importance, which promise well for the future of the joint undertaking. Two ancient hearths were found, of which the upper yielded artefacts typical of the Magdalenian period. Just below was an Aurignacian hearth with typical knives, scrapers, points and decorative pendants of flint and bone. An unexpected find was a triton shell, which must have come from warm water then far to the south, probably from Africa. The technique of one of the numerous wall-paintings observed is described as unique. The animal form had been produced by the thumb of the painter, which had been dipped in the wet pigment and then pressed on the wall. The paintings of the Marsoulas Cave are singular in the fact that they are near the entrance instead of in the far recesses of the Cave as is more usual. Their excellent state of preservation suggests that the entrance of the cave must have been blocked by an obstruction for a very long period after the close of the palæolithic age.

Cereals for Spring Sowing

The selection of the best varieties of cereals for spring sowing is always a question of importance for the farmer. To meet this need, the National Institute of Agricultural Botany, Cambridge, has issued a leaflet (*Farmer's Leaflet*, No. 2) describing the varieties most suitable for use in the Midlands, east, and south of England, the recommendations being based on tests carried out at a number of trial stations. The sowing of spring wheat is not, in general, advocated, but of the varieties available, Little Joss is suggested for February and Red Marvel or A1 for early March sowings. The choice of oats is, however, much wider. Victory is one of the best all-round varieties, useful both for sale and feeding. Star, an oat similar, on the whole, to Victory, has the additional advantage of a thinner husk and a better standing straw, and is, therefore, preferable on highly fertile soils. Golden Rain and Golden Rain II. also deserve consideration when the crop is intended for feeding on the farm, since the colour of the grain is apt to affect the market price adversely. Marvellous is a further variety which usually gives heavy crops, but it is only suitable for early February sowings. As regards barley, the choice lies between the well-established Plumage and Spratt-Archers and the new variety recently produced by Dr. Beaven, called Golden Archer. The latter is of the Spratt-Archer type, with similar malting quality, but the yield is rather better. For unusually late sowings, the early ripening Victory is suggested as the most suitable. Early sowing of all spring cereals is regarded as of the utmost importance, irrespective of the variety chosen. In view of the bad harvest conditions of 1931, farmers are advised to pay special attention to germination. The Official Seed Testing Station, Cambridge, undertakes germination tests at the nominal fee of 6*d*. per sample.

Selection of Sugar Beet Seed

The question of the selection of sugar beet seed will soon be receiving the attention of farmers, now that most factories have fixed sugar beet prices for 1932. The results of the exhaustive trials carried out by the National Institute of Agricultural Botany, Cambridge, in recent years, have been reviewed in the light of the new prices, and it can be confidently said that on most soils the heavy yielding (or E types) will pay the farmer better than the high-sugar-content (or Z) types. For general cultivation, Kleinwanzleben E or N, Dippe E, Dobrovice, Hoerning R.R., and Zapotil I can all be recommended ; Marsters and Johnston's Perfection should be chosen for early sowing, and on very rich land either of these two or Kuhn P. A leaflet describing these strains can be obtained, free of charge, from county organisers, or the Institute, to which application can also be made by those desirous of advice or further information.

Forestry in Kenya

The Annual Report of the Kenya Forest Department for the year ending Dec. 31, 1930, affords pleasurable reading for all those interested in the progress of forestry conservation and development in the Empire. The whole Colony enjoyed good rains, and a record acreage of new plantations, 4429 acres, was made. Excellent growth both of the new and old plantations was recorded, and there were no forest fires of any consequence. The economic slump, as is a common experience in forestry operations, resulted in a considerable drop in the revenue from timber and from the sale of young trees and seeds. For the first time the revenue from firewood actually exceeded that from timber. This factor alone would justify the far-seeing policy of the Colony's administrators in supporting a correct forest administration. It is of interest to note that the management of the intensively worked forests of the Nairobi District was placed on a satisfactory basis during the year by the completion of detailed working plans. The Chinese tung oil tree, *Aleurites Fordii*, has been previously alluded to in Nature, and it was mentioned at the time that experiments were being carried out to ascertain the possibilities of growing the tree commercially in several of the Colonies. Great interest is being shown in this tree by farmers in Kenya, and the Forest Department has acted as agent in the distribution of the seed. A few experimental trees have been planted, since it was first grown in the Department's arboretum in 1922, at practically every forest station, to test the suitability of the various districts, but the trees are as yet too young to give definite indications.

A Modern Telephone Cable

In January 1931 a telephone service was inaugurated over a new submarine cable spanning the hundred miles between Key West, United States, and Havana, Cuba. The new cable is the longest deep-sea telephone cable in the world, and it is unique in having neither intermediate repeaters nor inductive loading. A paper describing its engineering characteristics was read by H. A. Affel, W. S. Gorton, and R. W. Chesnut at the winter convention, held in January, of the American Institute of Electrical Engineers. The new cable can operate at a frequency of 28,000 cycles a second, which is about eight times faster than ordinary cables. The feature of the new cable which has made this great improvement possible is the use of paragutta, the new insulating material invented at the Bell Telephone Laboratories. There are three telephone channels in the cable, obtained by an adaptation of the ordinary carrier apparatus used for long distance transmission over open wire lines. There are six frequency bands, one for each direction in the three channels. The largest skin effect occurs in the central conductors, but the effect is also noticeable in the thin return copper tapes. Elaborate precautions were taken to prevent 'noise' intruding in the speech circuit. Frequency limiting filters were introduced into several neighbouring circuits and proved effective. If traffic requirements grow so that more facilities are required, a higher frequency range can be employed and additional channels obtained. In addition, if telegraph circuits are required, carrier telegraph systems may be operated in place of one or more of the telephone channels. For example, with the six telephone channels, a possible arrangement would be to employ two of these channels for carrier telegraph circuits. The cable could then carry simultaneously a load of four telephone messages and twenty-four or more two-way telegraph messages.

Medical Uses of Radium

The Medical Research Council has issued a report which summarises the results of research work in the treatment of cancer done during 1930 by means of radium salt entrusted by H.M. Government to the Council (*Special Rep. Series*, No. 160. London: H.M. Stationery Office. 1*s*. net). It also contains data concerning patients treated in earlier years, and thus maintains continuity with the eight previous and similar reports that have been issued. The stock of radium entrusted to the Council has been distributed on loan to selected research centres throughout Great Britain. Growths of the breast, cervix uteri, and buccal cavity are at present most favourable for radium therapy, but in rectal growths little success has attended the treatment. It is remarked that up to the present no method has been discovered by which malignant cells can be made more radium-sensitive, and that any advance in this direction would have wide-felt effects. Of cases of sarcoma, 23·50 per cent react favourably to radium treatment, and five cases of brain tumour have been treated, with two apparent successes.

Physiology and the 'Aura'

In our issue of Feb. 6, p. 197, a note was published referring to Prof. D. F. Fraser-Harris's paper at a recent meeting of the British Psychological Society, in which he described the so-called human aura as the familiar negative after-image produced by temporal retinal induction. Dr. F. W. Edridge-Green has written pointing out that the phenomenon can be shown with white cardboard, and that it and "numerous others of a similar character are due to the movement of the photochemical fluid in the interretinal space. There appears to be a continuous flow towards the centre of the retina when the eyes are being used." We may add that Prof. E. N. da C. Andrade gave a humorous description of some experiments on this subject in Nature of Dec. 23, 1922, p. 843. Prof. Andrade used his hand and also cardboard hands and figures, and his conclusion was that the effects were due to after-images, an explanation given of a similar experiment referred to by Dr. Edridge-Green in Nature of Dec. 9, 1922, p. 772.

Palæontological Expedition to Northern India

It is reported by Science Service that an expedition organised by Yale University under Prof. Hellmut de Terra is proceeding to Northern India with the object of investigating the geology and palæontology of the Salt Range, one of the smaller mountain ranges of Northern India, situated about eighty miles south of the Himalayas. This range, which is considered by some to be one of the key positions of Asia in the geological sense, is an area of great promise for these branches of research, as it has never been examined systematically for palæontological evidence. The expedition, it is hoped, may find there evidence bearing on the development of man. The members of the expedition, beside the leader, are Mrs. Hellmut de Terra, Prof. G. E. Hutchinson, and Mr. George E. Lewis.

Announcements

At the anniversary meeting of the Royal Astronomical Society, held on Feb. 12, Dr. H. Knox-Shaw, Radcliffe Observer, Oxford, was re-elected president of the Society, and the new members of Council elected were Mr. C. R. Davidson, Sir Arthur Eddington, Mr. John Evershed, and Dr. R. Stoneley.

It is announced in *Science* for Jan. 22 that the Richards Gold Medal for conspicuous achievement in chemistry has been awarded by the North-Eastern Section of the American Chemical Society to Prof. Arthur A. Noyes, director of the Gates Chemical Laboratory of the California Institute of Technology, Pasadena. The Richards Medal, which has thus been awarded for the first time, was established in 1929 to commemorate the contributions to chemistry by the late Prof. Theodore W. Richards, who was professor of chemistry in Harvard University. A trust fund of 10,000 dollars has been raised to endow the medal.

We have received a copy of a new catalogue of Zeiss surveying instruments from Messrs. Carl Zeiss, Mortimer Street, London, which includes details and illustrations of a number of levels, tacheometers, and theodolites, including the new Zeiss theodolite, type III. It is claimed that this instrument shows several improvements on previous models. The weight complete is only seventeen and a half pounds.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in pharmaceutics at the School of Pharmacy, Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (Feb. 24). An assistant aircraft inspector under the Government of India—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Feb. 25). A lecturer and instructor at the Royal Air Force Electrical and Wireless School, Cranwell, with knowledge of alternating current work and its application to high-frequency engineering—The Secretary, Air Ministry (Feb. 27). A full-time teacher in the Department of Mathematics and Physics of the West Ham Municipal College—The Principal, West Ham Municipal College, Romford Road, Stratford, E.15 (Feb. 27). A head of the Mechanical Engineering Department of the Coventry Technical College—The Director of Education, Council House, Coventry (March 3). A professor of philosophy in the University College of North Wales, Bangor—The Secretary and Registrar, University College of North Wales, Bangor (May 14).

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.]*

Nomenclature for Lines in the β-Ray Spectra of Radioactive Bodies

I HAVE found on several occasions considerable trouble and confusion occurring owing to the absence of any system of nomenclature for the lines in the β-ray spectra of the radioactive bodies. These spectra consist of a great number of lines formed by homogeneous groups of electrons, and in nearly every case they have been analysed by means of a magnetic field. The quantity, therefore, that is determined experimentally is $H\rho = m_0 c\beta/\sqrt{1-\beta^2}$, where ρ is the radius of curvature of the β-particle in a magnetic field of value H, and m_0, c, and β have the usual significance. The quantity that is needed in most theoretical discussions is the kinetic energy of the β-particles, and this is obtained by calculation from $H\rho$. When it has been necessary to specify a particular line, it has been usual to give either the $H\rho$ value or the energy, the latter being expressed sometimes in ergs and sometimes in electron volts. Thus, statements such as "the line $H\rho$ 1410" or "the line of energy $1{\cdot}529 \times 10^5$ volts" are current everywhere in the literature of the subject.

This might be practicable if these values of $H\rho$ and energy for a particular line were likely to remain the same, but the reverse is the case. There is probably no β-ray line for which we know the $H\rho$ value to one part in a thousand, and the calculation of the energy involves e/m, giving again a possibility of change in the final result. Almost every research on these spectra introduces slight improvements in the $H\rho$ values, and this will probably be even more prominent in the future, now that the importance of these spectra in nuclear problems is apparent. We are therefore liable to meet statements about a line $H\rho$ 2916, with a footnote to the effect that this is the $H\rho$ 2913 measured by 'X' a year previously. Further, from the energies of the β-ray groups it is possible to determine the energy of the γ-ray responsible for them by conversion in one of the electronic states, and such γ-rays are referred to either by their energy values or wave-lengths, which are similarly subject to continual change.

Now, a β-ray line and a γ-ray are perfectly definite things, and it is highly desirable that each should be named. Any writer in the subject could then specify without ambiguity the β-ray line or γ-ray to which he is referring, and could state the $H\rho$ or energy which he considers best to assign to it. The question of what nomenclature to adopt is a difficult one. Since one γ-ray can in principle produce as many β-ray lines as there are different electronic states in the atom, it might appear best to name the γ-ray, say, G, and then specify the β-ray group GK to mean that group due to conversion of this γ-ray in the K-level. I am not in favour of such a system, because the origin of all the β-ray lines is not known, and there is even a possibility of a change in the cases where we think we know the origin. I am, also, not even in favour of attempting to group all the lines due to a certain radioactive body under one system of nomenclature, because there are numerous cases of β-ray lines of the existence of which we are quite certain, but where there is considerable doubt about which of two bodies actually emits them.

I think it would therefore be best to name on a common basis all those β-ray lines obtainable from the most usual sources. For example, I would suggest that all the lines obtainable from a source of thorium-B in equilibrium with its products thorium-C, thorium-C′, and thorium-C″ be grouped together; radium-B plus the radium-C bodies would form another group, and so on. This may not be quite so convenient as endeavouring to effect a smaller subdivision, but it will avoid continual annoying changes in the naming of the weaker lines.

As regards the actual method of naming the lines, I suggest one that is based on intensities, but since we are deliberately using no quantitative data, any method which is proposed must depend on a certain amount of arbitrary choice.

However, I do not think it would be difficult to go through any spectrum and classify the lines relative to their neighbours, and as a basis of classification I would take the direct appearance of the photographic plate *when suitably exposed* for that region of the spectrum, and call the lines prominent, fairly prominent, or less prominent, irrespective of their absolute intensities measured in the number of electrons in the line per unit exposure. The prominent lines I would name with capital letters in the order of increasing $H\rho$ throughout the spectrum. The fairly prominent lines would be named by small letters but with reference to the prominent line next lowest in the $H\rho$ scale: that is, the first line after the prominent line D would be called Da (see Fig. 1) and the next Db, and so on; and then on the farther side of E the same type of line would be named Ea, Eb, etc. For the remaining lines, numerals could be used within each division defined by the more prominent lines: thus, the significance of $D1$, $Da1$, $Da2$ is obvious. I think it is a fair assumption that any new lines that are detected will be very faint, and they can easily be named by employing a decimal notation. For example, $Eb2{\cdot}1$ would mean a line lying between $Eb2$ and $Eb3$. I think this system would work well if the initial assignment of letters is done so as to provide a large number of divisions in the spectrum.

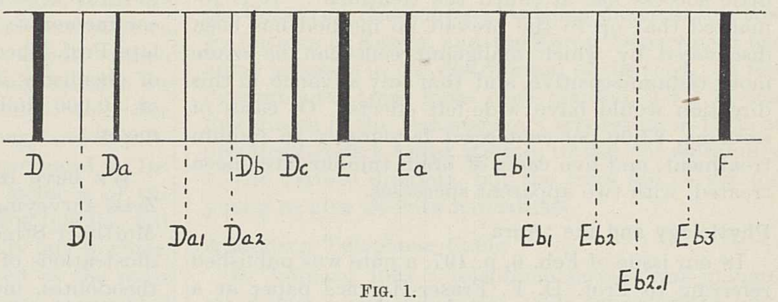


FIG. 1.

I am indebted to Dr. Feather for the suggestion that certain groups of capital letters should be assigned to definite regions of the spectrum, even if there are not sufficient prominent lines to use them all. A rough idea of the speed of a group would then at once be obtained from its name. For example, letters A-F might be reserved for lines up to $H\rho$ 1500; G-K for $H\rho$ 1500-2500; L-P for $H\rho$ 2500-4000; Q-U for $H\rho$ 4000-7000; and V-Z for above $H\rho$ 7000. A γ-ray could, of course, be named in a natural manner by prefixing γ to the name of the most intense β-ray line for which it was responsible.

I am convinced that this question, while perhaps at first sight trivial, is, on the contrary, urgent and important, and that a suitable decision now will save a great deal of trouble in the future. I do not lay great stress on the particular method I have proposed, and should be only too willing to adopt any other method that seems likely to offer more advantages.

C. D. Ellis.

Cavendish Laboratory, Cambridge,
Jan. 15.

Crystal Structures of Vitamin D and Related Compounds

I have had the opportunity of examining by X-rays the crystals of ergosterol and certain of its irradiation products, recently described by a team working at the National Institute for Medical Research.[1] Though the results are only preliminary, they seem of sufficient interest to warrant publication at this stage. Five substances, all of composition $C_{27}H_{41}OH$ or $C_{27}H_{43}OH$, have been examined, with the results shown in the accompanying table.

The most striking features of the crystals are their essential similarities of properties and the simple relation between their unit cells. All the substances except lumisterol occur in platy crystals of a long-chain paraffinoid type. All are monoclinic and show a distinct tendency to elongation along the b-axis. (In lumisterol the crystals are fine needles with b as needle axis.) All are optically positive with (010) as optic axial plane and the fast direction γ inclined at a moderate angle to the c face. All have the same b axis of 7·2 A. and their a and c axes are simple multiples of 10 A. and 20 A. respectively. The spacing of the c plane is remarkably constant at 35·5 A., agreeing with the value found by K. Wejdling and E. Bäcklin.[2] It differs significantly from that of cholesterol, which was examined for comparison. Lumisterol has a halved c spacing, and α-dihydroergosterol, owing to the presence of alcohol of crystallisation, deviates from the others.

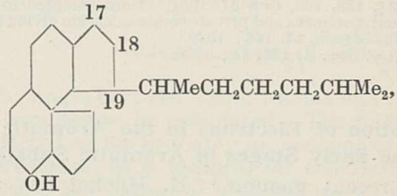
Substance	a	b	c	β	$c \sin\beta = d_{001}$	Space Group	No. of Mol. per Cell	No. of Mol. in Asymmetric Unit	Orders of Basal Plane, Estimated Intensities: 1	2	3	4	5	6	7	8	9	10
Ergosterol . .	9·75	7·4	39·1	65°	*35·40*	C_2^2–$P2_1$	4	2	vvs	vs	mw	a	vw	mw	s	vw	m	vw
α-Dihydroergosterol and ethyl alcohol	30·8	7·4	43·1	53	*34·5*	C_2^3–$C2$	12	3	..	vs	mw	a	vw	mw	s	a	m	..
Calciferol . .	20·8	7·15	38·5	68	*35·65*	C_2^2–$P2_1$	8	4	vvs	vs	s	a	vw	mw	ms	vw	ms	..
Pyrocalciferol calciferol	20·2	7·35	40·0	63	*35·8*	C_2^3–$C2$	8	1	..	w	a	a	a	ms	w	m	w	m
Lumisterol . .	20·3	7·25	20·4	60	*17·8* $=\frac{1}{2}\times 35{\cdot}6$	C_2^2–$P2_1$	4	2	..	..	..	w	a	s	a	m	a	w
Cholesterol . .	16·4	..	..	..	*33·3*	C_1^1–$P1$	..	..	..	vs	a	a	a	w	ms	vw	ms	w

N.B.—Letters for intensities: vs, very strong; mw, medium weak; etc.

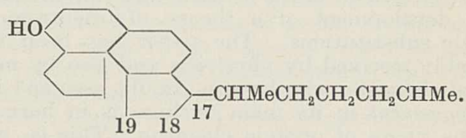
From these observations certain conclusions can be drawn:

1. The unit cell of the molecular compound calciferol-pyrocalciferol contains four molecules of each kind, which is the number the symmetry demands for the space group C_2^3–$C2$. This proves either that calciferol is a simple substance or that it contains other substances indistinguishable by X-rays. The former conclusion is far the more probable. The association of molecules found in the other cases consequently does not show that any of them consists of more than one molecular species and is purely of geometrical intermolecular origin.

2. The molecule of ergosterol and its photo-derivatives has the approximate dimensions 5 A. × 7·2 A. × 17–20 A. These form a double layer similar to those of long-chain alcohols and acids. Such dimensions are difficult to reconcile with the usually accepted sterol formula



which would lead to a wider and shorter molecule, but agree much better with one where the carbon chain is attached to atom 17 in ring iv,



3. The rings lie approximately in the bc plane, that of the larger refractive indices $\beta\gamma$, and their width 7·2 is approximately constant in all the compounds. This is borne out by the observations of sterol films by N. K. Adam,[3] who finds the molecule area of 36 sq. A. for ergosterol, as against 35 sq. A. in the solid crystal.

4. The differences between the compounds is due to a difference in the side groups or linkages in the rings, leading to a different form of association in the solid and to a small but distinct redistribution of scattering matter along the chain lengths, as shown by the intensities of the c plane spectra. The greatest similarity is shown between ergosterol and calciferol, the chief difference being a double association of molecules in the latter case. It may be significant that while the basal plane intensities of ergosterol and dihydroergosterol are practically indistinguishable in spite of the notable difference in spacing, those of ergosterol differ from them particularly in the third and ninth orders. This would seem to indicate that the change had affected the carbon skeleton, not merely the position of double bonds in the molecule. In lumisterol and pyrocalciferol the change in intensities is so much greater that the resemblance is almost obliterated. It is doubtful, however, in view of the extreme complexity of the molecules, whether any conclusive evidence of the actual intra-molecular change can be found by X-rays alone. The most

hopeful method would seem to be the examination of the ultra-violet absorption and Raman spectra of single crystals with polarised light at liquid hydrogen temperatures. J. D. Bernal.

Mineralogical Museums,
Cambridge, Feb. 2.

[1] F. A. Askew, R. B. Bourdillon, H. M. Bruce, R. K. Callow, J. L. Philpot and T. A. Webster; *Proc. Roy. Soc.*, B, **109**, 488; 1932. See also Nature, **128**, 758, Oct. 31, 1931. I am indebted to Dr. Callow for the actual specimens and private communication giving later values.
[2] *Acta Radiologica*, **11**, 166; 1930.
[3] *Proc. Roy. Soc.*, A, **126**, 25; 1930.

Distribution of Electrons in the Aromatic Nucleus and the Early Stages of Aromatic Substitutions

In a recent memoir[1] E. Hückel has made an interesting attempt to apply modern mathematical and physical conceptions of the electron in valency bonds to an *a priori* deduction of the distribution of negative electricity in the benzene ring and ultimately to the development of a theory of orientation in aromatic substitutions. The paper has been very favourably received by physicists and also by many physical chemists, who have no doubt assumed that the *dénouement* in its main outlines is in harmony with the views of organic chemists. This is, however, not the case; so far as we are concerned, we expected conclusions to be reached which are the opposite of those arrived at by Hückel. Where this author postulates an excess of electrons we consider there is a defect, and vice versa.

It should be stated that we are confining our attention to the reactive positions, and the remarks made in this note are not intended to apply to the circumstances of any of the other carbon atoms in the nucleus. Thus there is little chemical evidence for the alternation proposed by Hückel, even if all the signs are inverted. The theory of Hückel requires that, of two carbon atoms, the one which is the more deficient in electrons will be the more prone to undergo substitution (for example, nitration, sulphonation, or halogenation). The mechanism propounded is initially extrusion of a proton by the relatively *positive* centre, followed by attack of the vacant position by the reagent. On the other hand, we say that the reagent (of the electron-seeking kind, as in the processes specified) attacks the centres of *electron excess*, and that this is followed by the expulsion of the proton.

Our theoretical systems, though not identical in every respect, have been found successful in correlating certain important generalisations in organic chemistry with the changes observed in the properties of inorganic compounds as the charge on the nucleus of the central element alters: B→C→N; P→S→Cl. They have also proved useful in the interpretation of organic chemical phenomena of the most varied types.

The arguments that could be brought to bear on the present subject are accordingly very numerous, and it will suffice to mention the following three points:

(1) Any theory of aromatic substitution is inadequate if it fails to take account of the fact that the influence of groups on the course taken by substitution in the aromatic series can be perfectly correlated with the effects of the same groups on the orientation of additive reactions of non-aromatic unsaturated substances. Such reactions obviously obey the same fundamental laws as those that govern aromatic substitution and yet the *expulsion of a proton does not occur at any stage of the process.* We claim that in both cases the reagent seeks the centres of greater electronic density.

(2) From a study of the relative strengths of acids and bases, it is known that certain substituents have the effect of loosening the grip of a molecule on a proton; others tighten it. Clearly, in Hückel's theory the groups that make an acid stronger and a base weaker should, when introduced into the benzene molecule, facilitate the process of further substitution. Thus nitrobenzene should be *more* reactive than benzene, whereas toluene should be *less* reactive. Actually the reverse is the case, and circumstances, which from all analogies must assist in the process of extrusion of protons, do not render aromatic substitutions more facile, but, on the contrary, they make them much more difficult.

(3) Even in aromatic substitutions, the proton which is expelled may be detached from a part of the molecule remote from the point of attack of the reagent and of attachment of the new substituent. An example is the perhalogenation of certain phenols and in general all that numerous class of reactions leading to blocked hydroaromatic types. In these cases it is not the atom suffering loss of a proton that receives the substituent, and therefore Hückel's theory could not be applied without such modifications as would amount to a reversal of the principle.

Without, therefore, going into the minutiæ of the special organic reactions concerned, we venture to think that the above considerations render the view of Hückel untenable.

Unfortunately, the postulated distribution of electrons in the nucleus must stand or fall with the theory of substitutions, and we therefore assume that some error has crept into the discussion, the mathematical physics of which we are not competent to criticise.

The above remarks apply only to the course of ordinary aromatic substitution, which most organic chemists agree in attributing to the active intervention of unsaturated systems of two or more carbon atoms; substitution in saturated carbon compounds is quite a different phenomenon and may well be preceded by the loosening of the proton replaced. In this connexion the suggestion is not at all novel. Furthermore, cases in which aromatic substitution occur with great difficulty may perhaps be correctly described as of saturated hydrocarbon substitution type, a possible example being the conversion of *m*-dinitrobenzene into trinitrobenzene.

Nevertheless, the theory of substitutions in saturated compounds has not yet been satisfactorily treated, and we do not claim that the idea of incipient proton dissociation is proved in any one example; there are too few reliable data and the evidence is conflicting.

The object of this note is to direct attention to our opinion that the conclusions reached by E. Hückel regarding the distribution of electrons in benzene derivatives and the mechanism of substitution are quite unacceptable.

A. Lapworth.
The University,
Manchester.

R. Robinson.
The Dyson Perrins Laboratory,
Oxford.

[1] *Z. Phys.*, **72**, 310; 1931.

Surface Tension of Soap Solutions

Prof. Mahajan's latest letter[1] and his paper[2] suggest that he has entirely misunderstood, not only my own work and the conclusions derived from my experiments, but even the very meaning of the terms dynamic and static surface tension.

The methods used by Prof. Mahajan for the measurement of surface tension are quite incapable of giving a true value of dynamic surface tension, as this requires the measurements to be made in about 0·1 second, or less, especially when small and rapidly moving molecules, such as those of sodium oleate, are concerned. Therefore, what Prof. Mahajan terms 'dynamic values' are nothing but *semi-static* values, more or less close to the real static value corresponding to the veritable equilibrium. I have published the results of certain experiments made on solutions of pure sodium oleate [3] at the concentrations 1/25,000, 1/50,000, 1/100,000, which show very plainly that, when the surface tension is measured very rapidly (ten successive determinations were made in the first minute), the dynamic value for a solution in which the active molecules are as near as possible of a homogeneous distribution, is very near that of pure water. Had it been possible to measure the surface tension in the first one hundredth of a second or so, the value would have been identical with that of water. As it was, the following values were obtained :

Concentration.	1/25,000.	1/50,000.	1/100,000.	
Dynamic (immediately after stirring)	68·0	71·0	71·0	dynes/cm. 22°
After 15 sec. .	64·0	70·0	70·0	
,, 30 ,, .	58·0	68·0	69·0	
,, 1 min. .	42.0	63·0	68·0	
,, 2 ,, .	39·0	52·0	64·0	
,, 3 ,, .	38·0	41·0	61·0	
,, 5 ,, .	37·0	37·0	55·0	
Static value after 12 min.	36·6	35·0	32·1	
After 2 hours .	36·6	35·0	32·1	

It is obvious that, as the concentration increases, the initial value (dynamic) will be lower. It requires less time for the molecules to become adsorbed in the surface layer, as they are closer to it, and in larger number. Consequently, if we deal with solutions of, say, 1 per mille, or 1 per cent, the measurement must be done in a small fraction of a second in order to correspond to that of water, as the 'drop' is very rapid. I hope I have made it clear that the important drop in surface tension, which, for technical reasons, can only be followed step by step in the case of dilute solutions, is due to the Gibbs-Thomson adsorption of active molecules in the surface layer.

When Prof. Mahajan mentions surface tension values of the order of 30-40 dynes, he cannot use the term 'dynamic', as most, if not all, of the adsorption in the surface layer has already taken place. What is meant by 'time-drop due to adsorption' is precisely the phenomenon which has brought the surface tension down from 73 dynes to a value around 30 dynes.

What Prof. Mahajan therefore observes is an additional phenomenon, of small amplitude, which takes place *after* the Gibbs-Thomson adsorption, which Prof. Mahajan seems to ignore altogether, has played its part.

I take this opportunity to advise Prof. Mahajan against quoting the values of surface tension to the third decimal point. After more than ten years of experience with all possible methods of measurements, I have come to the conclusion that the second decimal point is generally dubious when dealing with pure liquids, and is absolutely meaningless in case of colloidal solutions.

P. LECOMTE DU NOÜY.

Institut Pasteur,
Paris.

[1] NATURE, **129**, 133, Jan. 23, 1932.
[2] *Ind. J. Phys.*, **6** (2), p. 147.
[3] Du Noüy, *J. de Phys. Radium*, **6** (VI.), pp. 145-153, and "Équilibres superficiels des solutions colloïdales" (Masson, Paris), p. 40.

Stokes's Formula in Geodesy

STOKES in his "Collected Papers", vol. 2, p. 168, gave a very elegant formula, giving elevation N of geoid above its reference spheroid in terms of g-anomalies. The formula is $N=\frac{R}{G}\int_0^{\pi}(\Delta g)_{\psi}\,.\,Fd\psi$, where

$$F=\tfrac{1}{2}\left\{\operatorname{cosec}\frac{\psi}{2}+1-6\sin\frac{\psi}{2}-5\cos\psi-3\cos\psi\log\sin\frac{\psi}{2}\left(1+\sin\frac{\psi}{2}\right)\right\}\sin\psi,$$

ψ being the angle between current point and the point at which rise has to be calculated. The formula has been neglected so far probably on account of paucity of g-observations, as it requires for calculation of N at one place, the values of g-anomalies all over the globe. Recently, however, it has been brought into prominence by articles by V. Meinesz [1] and by W. D. Lambert.[2]

The former goes so far as to say that it can be used for giving local deviations of geoid. While one may be able to use it to get a general idea of elevation of a broad feature of continental extent, and with luck to get differential elevations of two close points above spheroid, I believe it will never be possible to use it for getting absolute elevations.

For computational purposes it is best to divide the earth into concentric rings round the station, and then we get

$$N=\frac{R}{G}\Delta\psi_0\Sigma F_1(\psi)\,.\,\Delta g_M,$$

where $\Delta\psi_0$ is the breadth of a ring, Δg_M is the mean value of Δg in that ring, and $F_1(\psi)$ is the mean value of $F(\psi)$ in that ring.

From this the effect of the various zones for $\Delta g=0{\cdot}001$ cm./sec.^{2} is given in Table 1.

TABLE 1

Zone.	N in ft.	Zone.	N in ft.
0°– 2°	+1	70°– 80°	−4
2 – 4	+1	80 – 90	−4
4 – 6	+1	90 –100	−3
6 – 8	+1	100 –110	−1
8 –10	+1	110 –120	0
10 –20	+4	120 –130	+1
20 –30	+3	130 –140	+2
30 –40	+1	140 –150	+2
40 –50	−1	150 –160	+2
50 –60	−3	160 –170	+1
60 –70	−4	170 –180	0

The figures in this table are correct to the nearest foot.

In actual practice, to get mean Δg in each zone, we will have to divide these zones into smaller compartments, and calculate the mean Δg from each of the compartments and then deduce the mean Δg with its probable error for the whole zone. While near the station the probable error of the mean Δg in our zones may be of the order of 0·005, in outer zones it may easily attain a magnitude of 0·01. These probable errors will enable us to assess the maximum error in our estimated N. A probable error of 0·01 in zone 60°-70° will mean that our estimation of the share of that zone in producing rise of geoid may be wrong by, say, 40 ft. A systematic error of 0·01 in zones from 40°-100°, and of −0·01 in zones from 130°-170° would vitiate the results hopelessly. In no case could one say with any reasonable certainty that N at a station was correct to even 100 ft. or 200 ft.

For differential purposes, however, the situation is different. The effect of error in each compartment, especially for the distant zones, is practically the same for two nearby stations. If, then, we have got a map of the world with our estimated Δg's, we could by suitable templates in a manner analogous to Hayford's isostatic reductions read off the mean Δg for our rings, and probably get a reasonable answer for the differential heights of the points in a local area.

Hence, although the validity of the formula, which was doubted by Helmert, is unquestionable, as V. Meinesz proves, it must be realised that for countries of such wide extent as India, where the elevations of geoid above its spheroid of best fit, as indicated by plumb line deflexions, are of the order of only 20 ft., it is not likely to be of much use, as the uncertainty of the value of Δg in the outer zones makes it impossible to attain this order of accuracy.

B. L. GULATEE.
Geodetic Branch, Survey of India,
Dehra Dun, Jan. 7.

[1] *Konin. Acad. von Wetenschappen te Amsterdam*, vol. 31.
[2] *Bull. Geod.*, 1930.

The Zodiacal Light and the Luminosity of the Night Sky

THE spectrum of the zodiacal light was photographed by Fath,[1] who found that it showed the Fraunhofer line *G* and a blend of *H* and *K* lines, and did not show indication of any bright line. He concluded that zodiacal light is reflected sunlight. I have recently obtained photographs of the spectrum of zodiacal light on very clear nights at Poona (lat. 18° 31′ N.) with an F/1·5 glass spectrograph constructed locally (with the kind assistance of Mr. S. P. Venkateswaran). Using Mimosa extreme orthochromatic plates (H and D for light from half-watt lamp 2600), which I have found to be the most rapid for this work, the spectrograph is sufficiently powerful to bring out the night sky line 5577 A. in one hour's exposure with a slit-width of 0·7 mm.

When the spectrograph is turned towards the zodiacal light at an angle of about 25° above the horizon and successive photographs (each exposure lasting one hour or one hour and a half) taken on the same plate, beginning when the sun is about 20° below the horizon, it is found that the line 5577 A. comes out strongly, and with the decrease of intensity of the zodiacal light the line also becomes fainter. The intensity of the light decreases to about a third between 8 P.M. and midnight in December, and remains more or less steady thereafter.

It may be mentioned that the brightness of the continuous background in the zodiacal light is too small to affect the above conclusion. In the northern and southern skies, the intensity of the green line is more or less steady, with some slight variations which are under investigation. The midnight maximum noticed by McLennan and collaborators, and by Lord Rayleigh, is not unambiguously evident in these latitudes.

The above observations raise the question whether the luminosity of the night sky and of the zodiacal light are not identical in origin. The presence of the green line 5577 A. in the zodiacal light, and hence of atomic oxygen at great distances from the earth, are particularly interesting from the point of view of theories of the origin of zodiacal light.[2]

Photometric measurements to decide the issues raised above are in progress.

K. R. RAMANATHAN.
Ganeshkurd Road,
Poona 5, Jan. 1.

[1] Fath, *Lick Obs. Bull.*, **5**, 141; 1909.
[2] Hulburt, *Phys. Rev.*, **35**, 1098; 1930.

Polish on Metals

WE are much interested in Mr. French's letter in NATURE of Jan. 30, as we ourselves have just constructed an electron camera for the examination of the polish on metals and similar problems. In an earlier paper by Prof. G. P. Thomson[1] it has been stated that no pattern was detected from polished metal surfaces, and it was felt at the time that this result was not in accord with other work then proceeding in this laboratory. It had been found[2] that so-called amorphous substances, such as glasses of widely differing chemical compositions, gave rise to very definite X-ray diffraction patterns which bore strong similarities to the line patterns of corresponding crystalline substances. This led us to the view that, while glasses may contain some material in a truly amorphous form, the greater number of atoms are built up in the form of exceedingly small crystals, probably not exceeding 10^{-6} cm. in size. At the same time, small differences were noted between the spacings of the diffuse bands of the vitreous substance and those of the corresponding completely crystalline substance.

It had already been shown theoretically[3] that the atoms in the surface layer of a crystal have a slightly

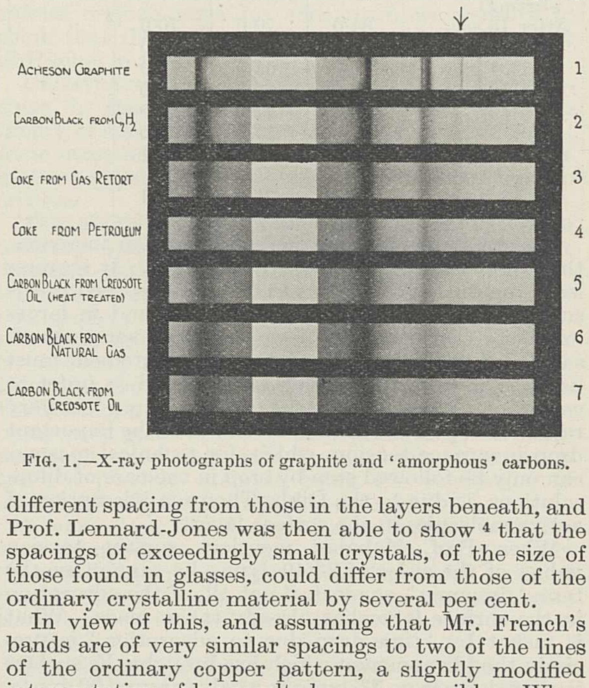


FIG. 1.—X-ray photographs of graphite and 'amorphous' carbons.

different spacing from those in the layers beneath, and Prof. Lennard-Jones was then able to show[4] that the spacings of exceedingly small crystals, of the size of those found in glasses, could differ from those of the ordinary crystalline material by several per cent.

In view of this, and assuming that Mr. French's bands are of very similar spacings to two of the lines of the ordinary copper pattern, a slightly modified interpretation of his results becomes possible. When a metallic surface is polished the crystals break down into smaller units, causing the diffraction pattern to become slightly diffuse. As the polishing proceeds, the crystals break up into still smaller units, so that the interplanar spacings also alter. At the same time, no doubt, a certain amount of truly amorphous material may be produced. This would tend to fog the diffraction pattern still more, so that the weaker bands would become very indistinct, if not impossible to see.

It does not necessarily follow that because the diffraction pattern of the polished surface does not contain the same number of bands as the crystal pattern does lines, that the two lattices are not essentially the same. This point is emphasised in the accompanying series of X-ray photographs of graphite and 'amorphous' carbons (Fig. 1). It is not meant to discuss these in detail here, but it will be seen that the outer diffuse line of photograph (2) has almost disappeared in (3) and cannot be distinguished in any of the remainin gphotographs.* Further, measurements show that as the crystal size decreases, the basal plane (002) spacing increases, while the (100) spacing decreases at a lesser rate. This general trend can be seen in the photographs. Such changes of spacing had already been noticed,[5] but we think the present series of photographs gives rather a convincing demonstration of the gradations between a truly crystalline substance and one which would formerly have been called amorphous. It must also be remembered that the shape of the ultimate crystallites of the polished surface will have a bearing on the relative intensities of the bands.

J. T. RANDALL.
H. P. ROOKSBY.
Research Laboratories of the
General Electric Company, Ltd.,
Wembley, Feb. 2.

[1] G. P. Thomson, *Proc. Roy. Soc.*, A, **128**, 649 ; 1930.
[2] J. T. Randall, H. P. Rooksby, B. S. Cooper, *Z. Krist.*, **75**, 196 ; 1930.
[3] J. E. Lennard-Jones and B. M. Dent, *Proc. Roy. Soc.*, A, **121**, 247 ; 1928.
[4] J. E. Lennard-Jones, *Z. Krist.*, **75**, 215 ; 1930.
[5] H. H. Lowry and R. M. Bozorth, *J. Phys. Chem.*, **32**, 1524 ; 1928.
* The line referred to is positioned beneath the arrow at the top of the figure.

Mechanism of Racemisation

IN some work shortly to be published, we have shown that the racemisation of Rochelle salt by caustic soda is accompanied, and probably conditioned, by complex formation. It was previously observed by Thomsen,[1] and confirmed by Winther [2] and by ourselves, that the rotation of sodium tartrate is reduced by the addition of alkali. We have, therefore, in continuation of our work on racemisation, investigated the behaviour of the specific rotation of Rochelle salt with increasing concentrations of alkali, and we find that the specific rotation of Rochelle salt eventually becomes strongly negative. In other words, the complex is itself lævo-rotatory, and the progressive reduction in the rotation is due to increasing formation of complex with addition of alkali. The rotation changes sign at an alkali concentration of 10 *N* caustic soda (approx.). It should be stressed that these changes of rotation are prior to any racemisation, in the ordinary sense of the term, the rotations being quite stable in the strongest alkali, provided the solutions are kept at room temperature.

If, as we suppose, the complex is produced by the entrance of sodium atoms in place of the hydrogens of the radicle OH-groups, it appears that interchange of groups takes place, immediately on dissolving in alkali, if we accept the usual hypothesis of the mechanism of racemisation. On this view, the subsequent process of heating to produce racemisation is merely one of stabilisation to prevent the converse interchange of groups on acidification. This view meets with the following difficulties : (1) it is difficult to see in what this process of stabilisation consists ; (2) under certain conditions, the heating should lead to an inversion, and not a racemisation. In our opinion, the stereochemical conception of optical activity as a static phenomenon is not entirely satisfactory.

ALAN NEWTON CAMPBELL.
ALEXANDRA JEAN ROBSON CAMPBELL.
Department of Chemistry,
University of Manitoba,
Winnipeg, Jan. 16.

[1] *J. prakt. Chemie* (2), **34**, 83.
[2] *Z. physik. Chem.*, **56**, 465 ; 1906.

Measuring the Surface Area of Living Animals

A NEW method of estimating the surface area of living animals used in metabolism work seems likely to be of interest to many biological workers outside the agricultural sphere. Such a method has recently been developed by me in this laboratory.

Although the animals immediately concerned are pigs, the method is applicable generally to all animals not encumbered with a thick shaggy coat, and consists, essentially, in the estimation of the approximate value of the integral $\int P dx$ over the surface of the animal, where P is the perimeter in a plane perpendicular to the axis of x. In the case of pigs, it appeared satisfactory to take $P = k\pi(a+b)$, assuming the cross section elliptical for the head and body. Here k is a constant which indicates the departure from perfect ellipticity and varies somewhat in value at different parts of the body, while a and b have their usual connotations in the approximate formula for the perimeter of an ellipse. The approximate integration is then made by Simpson's rule, the values of the ordinates a and b for different values of x being read off directly from scale photographs, one taken from the side and the other from directly above the animal. The ears, legs, and tail are estimated separately.

A consideration of the various corrections required and of the errors involved leads to the conclusion that the total error in the method, when all precautions are taken, amounts to not more than 2·0-2·5 per cent, varying a little with the individual animal, in the case of pigs.

For other animals, the constant k and the errors would have to be determined, but there seems reason to suppose that—except perhaps in the case of human beings, for whose superficial area a mass of data is available—a very considerable increase in accuracy may be expected by the employment of the method outlined, in preference to the use of empirical formulæ depending on weight, height, length, or any or all of these. Experience shows that such formulæ are all liable to errors of the order of 10 per cent when applied to animals of the same species other than the ones actually used by the experimenter in determining the formula.

A full account of the method will appear in the April issue of the *Journal of Agricultural Science*.

THOS. DEIGHTON.
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Cambridge, Jan. 28.

Crystal Structure of β-Zirconium

FROM the temperature variation of the resistivity, the thermal dilatation and the thermionic emission, C. Zwikker [1] has deduced that zirconium is transformed into another modification between 1150° K. and 1430° K. Quite recently, the transition point was accurately measured by R. Vogel and W. Tonn [2] from a study of the cooling curve. They found it to be $862° \pm 5°$. The crystal structure of the high temperature modification (β-zirconium) has been determined by us to be cubic body-centred, with two atoms of the metal in an elementary cube, the side-length of which at a temperature in the neighbourhood of the transition point is 3·61 A. The experimental details and the high temperature vacuum camera used will be described elsewhere (*Z. anorg. allgem. Chem.*).

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Eindhoven, Holland.

[1] *Physica*, **6**, 361; 1926.
[2] *Z. anorg. allgem. Chem.*, **202**, 292; 1931.

Research Items

Colombian Archæology.—An account by Mr. J. Alden Mason of a year's field work of an expedition of the Field Museum of Natural History, Chicago, to the Santa Marta area of Colombia in 1922–23 (*Pub.* 304, Anthropological Series, vol. 20, No. 1) describes the examination and excavation of a number of sites in what was once the habitat of the long extinct Tairona Indians. Previously their culture was practically unknown. The area is an island mass rising from tropical coast-land to eternal snow, a system entirely independent of the adjacent Andes. The sites investigated fall into three classes, coastal, foothill, and high mountain. Of the coastal sites, Gairaca provided interesting evidence as to burial customs. It was evidently primarily, if not mainly, an interment site, though it appears to have been occupied seasonally. The interments all date from approximately the same period, and there is no evidence of post-Columbian occupation. The urn burials were secondary: that is, they represent the reinterment of disarticulated bones; but occasionally primary burials were found. Pet animals may have been sacrificed. Implements and ornaments were sometimes enclosed in the burial urns, but more often in smaller urns or in the surrounding soil. Food was also enclosed in small pottery vessels. The pottery is of two types, a coarse red ware with appliqué relief, and thin black polished vessels with incised ornament or moulded relief. The two are evidently contemporaneous. On a site at Nahuange some interesting artefacts were found in association with skeletal remains and pottery vessels. These included six or eight artistic, but highly stylised, heads of crocodiles made of a large univalve mollusc shell, crescentic pendants of shell, tubular beads and other beads of shell, carnelian, etc., two plaques of gold-copper alloy and other gold objects, and ornaments made of univalve shells which may have been used as rattles on clothing. A number of pictographs of a unique character and architectural remains were found at the foothill sites. The material objects found and the scientific deductions will be dealt with in two subsequent reports.

British Migration Elucidated by Ringing Methods.—H. F. Witherby and E. P. Leach have continued their valuable compilation of all the records of birds which, ringed in the British Islands, have been recovered abroad, and of birds which, ringed abroad, have been found in these islands (*Brit. Birds*, Dec. 1931, p. 174). The maps upon which the records of particular species are shown bring out many points in a clear way. The lapwing performs westward and southward movements, British shores being replenished by birds bred in Denmark, Sweden, and Holland; while British native birds have been recovered only south of these islands from northern France, along the west coasts of France, Spain, and Portugal to North Africa. On the other hand, the lists show that mallard and teal which have been bred in the British Isles move east and north, and in their case there is no evidence of a southward migration.

Habits of a Japanese Limpet.—The limpets (*Acmæa dorsuosa*) of Mutsu Bay show seasonal groupings, the spring to autumn period (April to September) being a season of congregation, when individuals appear in groups above high-water mark, whereas from mid-September to March the groups are dispersed (Noboru Abe. *Science Reports, Tôhoku Imp. Univ.*, vol. 4, Sept. 1931, p. 403). This species has the power of both backward and forward locomotion, and its greatest rate of progress is about 2·8 cm. a minute, less than one-third of the speed attained by its congener *A. schrenckii.* The larger limpets have definite spots to which they return after wandering, but such ' homes ' do not appear to be permanent. The force of adhesion of the foot of *A. dorsuosa* is equivalent to 373 grams or more for each square centimetre of the surface of the foot.

British Palmate Orchids.—H. Cary Gilson, in collecting and collating much scattered data referring to the British palmate orchids, has produced a useful summary of information on this highly critical group of plants (*Winchester College Nat. Hist. Soc. Publications*). Descriptions of species and varieties occupy the first part of the paper, and the conflicting opinions on the status of *O. latifolia* are summarised. Hybrids are not described, but many are well illustrated by photographs. The second part of the work deals with the palmate orchids of the Winchester district, together with the author's own views on the constitution of *O. latifolia*, which he suggests may have arisen through the hybrid *O. maculata* (*agg.*) × *prætermissa* by repeated back-crossing of the progeny with one parent followed by selfing to give a small proportion of homozygous plants. The suggestion, whilst providing an explanation of some of the observed facts connected with the polymorphy of *O. latifolia*, is quite hypothetical, and emphasises the need for a cytological and genetical examination of this and related orchids.

Geology of East Greenland.—The geological work of the Cambridge Expedition to East Greenland in 1929 has been described in an important paper by M. M. L. Parkinson and W. F. Whittard (*Quart. J. Geol. Soc.*, pp. 650-74, 1931), with some excellent maps and illustrations. The work was concentrated mainly on the elucidation of certain tectonic problems in the pre-Old Red Sandstone rocks of the area about the Franz Josef and King Oscar Fjords. The outstanding fact in the Palæozoic geology of the region is the triple repetition of belts of sedimentary and metamorphic rocks, and its explanation appears to be closely related to the Caledonian movements. In pre-Cambrian times a complete trough of deposition lay north and south between Laurentia and Baltica. In the East Greenland mountains the shallow-water sediments then deposited in the western border of this trough are preserved. In Cambrian times two or more geanticlines of pre-Cambrian metamorphic rocks which had appeared earlier continued to develop, while the intervening basins harboured shallow-water sediments with shelly faunas. Wedges of metamorphic and sedimentary rocks advanced westwards up thrust planes. The main pressure persisted until at least the Middle Ordovician and possibly the Silurian. The Central Metamorphic Complex represents the most westerly of these geanticlines, while the most easterly is the Eastern Metamorphic Complex.

The South Sandwich Islands.—Little has been added to the knowledge of these subantarctic islands since their discovery by Cook in 1775 and the visit by Bellingshausen in 1820 until *Discovery II.* spent some days at the group in 1930. In a lecture to the Royal Geographical Society on Dec. 14, Dr. S. Kemp gave an account of the main discoveries. All the eleven islands are of volcanic formation dating probably from tertiary times. Five still show signs of activity with craters and fumaroles emitting steam and vapour. Three others retain some warmth, and the remaining three are more or less heavily glaciated. There is considerable evidence of lost land areas around some of the islands. The introduction of echo-sounding into this area of the South Atlantic has thrown light on the relation of the group to other land areas though more work must be done before the problem is finally solved. There is strong evidence of a submarine ridge extending between South America and the South Sandwich group via the Burdwood Bank, the Shag Rocks and South Georgia, but the continuance of the ridge between the South Sandwich Islands and the South Orkneys is not so well established. East of the islands there is an extensive curved deep falling to at least 4421 fathoms. These facts support Suess's theory of the South Antillean arc, which is further supported by the occurrence of typical Andean lavas in Thule Island, the southernmost of the group.

Mapping of the Southern Ocean.—A chart of the Southern Ocean, from long. 50° S. to 73° S. and from lat. 20° W. to 100° E., has been worked out on Mercator's projection by the Norwegian Geographical Institute, the scale being 1 : 4,000,000 at 60° S. (Publikasjon nr. 10 fra Kommandör Chr. Christensens Hvalfangstmuseum; Utarbeitet for Hvalangernes Assuranceforenig, Sandefjord). A considerable number of fresh soundings obtained by Norwegian antarctic whaling expeditions are included. A plan (1 : 100,000) is given of Bouvet Island, which was the subject of diplomatic exchanges some years ago and was ceded by Great Britain to Norway in 1928 as an act of grace.

A Sensitive Barograph.—We have received from Messrs. Negretti and Zambra, the well-known scientific instrument makers, a specimen record of the variations of atmospheric pressure during the week Jan. 18–25, 1932, obtained with the aid of a micro-barograph which gives a record on a scale of five inches to an inch of mercury. This instrument is numbered *M* 2071 in the firm's catalogue of standard meteorological instruments, and is styled the Precision Recording Barometer. In order to obtain sufficient control to overcome the friction involved in obtaining such magnification, four sets of special diaphragms are used in pairs. Their movement is transmitted to the main lever through flexing strips, thus avoiding the use of pivots, and then by a special form of link to the pen arm, the record being obtained on the ordinary clock-driven drum. The charts are five inches wide; since this does not provide for the possible range of pressure in one place, it is necessary to reset the pen when the latter reaches the top or bottom of the chart; there is a spring-controlled thumb-screw for carrying this out. A failure to secure the necessary freedom of movement for recording minute variations of pressure would be evident from the appearance of 'flats' or 'steps' in the trace. Of these there are no examples on the specimen chart, which incidentally, thanks partly to the quiet anticyclonic conditions prevailing during the week in question, shows the diurnal variations of atmospheric pressure very clearly. One obvious use of the instrument is for obtaining the changes of pressure at the ground for correcting the indications of height given by an altimeter. The claim that it will measure changes of the order of two hundredths of an inch would appear to be an understatement of the sensitivity if the specimen record is a typical one. The price, with ink, pen, and 100 charts, is £40.

Origin of Vitamin C.—Three Scandinavian workers, Ottar Rygh, Aagot Rygh, and Per Laland, have obtained what appears to be conclusive evidence that narcotine, one of the less toxic alkaloids present in opium, is a, if not the, precursor of the antiscorbutic vitamin C. In the first issue of the *Zeitschrift für physiologische Chemie* for 1932, these authors describe how they found the alkaloid in various unripe fruits and vegetables, but failed to detect its presence in the ripened materials. From 200 unripe oranges they prepared 600 mgm. of the alkaloid; and by extracting the concentrate, consisting of oil and crystals, from 15,000 oranges at various stages of ripeness, they were able to trace the gradual increase in antiscorbutic power as ripening proceeded. Pure, commercial narcotine was not antiscorbutic, but irradiation from a quartz mercury vapour lamp activated it to some extent without appreciably altering its physical properties. Guinea-pigs were fed on dietaries containing narcotine and irradiated narcotine; both groups died about the same time, but the former group developed strong signs of scurvy before dying and the latter none. Narcotine was found in unripe tomatoes (20 mgm. in 20 kgm.), white cabbage (40 mgm. in 100 kgm.), and in potatoes (12 mgm. in 20 kgm.); qualitative indications of the presence of narcotine were found in milk, but none in red bilberries. Of various derivatives of narcotine, the ortho-dihydroxy derivative — methylnornarcotine — was found to be particularly antiscorbutic. In presence of germinating seeds, known to produce vitamin C, narcotine became active; it disappeared and gave rise to phenols.

Electric Moment and Temperature.—Experiments on dipole moments of substances have shown that, in many cases, these are independent of temperature. One or two cases in which a variation has been reported have been explained on the basis of association, but they are somewhat doubtful. Smyth, Dornte, and Wilson have now discussed the effect of intramolecular rotation upon the moment of a molecule of the type of ethylene chloride, both on the classical and quantum theories (*J. Amer. Chem. Soc.*, Dec. 1931). The quantum calculation shows that, at room temperature, the great majority of the molecules are in low energy levels, where the dipoles oppose one another to a considerable extent, giving a low mean moment. With rising temperature there is an increased oscillation, but the seventy-fifth level is still short of complete rotation. In the experimental part of the paper it is shown that the polarisation of ethylene chloride increases with rising temperature in dilute solutions but decreases in concentrated solutions, the change of polarisation with concentration being surprisingly small. The moments of ethylene chlorobromide and diethyl succinate also vary with temperature. Ethylene chloride and bromide, ethylene chlorobromide and diethyl succinate show different moments in heptane and benzene solutions, so that the moment of a molecule containing two or more dipoles, the axes of which may alter their positions relative to one another, may be affected both by temperature and environment.

Theory of the Glass Electrode.—Dole has described (*J. Amer. Chem. Soc.*, Dec. 1931) some experiments on the glass electrode and given a full critical account of the theories proposed to explain the behaviour of this electrode. The electrode behaves differently in three well-defined *p*H regions. Between *p*H 1 and *p*H 9 it gives potentials which vary with the hydrogen ion activity in the same way as a hydrogen electrode. Above *p*H 8 or 9 and below *p*H 0 or 1 it behaves anomalously. There are three main groups of theories of its behaviour, namely, the phase boundary theory, the ion exchange or adsorption theory, and the membrane or diffusion potential theory. There are some difficulties in all these theories in their present state, the first being inconsistent with facts and the second containing improbable or unverified assumptions. A new equation for the electrode is developed which is shown to agree with the data up to *p*H 12. A similar equation may be derived, for uniunivalent salts, from the Henderson and Planck liquid junction equations if the relative mobility of the positive ions is assumed to be a function of *p*H. It is assumed that the electric double layer at the glass-aqueous solution interface determines the selective mobility of the ions across the boundary.

Anhydrous and Hydrated Manganese Sulphate.—In a paper presented recently to the Czech Academy of Science (*Collection of Czechoslovak Chemical Communications*, 1931, pp. 517-35) Prof. H. Křepelka and Dr. B. Rejha describe the results of an exhaustive research upon the hydrates of manganese sulphate. No less than fourteen different compounds have been mentioned in the literature, but in this investigation the authors have established the existence of only six of these, namely, the anhydrous salt, two forms of the monohydrate, and salts with four, five, and seven molecules of water of crystallisation. Those compounds previously described as possessing a half, two, three, and six molecules of water of crystallisation are said definitely not to exist. It is further stated that anhydrous manganese sulphate can be prepared from any of the hydrated salts by heating first to 100° C., then at 150°, and finally at about 550° C. in an electric furnace and, afterwards, slowly cooling in a desiccator. Much attention was paid in this research to the monohydrate, $MnSO_4$, H_2O, which is readily prepared by heating any of the higher hydrates above 100° C. but below 200° C. The authors found that it was unnecessary to specify definitely any exact temperature between these limits. Again, on exposure to air the higher hydrates effloresce, leaving the monohydrate, which, it is concluded, must have the same pressure of aqueous vapour as the atmosphere. The anhydrous salt also absorbed moisture from the air, forming the monohydrate. Prepared in this manner the salt is not polymerised, but when formed by dehydration at temperatures above 100° C., its molecular weight was double that of the single salt. The essential condition for the separation from solution of crystals containing four molecules of water of crystallisation is that the temperature should be between the limits 26° and 45° C. Above and below these points mixed crystals make their appearance, and this may have misled earlier investigators into the error of reporting the isolation of non-existent hydrates. The salt, $MnSO_4$, $5H_2O$, separates most conveniently from aqueous solution between 9° and 26° C. Below 9° C. ordinary manganese sulphate with seven molecules of water of crystallisation is deposited.

Astronomical Topics

Sunspot Activity during 1931.—In the annual report of the Council to the Royal Astronomical Society, a summary is included of the sunspot activity for 1931. The average daily area of sunspots measured at Greenwich was approximately 260 millionths of the sun's hemisphere. This value for 1931 is half that for 1930, and the average daily number of spots showed a decrease in about the same ratio. On about forty days during 1931 no spots were seen on the sun's disc. Large groups of spots were, however, by no means entirely absent, and the following dates are the times of central meridian passage of groups of spots of 500 millionths or larger, that is, of the order of size at which a spot is visible near the centre of the disc without telescopic aid: Jan. 12·5, Feb. 20·6, Feb. 20·7, March 15·4, May 20·5, Nov. 26·9. The largest of these groups, with central meridian passage on Feb. 20·7 and in latitude 6° north, had a maximum area of nearly 1900 millionths. A note on this group was given in Nature, **127**, 321; 1931.

Thirteen spots, including three of the above, were observed spectroscopically to be more than usually active. This activity often took the form of brilliant, short-lived eruptions of hydrogen (Hα), which in several cases were accompanied by dark hydrogen markings moving with high velocity of the order of 50 km./sec. Terrestrial magnetic activity was distinctly less than in 1930, there being seven disturbances of storm range registered at the Greenwich magnetic station as compared with twenty-three in the previous year.

The relation of the sun's activity during 1931 to the present eleven-year sunspot cycle is shown by the following values of the mean daily area of sunspots, corrected for foreshortening and expressed in millionths of the sun's hemisphere:

Year	Area	Year	Area
1923	55	1928	1390
1924	276	1929	1242
1925	830	1930	516
1926	1262	1931	260
1927	1058		

Two Very Distant Spiral Nebulæ.—Science Service Bulletin for Jan. 14 reports a further advance in the study of the radial motion of the distant spirals which has been in progress at Mt. Wilson for some time. Dr. Edwin P. Hubble discovered a cluster of very faint spirals in Gemini; Mr. Milton L. Humason has investigated their radial velocity, and finds a recession of 15,000 miles per second, which is much the highest value yet found. It is generally agreed that the shift of the spectral lines to the red, which is observed in the spectra of these nebulæ, is a good measure of their distance from us, whether it arises from actual recession or from some other cause. The distance deduced in the present case is 135 million light-years, which is approaching close to the 150 million light-years estimated some years ago to be the limit of the region of space within the reach of the 100-inch reflector at Mt. Wilson. It is anticipated that the contemplated 200-inch mirror will greatly extend the limit.

Mass of Eros.—Prof. W. H. Pickering points out in *Popular Astronomy* for January that if we accept the duplicity of Eros, which has long been suspected, and was strongly supported by the observations of Messrs. van den Bos and Finsen at Johannesburg a year ago and those of Mr. L. Campbell at the same time, we have the means of deducing the mass with considerable accuracy. The distance between the centres of the two bodies is taken as 17 miles. Their period of revolution is known with great accuracy from the light-variation; it is $5^h 16^m 12{\cdot}94^s$; the mass comes out 1/177,000,000 of the earth, or about 1/2,000,000 of the moon. Taking the diameter of each component as 8 miles, Prof. Pickering finds the density of each component to be 15·6 times that of water—an improbably high figure. It would be reduced to the density of iron if the diameters were 10 miles. The latter value for the diameters gives the albedo as 0·30, or two-thirds that of the earth—not an impossible value.

The University of Edinburgh

Extension of Departments of Geology and Engineering

Grant Institute of Geology

THE accommodation provided for the teaching of geology at the University of Edinburgh has been very inadequate ever since the establishment of the chair in 1871, with Archibald Geikie as the first professor. Owing to the great influx of students at the close of the War, the Department became so congested that it was impossible to carry on the practical classes at the Old University Building. Temporary quarters were provided in wooden huts which served the purpose for a time, but by 1929 these were falling into a state of disrepair. At this juncture, Sir Alexander Grant came to the aid of the University, and gave £50,000 for the erection of a new geological building. Sketch plans were prepared by Prof. Jehu and his staff and placed in the hands of the well-known architects, Sir Robert Lorimer and Mr. John F. Matthew.

The new building was completed this year and was formally opened by the Prime Minister on Jan. 28. It forms a part of the King's Buildings inaugurated by King George V., and is situated midway between the Chemistry and Zoology Departments, with a frontage of 213 ft. The building has two wings, giving a total depth from north to south of 108 ft.

The main entrance, facing north and centrally placed, leads to the hall and staircase, with corridors branching off right and left the whole length of the building, and lit by windows at the ends. The corridors are returned down the centre of the wings, terminating in a lecture hall, 42 ft. 6 in. by 31 ft. (to seat 175), in the east wing, and in a room for the collections of mineralogy and petrology in the west wing. Leading directly from the corridor on the ground floor are the laboratories for economic geology, mineralogy, and elementary and honours petrology, with rooms for the lecturers and for research—and all having windows looking north. On the south side of the corridor are the chemical laboratory, with balance room, and photographic and optical dark rooms, a workroom, and cloakrooms for men students. The accommodation in the wings includes a large blow-pipe laboratory with students' and departmental rock-cutting rooms, research, tutorial, and preparation rooms.

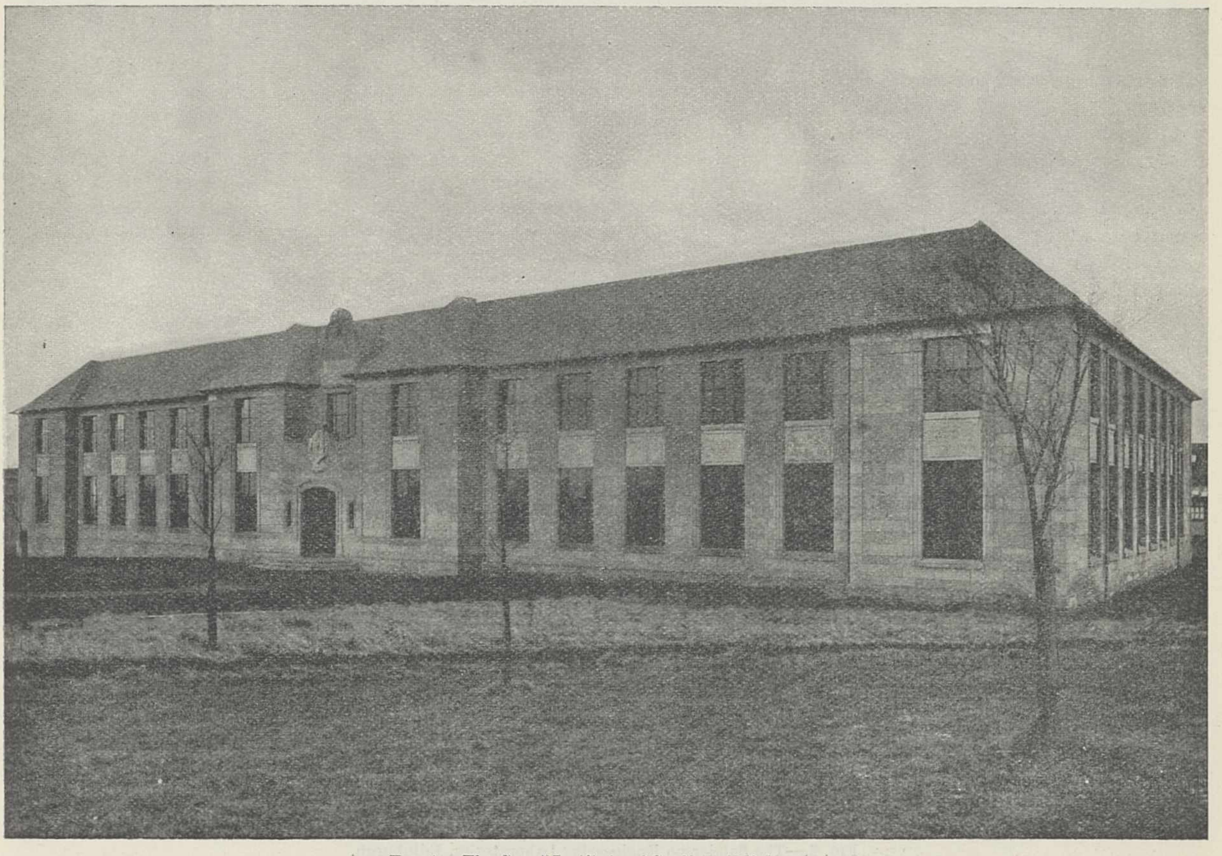

FIG. 1.—The Grant Institute of Geology, Edinburgh.

On the first floor facing north are the professor's room and laboratory, laboratories for elementary and advanced palæontology, a room for the lecturer in palæontology, and a group of research rooms. On the south side of the corridor are the assistant's room, the office and typist's room, cloakroom for women students, and storage accommodation. In the west wing lie the room for stratigraphy and map drawing, a small lecture room, with the library occupying the south end. The library is perhaps the best-equipped departmental library in the University, due largely to the gift of books and papers by the two Geikies. The east wing is occupied by the elementary palæontology laboratory, and a research room, and terminates in a large museum. The museum contains mineral collections given by Mr. Brown of Lanfine; the collection of minerals, rocks, and fossils left by Sir Charles Lyell and presented by the late Lady Lyell of Kinnordy; and the collection of the late Dr. James Currie, so generously given to the University by Mrs. Currie and family.

In addition to the main staircase, a service stair has been provided in each wing, and an electric lift. Both the library and the museum have storage rooms adjoining, and in the attic a large space has been reserved for the accommodation of surplus collections. enlarged fossil shell forms the setting for the figure. This feature is the work of Alexander Carrick.

The University is now provided with an excellently planned and well-lit building worthy of the city of Edinburgh.

Sanderson Engineering Laboratories

The new engineering building also forms part of King's Buildings. It fronts Mayfield Road and lies south of the new zoology buildings. In plan the front extends to a length of 200 ft. with a depth of 144 ft. from east to west, the water tower and cement and concrete testing rooms projecting beyond the west side. The two-storied front part of the building accounts for practically one half of the total area. On the ground floor are a lecture hall, with seating accommodation for 216 students, and three smaller classrooms, lavatories, and various storerooms. The front upper floor is devoted to the drawing office—a spacious room 155 ft. long and 28 ft. wide—and the departmental library, while on the west side of the upper corridor are the various staff rooms and rooms for photographic work and research.

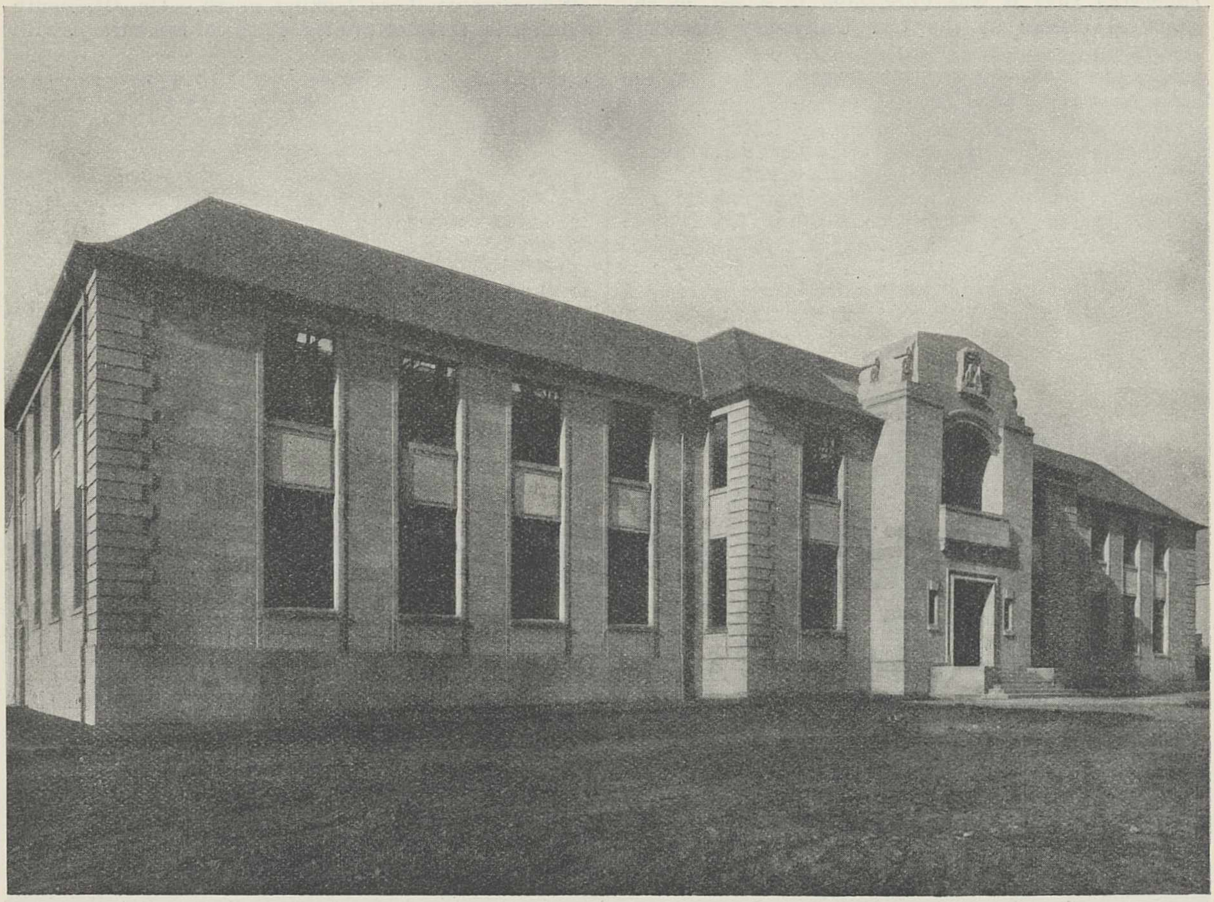

Fig. 2.—The Sanderson Engineering Laboratories, Edinburgh.

At the east end of the building, owing to the level of the ground, an excellent basement was made possible, and here are situated the heating chamber, switch room, additional storerooms, and access to the lift.

The masonry of the new building is of sandstone from Blaxter Quarry in Northumberland. The floors are constructed in reinforced concrete, and the roofs are covered with Ballachulish slates. The window frames are galvanised steel. The heating is by low pressure steam supplied from the central boiler installation, which supplies the heating for all the buildings on this site. The paving in the entrance hall and the staircase is synthetic stone. The floors and dadoes in the corridors and cloakrooms are finished with terrazzo, otherwise the flooring throughout is pitch pine.

Appropriate to the purpose of the building, the figure carved in stone over the main entrance represents early man seated on a rock, his left arm supporting a slab with a fossil shell embedded in it; another

A corridor on the ground floor, 12 ft. wide, extending the whole length of the building, gives access from the front of the building to the four laboratories, workshop, and boilerhouse; these are all one story in height, well lit by roof lights in the steel-constructed roof. Wide sliding doors at the rear of the laboratories give access to the roadway surrounding the building, and this facilitates the reception of new machinery or plant for testing purposes.

The most southerly of the laboratories, devoted to experimental work on the testing of materials, has a floor area of about 3000 square feet, and is equipped with some twenty testing-machines, varying in power from 1 ton to 100 tons. The plant is arranged both for ordinary teaching work and for research.

Adjoining this are the heat engines laboratory, divided into two bays, and the boilerhouse—the floor space is about 5000 sq. ft.; one bay is devoted to internal combustion engines and the other to steam plant. The plant in the internal combustion bay includes types of gas engines and heavy and light oil engines of the most recent make, and in the steam bay both reciprocating engines and turbines have been installed. All the necessary condenser plant for these is concentrated in a pit some four feet below the laboratory floor level. All these units are fitted with measuring appliances to enable complete thermal efficiency tests to be made. The experimental steam boiler, of the latest Yarrow type, can supply ample steam at a pressure of 250 lb. either saturated or superheated, and the boiler is equipped with all the necessary measuring appliances for complete thermal tests under all working conditions.

The next bay to the north is occupied by the hydraulics laboratory, the floor of which is laid out on two levels. Most of the experimental apparatus is on the upper level, and all the discharge from this apparatus is led by drainage channels to large measuring tanks beneath the floor at the lower end of the laboratory. An open concrete channel, 30 ft. long and 3 ft. wide, runs the whole length of the upper level and discharges over a weir into the measuring tanks, which have a capacity of 10,000 gallons. The tanks have been built in reinforced concrete. For work requiring a steady head, a storage tank of 6500 gallons capacity has been built in, at the top of the water tower, giving a head of 70 ft. Every piece of apparatus in this laboratory is provided with a measuring gauge, either of the Venturi type or of the orifice type, thus making it a self-contained unit, so that many experiments can be carried on simultaneously.

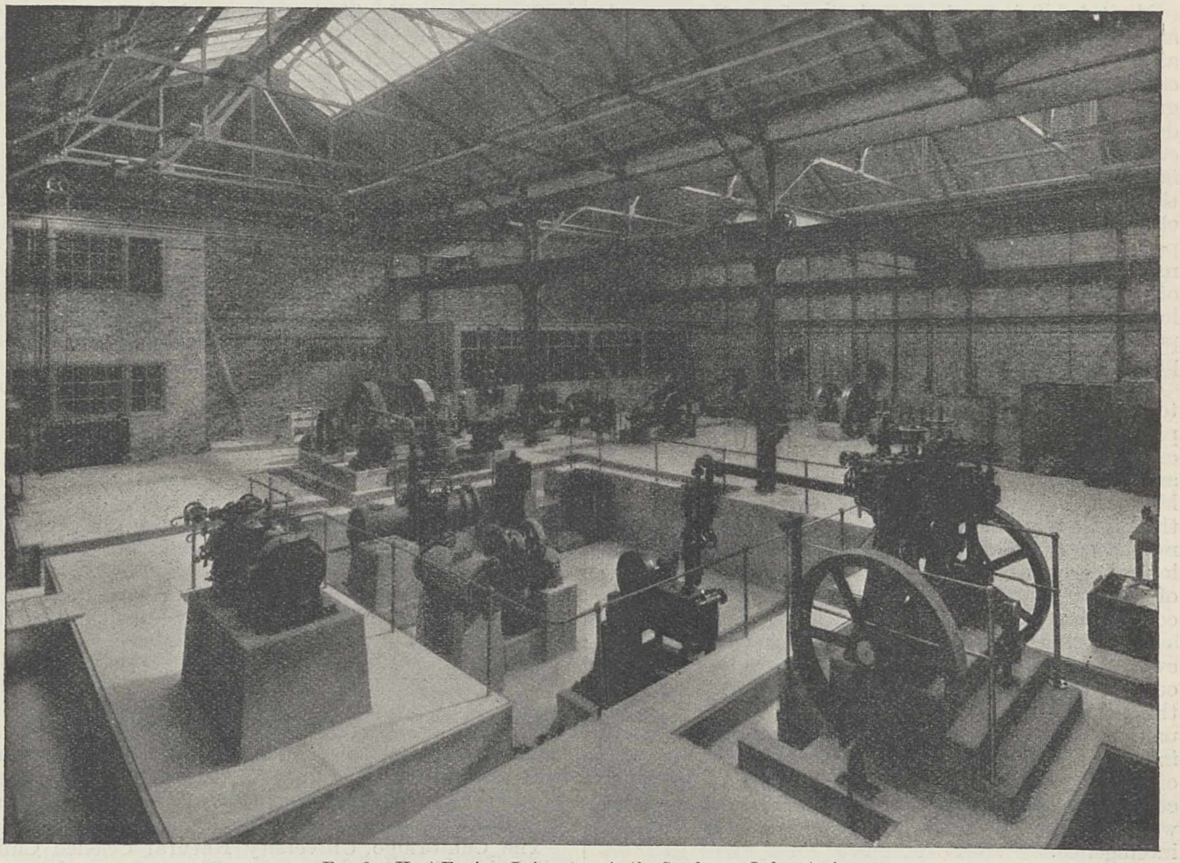

Fig. 3.—Heat Engines Laboratory in the Sanderson Laboratories.

Beyond the hydraulics laboratory, in the last bay, a mechanics laboratory has been fitted up for experimental work on applied mechanics.

The cost of the buildings was met by a bequest of about £50,000 by the late Mr. James Sanderson, senior partner in the firm of Messrs. R. and A. Sanderson and Co., one of the oldest established firms in the Scottish tweed trade in Galashiels.

Mental Deficiency

During the centenary meeting of the British Association held in London in September, several papers on different aspects of mental deficiency were read before Section J (Psychology). Dr. E. O. Lewis spoke on the social aspect of the subject, Prof. F. A. E. Crew on its genetic background, Dr. F. C. Shrubsall on the incidence of different types, and Dr. R. G. Gordon on some psychological experiments he made on mental defectives at Stoke Park Colony in collaboration with Dr. E. Norman.

Dr. Lewis set forth some fundamental issues involved in the social problem. Public interest has been shown in mental deficiency and especially in the discussion of remedial measures. Some of these measures bear the hall-mark of empiricism; they show no clear conception of the nature of mental deficiency and would, if adopted, probably do much harm without achieving much good. Progress in arriving at a solution of the social problem presented by mental deficiency is considerably hampered by failure to appreciate the complexity and variety of clinical conditions to which the generic term 'mental deficiency' is applied. There are varying degrees and varying types, so that it is advisable to speak of mental deficiencies rather than mental deficiency. No single remedial measure is applicable to all cases.

Mental deficiency is a variation from the normal, and there are two types of such variation, normal and abnormal: the former is called by Dr. Lewis *sub-cultural,* the latter *pathological.* The pathological group comprises those whose condition is due to a definite organic lesion or abnormality; in the sub-cultural group there is no such alien factor, the deficiency is only an extreme variety of normal variation and of mental endowment; there is no definite cleavage between this group and the mass of normal persons. The higher grades of sub-cultural deficiency merge gradually into the lower grades of dullness or of temperamental instability; there is a close biological kinship between them and the mass of normal persons, a kinship which can not be attributed to the pathological defective.

This classification, Dr. Lewis considers, helps one to understand the social problem. Most of the pathological cases are lower grade defectives, idiots or imbeciles, whereas most of the sub-cultural cases are feeble-minded, a milder form of mental defect. Most defectives belong to the sub-cultural group: the feeble-minded are approximately three times as numerous as the lower grade defectives. The pathological cases are evenly distributed among all sections of the community, whereas the sub-cultural type is concentrated to a large extent in the lower section and is often associated with various chronic social evils, such as chronic pauperism, slumdom, and its concomitants. Heredity is an important factor in the production of the sub-cultural group, though, undoubtedly, pathological defects also are inherited in some cases. When several defectives appear in one family, they are almost invariably of the sub-cultural type, and most of the members of the family who are not mentally defective are of subnormal intelligence.

It is the sub-cultural group which is the social problem. The fact that it is a normal variant makes it an index of the mental state of the whole group—it is a form of general mental debility. Remedies should not be surgical, but preventive: the solution of the social problem of sub-cultural mental deficiency lies in increasing the mental vitality of the whole community.

Prof. Crew, speaking on the genetic background of mental defect, said the human subject is the least convenient material for genetical study, that almost all that is known of hereditary characters refers to details of structure which are easily recognised and readily measured, and, save by grossly unfavourable physical conditions, are apparently uninfluenced by environmental factors, but that there are many heritable characters the actual expression of which is conditioned by environmental agencies. There are three kinds of mental deficiency: (1) the type in which the character is the direct expression of genetic factors unaffected in their action by environmental forces; (2) the type in which the character for its expression requires the interaction of genetic constitution and environmental factors; and (3) the type which is a non-inherited acquisition. Differential diagnosis is difficult: the real difficulty is to decide whether genetic or environmental factors (or both) are operating in any given case. The difference between normality and abnormality may be magnified by environmental agencies. So long as the demonstrable significance of those agencies is disregarded and attempts are made to find a single constant basis for a character which can be the end-result of so many different developmental happenings, there can be no hope of assessing the rôles of whatever genetic factors may enter into the determination of mental deficiency.

Since defect of mind is no more of a biological unity than is defect of body, mental deficiency may be genetically many different things, in some instances an autosomal recessive, in others an autosomal dominant, sex-linked, or multiple factor character, or even a step-allelomorph. The evidence points in that direction, and such a view is more helpful in an analysis of the etiology of the condition than that which insists that there is a constant genetic origin for it. That genetic factors play a prominent part in the etiology of mental deficiency is certain, but as to their nature or number there is no precise knowledge. What is needed is investigation and careful critical analysis. Only when such research has been carried out can policies relating to the control of mental deficiency through controlled breeding be framed which will command the unqualified endorsement of the geneticist.

Dr. R. G. Gordon described the results of a repetition on two hundred mental defectives of experiments made by Sir Henry Head on aphasics. He found that while language as a whole is difficult for defectives, pure language manipulation is easier than spatial orientation and control, and that this conclusion is borne out by other experiments with puzzle-boxes in which the behaviour of his subjects showed definite similarity to that obtained by analogous experiments with animals.

University and Educational Intelligence

Cambridge.—The Gordon Wigan prize for chemistry for 1931 has been awarded to A. H. Hughes (Trinity Hall) for a thesis entitled "The Constitution of Surface Films of Organic Molecules".

The Cambridge University Natural Science Club will hold a dinner on Saturday, March 5, to celebrate the 1300th meeting of the Club. Past members wishing to attend should communicate with the secretary, D. W. I. Piggott, Gonville and Caius College, Cambridge.

Glasgow.—The Frazer lecture in anthropology will be delivered on March 4, by Sir Arthur Keith.

The annual meeting of the Association of Technical Institutions will be held in the Leathersellers' Hall, St. Helen's Place, London, E.C., on Feb. 26–27, under the presidency of Sir John Dewrance. The following papers will be read: "Technical Education in Canada", by Prof. R. W. Angus; "Technical Education in the Bakery Trade", by Mr. W. H. Quinn; and "Teaching of Modern Languages in Technical Colleges", by Mr. P. G. Wilson. Mr. J. Cameron Smail, principal of the Heriot-Watt College, Edinburgh, will give an address on the report on "Policy in Technical Education", and Sir Francis Goodenough on the report on "Education for Salesmanship". A demonstration of the use of the gramophone in teaching modern languages will be given by Mr. W. H. Kerridge. The secretary of the Association is Dr. H. Schofield, Loughborough College, Loughborough, Leicestershire.

The examination for county minor scholarships of 15,485 children of 10-12 years of age in the West Riding of Yorkshire last February forms the subject of an interesting report issued by the County Education Committee. The task of organising the assignment of marks to so large a number of examinees with the nearest possible approach to uniformity presents formidable difficulties, and the report sets out in detail how these difficulties were met. A decentralised system of marking was adopted in 1927 with the object of associating in the conduct of the examination the whole body of teachers in the area. By selecting the assistant examiners from a panel nominated by local committees, by limiting their number to about fifty, by assigning to them scripts in their favourite subjects, and by facilitating conference and consultation, this system has gradually been perfected and is now working satisfactorily. For the written test, papers were set in English and in arithmetic. These are reproduced in the report, with comments by the chief examiners. Taken with the statistics of results classified according to percentages of marks obtained, the whole report gives a fairly definite measurement of the intelligence of the children of the county.

Calendar of Geographical Exploration

Feb. 22, 1878.—The Essequibo and its Tributaries

Sir Everard im Thurn started from Aretaka, south of Bartica, on his first expedition up the Essequibo River. Thence he went by canoe to Pirara, and from that point crossed the savannah to the Takootoo River, down which he travelled to its junction with the Branco. Later in the same year he visited the Kaietur falls on the Potaro River, which here leaps 750 feet; the falls had been first visited in 1871 by C. Barrington Brown. In further visits to the region he explored other rivers, notably the Cuyuni and the Mazaruni. But his most important work was on the ethnological side; his studies of the customs of the Indians of British Guiana have become a classic.

Feb. 23, 1540.—The Coronado Expedition

F. V. de Coronado left Compostela with an army to conquer the Seven Cities of Cibola, now identified as probably the Zuñi Pueblos of New Mexico. Coronado went to Mexico in 1535 and became governor of New Galicia in 1539. In that year he heard rumours of the fabled wealth of Cibola and determined to conquer it. In this he succeeded, but he found no wealth. He moved westwards to the Rio Grande and sent out exploring parties, one of which found the records of Alarcon. The latter in 1540 ascended the Gulf of California and explored the Colorado River from its mouth: he reported that lower California was a peninsula. Another party under Cardenas discovered the Grand Cañon of the Colorado, which baffled their efforts to cross it. Coronado himself proceeded to Quivira, reported to be an El Dorado, which seems to have been in the region where the Arkansas and Kansas Rivers approach one another. Coronado and the tattered remnants of his army reached Mexico in 1542, having completely failed to find gold or silver. But from a geographical point of view his march was of first-class importance. It formed the basis of the cartography of the hitherto unknown interior of the northern continent. It gained the first information about the sedentary Pueblo tribes of the south-west of the United States and about the hunting tribes of Indians dependent upon the bison, an animal never before seen by the Spaniards, who called it a cow. In addition, the Grand Cañon had been discovered and the lower Colorado explored.

Feb. 23, 1770.—The Great Slave Lake

Samuel Hearne, an agent of the Hudson Bay Company, started on a journey the objects of which were to verify a rumour of the existence of copper ore and to find out whether there was a passage westward from Hudson Bay. He reached the northern shore of Dubawnt Lake, but there broke his quadrant and therefore returned. He had covered some new ground, but had failed in the main object of his journey. In December of the same year he started again, reached the Coppermine River, and followed it to its mouth, thus for the first time reaching the Arctic Ocean in this region. On his return journey he followed a different route and discovered the Great Slave Lake, which he crossed. He himself called the lake Athapuscow, and it was by some thought to be Athabasca, but his route indicates that this was a mistaken identification. His voyage settled the question of the existence of a north-west passage from Hudson Bay.

Feb. 26, 1807.—Pike's Peak

Z. N. Pike arrived at the Rio Grande del Norte, in the region where Alamosa, Col., now stands, and was taken prisoner by the Spanish authorities. Pike had set out in 1806 to lead an expedition which was to explore the country west and south-west of St. Louis to the headwaters of the Arkansas and Red rivers. He ascended the Arkansas through the Royal Gorge and sighted the mountain which now bears his name. He mistook the Rio Grande del Norte for the Red River. The Spanish sent him to Santa Fé and then to Chihuahua, whence he was deported, returning home through Texas. His account of his experiences made available for the first time a fairly accurate knowledge of New Mexico, Texas, and northern Mexico.

Societies and Academies

London

Royal Society, Feb. 11.—**J. Chadwick** and **J. E. R. Constable**: Artificial disintegration by α-particles. (2) Fluorine and aluminium. The protons liberated from fluorine and from aluminium when bombarded by α-particles from polonium have been examined. In each case they can be resolved into definite groups which occur in pairs. The results are explained on the assumption that the α-particles can enter the nucleus through certain resonance levels. To explain the fluorine disintegration it is necessary to suppose that there are two (possibly three) levels, while for aluminium four levels must be assumed.—**A. J. Bradley** and **A. H. Jay**: The formation of superlattices in alloys of iron and aluminium. Alloy structures of iron and aluminium in the range Fe-FeAl are primarily based on a simple body-centred cubic lattice like that of α-iron, but a detailed examination of the annealed and quenched states gave widely-differing results. Alloys quenched from 600° C. and above showed a random distribution of atoms up to 25 atomic per cent aluminium. Between 25-26 per cent and 50 per cent aluminium, cube centres differ in composition from cube corners. Annealed alloys with less than 18 atomic per cent aluminium have a random distribution, and at 40-50 per cent aluminium they have the FeAl type of structure exactly like the quenched alloys in this range. At intermediate compositions a new type of structure appears, which is of the type Fe_3Al. In the latter the aluminium atoms lie on a face-centred cubic lattice with dimensions twice as great as those of the small body-centred cube.—**E. B. Moullin**: A method of measuring the effective resistance of a condenser and of a long, straight wire. The method consists in using similar coils with wires of different specific resistance, and in plotting the measured resistance of the whole circuit against the calculated resistance of the coil. The result is a straight line which does not pass through the origin, thus showing that there is a component of resistance which does not depend on the conductivity of the material: the intercept on the resistance axis shows the effective resistance of the condenser at the frequency in use. The coils were long, narrow rectangles, and for such the skin effect formula for a long, straight wire is applicable without modification.

Dublin

Royal Dublin Society, Dec. 15.—**J. Lyons and W. Finlay**: The accuracy of fat determinations in buttermilk, and the effect of the presence of lecithin. The quantity of fat in buttermilk, as determined by certain methods, is affected by the lecithin content. The Gerber test is compared with the Rose-Gottlieb and the Minnesota tests, and the results show that the Gerber, like the Rose-Gottlieb, is affected by the lecithin present, while the Minnesota is not influenced by it.—**J. H. J. Poole**: Some measurements of the rate of flow of heat from water at nearly 0° C. to a submerged horizontal ice surface. The problem of the transference of heat from a liquid to its own solid by convection currents is of some geological interest. This paper describes certain measurements made for water and ice. The heat flow obtained was rather larger than had been expected. Unfortunately, however, it is difficult to determine what effect the dimensions of the ice surface would have on the results.

Paris

Academy of Sciences, Jan. 4.—**L. Blaringhem**: The fertility of the white lily, *Lilium candidum*. Details of a method of obtaining good seeds.—**Gabriel Bertrand and P. de Berredo Carneiro**: The existence and distribution of caffeine and of theobromine in the organs of the guarana. Both caffeine and theobromine were found, but very unequally distributed in the various organs.—**Emm. de Margerie**: Third and last report on the publication of the geological works of Marcel Bertrand.—**Lucien Daniel**: *Pirocydonia Claraci*.—**Bertrand Gambier**: The transformation of a simply infinite family of geodesics and of the family of conjugated curves.—**Paul Delens**: Varieties with affine connexion. The generalisation of Riccati's equation.—**Gaston Julia**: A decomposition of multiply connex areas.—**Paul Montel**: Harmonic functions admitting exceptional values.—**René de Possel**: Some problems of conformal representation.—**Arnaud Denjoy**: Some points of the theory of functions.—**Paul Le Rolland**: On the possibility of realising an arrangement for the measurement of time, insensible to the accelerations of its support.—**F. J. Bourrières**: The free oscillations of the extremities of elastic tubes traversed by a uniform current of fluid.—**H. Journaud**: Vortices in bands.—**D. Rosenthal**: The increase of resistance to repeated impacts of parts joined by welding.—**Pierre Dive**: The existence of a permanent regime of rotation in a fluid star with rings.—**Henri Mineur and Pierre Guintini**: The analytical study of the movements of the helium stars.—**Georges Bouligand**: A point concerning the technique of vibrations.—**R. Ferrier**: The slip of a periodic electrical influx along a cylinder axis.—**A. Guillet**: Contribution to the construction and use of an apparatus for the measurement of small deformations.—**Th. V. Ionescu and C. Mihul**: Ionised gases in the magnetic field: proof of the existence of the spinning electron. An experimental study of the effect of a magnetic field, parallel to the armatures of the ionised gas condenser, on the variation of the capacity and conductivity of this condenser for wavelengths between 2·34 metres and 19 metres. The experimental curves coincide well with the calculated curves.—**J. J. Trillat and Th. v. Hirsch**: Researches on the diffraction of electrons by single crystals of gold and platinum.—**C. Chéneveau and C. Courty**: The direct measurement of the magnetic susceptibilities of liquids by the Curie-Chéneveau magnetic balance. With a calibrated tube of the ordinary pattern, it is possible to measure directly the magnetic susceptibility of a liquid with the Curie-Chéneveau magnetic balance without weighings and without determining the density of the liquid.—**P. Lambert and J. Lecomte**: The infra-red absorption spectra of the benzene hydrocarbons.—**J. Cabannes and A. Rousset**: The rules of polarisation of the Raman lines in liquids. Theoretical statements and experimental verifications.—**René Audubert**: The influence of electrolytes on photovoltaic phenomena. Admitting the photolysis of water, suggested as a working hypothesis by the author in a previous paper, a rational explanation is afforded of the influence of electrolytes on the photovoltaic effects.—**A. Grumbach and F. Taboury**: The law of equidistances in photovoltaic batteries.—**P. Fourmarier**: The study of the lag in photoelectric gas cells. In the working of gas cells the ionisation by the positive ions cannot be neglected: this ionisation is probably the main cause of the lag.—**K. Boratynski and A. Nowakowski**: Researches by means of X-rays on the modifications of phosphoric anhydride. From the X-ray photographs it is concluded that commercial phosphorus pentoxide consists mainly of a crystalline form. During sublimation there is a partial disappearance of the crystalline structure and this is attributed to a process of polymerisation.—**Georges Denigès**: The direct realisation of the permanganate reaction of manganese even in solutions containing as much chloride as sea water. The usual methods for converting manganese salts into permanganate (lead peroxide, sodium bismuthate) fail in the presence of chlorides. Oxidation with hypochlorite, in the presence of copper sulphate as catalyst, can be carried out in presence of chlorides.—**G. Champetier and U. V. Thuau**: The dehydration of cupric hydroxide. X-ray diagrams of cupric hydroxide, taken at various stages of dehydration, show that at no stage are compounds other than copper oxide and copper hydroxide present.—**A. Perret and R. Perrot**: Lithium cyanamide. Study of the reaction between lithium and cyanogen.—**Mme. Ramart-Lucas and J. Hoch**: The absorption in the ultraviolet and chemical reactivity of certain classes of organic compounds.—**Charles Dufraisse and Nicolas Drisch**: Researches on the dissociable organic oxides. Substances presenting reversible oxidisability in aqueous solution. Dibromorubrene has been converted into the corresponding dicarboxylic acid by the Grignard reaction. The solutions of the free acid and its salts present all the peculiarities characterising solutions of bodies belonging to the rubrene group, including the decoloration by air in the presence of light, and the formation of a dissociable oxide.—**L. Palfray, S. Sabetay, and Mlle. Denise Sontag**: The action of potash on some aryl-fatty mercaptans. The primary mercaptans, in the β position with respect to the phenyl residue, lose sulphuretted hydrogen much more easily to potash than the other aryl-fatty mercaptans.—**Charpentier** and

Bocquet: Crystallised sodium α-glycero-phosphate.—**R. Cornubert** and **P. Robinet**: Constitution of the combinations known as tetrahydropyronic.—**Paul Gaubert**: The crystals produced by the solidification of a fused substance containing colouring matters in solution.—**Jean Lacoste**: Observations on the pre-Riffian and southern Riffian nummulitic series.—**Paul Fallot**: The geology of the borders of the provinces of Murcia and of Alicante.—**P. Russo**: The age of the formations of the Zima basin, region of Safi (Morocco).—**D. Skobeltzyn**: The angular distribution of the ultra-penetrating rays (cosmic rays).—**M. Branas**: The caryology of the Ampelideæ.—**Joseph Szymanek** and **Pierre Gavaudan**: Caryological observations on some species of *Gossypium*.—**N. Lœwenthal**: The transformations of orthogenetic order of the external Meibomius glands in some rodents.—**Paul Remy**: The fauna of forest humus.—**René Hazard**: Sparteine and adrenaline.—**Mme. J. Goude-Axelos** and **André Claude**: Bulbs with rare gases for the production of ultra-violet radiations. Tubes containing mixtures of neon, xenon, and krypton, excited by high-frequency currents with external electrodes, were studied from the point of view of use in therapeutics and also for use as daylight lamps for colour matching. Variations were made in the proportions of the gases in the tube and in the density of the current.—**A. Paillot**: The variations in normal bacterial parasitism in *Chaitophorus lyropictus*.—**Georges Lakhovsky**: A new method of filtration and sterilisation permitting the production of a bactericidal water. By the introduction of a certain proportion of silver chloride into the paste used for the preparation of porous porcelain filters, a filter tube is obtained containing finely divided metallic silver. Water filtered through such a tube is sterile.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 10, Oct. 15, 1931).—**O. Veblen** and **J. H. C. Whitehead**: A set of axioms for differential geometry. Describing the class of manifolds of n dimensions to which the theories at present grouped under differential geometry are applicable.—**H. Bateman**: Solutions of a certain partial differential equation.—**W. J. Trjitzinsky**: A synthesis of the theorems of Hadamard and Hurwitz on composition of singularities.—**Wilder D. Bancroft** and **J. E. Rutzler, Jr.**: Reversible coagulation in living tissue (6). Histamine can poison the central nervous system, producing anæsthesia as well as affecting the sympathetic system. Experiments on fresh nerve tissue suggest that the effect is due to reversible coagulation of proteins in the tissue.—(7). The tetanic convulsions caused by strychnine can be checked by sodium rhodanate (peptisation), ephedrine (peptisation), chloroform (agglomeration), curare (motor nerve coagulant) and potassium salts (muscle coagulant). The effects can be explained on Claude Bernard's theory of reversible coagulation of proteins.—**Arthur Bramley**: Radioactive disintegration. A theoretical discussion.—**Francis G. Benedict** and **Edward L. Fox**: Body temperature and heat regulation of large snakes. In the python the mouth and rectal temperatures are the same; in the fasting boa rectal temperature is lower than temperature of environment and follows slowly rises and falls with the latter. During muscular activity, digestion, and incubation rectal temperature is above that of the environment. Calorimetric measurements showed that in repose the snake gave off no sensible heat, all the heat resulting from metabolism being lost through vaporisation of water. By the use of a respiration chamber it was shown that a large snake loses 4·5 gm. water per kgm. body weight per 24 hours at 30° C.

Forthcoming Events

Societies

FRIDAY, February 19

Institution of Chemical Engineers (Annual Corporate Meeting) (at Hotel Victoria, Northumberland Avenue), at 12 noon.—W. A. S. Calder: Control of Industry (Presidential Address).—At 2.15.—Dr. Ezer Griffiths: Thermal Insulation.

Royal College of Surgeons of England, at 5.—Prof. W. E. Le Gros Clark: The Structure and Connexions of the Optic Thalamus (2).

Institution of Mechanical Engineers (Annual General Meeting), at 5.30.—Report of Council for 1931.—R. W. Bailey and A. M. Roberts: Testing of Materials for Service in High Temperature Steam Plant.

Royal Society of Medicine (Radiology Section), at 8.30.—Discussion on X-Ray Treatment of Non-malignant Conditions.

Royal Institution of Great Britain, at 9.—Prof. C. F. Jenkin: The Mechanics of Shifting Sands.

MONDAY, February 22

Royal College of Surgeons of England, at 5.—Prof. A. J. E. Cave: The Morphological and Functional Anatomy of the Human Cervical Spine.

TUESDAY, February 23

Royal Society of Arts (Dominions and Colonies Meeting), at 4.30.—W. G. Freeman: The Empire Fruit Industry (Lecture).

Royal Society of Medicine (Medicine Section), at 5.—Discussion on Respiratory Movements in Disease.

Royal College of Physicians of London, at 5.—Prof. C. Okell: The Rôle of the Hæmolytic Streptococci in Infective Disease (Milroy Lectures) (2).

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: Recent Work on Crystal Analysis (3).

WEDNESDAY, February 24

Royal Society of Medicine (Comparative Medicine Section), at 5.—Discussion on Milk Fever or Hypocalcæmia in Parturient Cows and Similar Conditions in Other Animals and Man.

Royal Society of Arts, at 8.—Dr. Alexander Scott: The Romance of Museum Restoration (Lecture).

THURSDAY, February 25

Royal College of Physicians of London, at 5.—Prof. C. Okell: The Rôle of the Hæmolytic Streptococci in Infective Disease (Milroy Lectures) (3).

Royal Institution of Great Britain, at 5.15.—Prof. J. B. S. Haldane: Heredity in Man (2).

Liverpool Biological Society (in Department of Zoology, Liverpool University), at 7.30.—Prof. J. H. Orton: Studies on the Relation between Organism and Environment (Presidential Address).

Hunterian Society of London (at Apothecaries' Hall, Water Lane, E.C.), at 9.—Dr. J. B. Christopherson: The Etiology of Chronic Bronchitis (Annual Oration).

FRIDAY, February 26

Association of Economic Biologists (Annual General Meeting) (in Botany Lecture Theatre, Imperial College of Science and Technology), at 2.30.—At 3.—Dr. H. Tattersfield, F. R. Cann, and others: Discussion on Laboratory Tests of Insecticides.—At 5.30.—Presidential Address: Temperature and Humidity in Relation to Insect Control.

Royal Astronomical Society (Geophysical Meeting), at 4.30.—Dr. S. F. Grace: A Method for the Determination of the Tides of a Broad, Deep Sea, with Application to the Gulf of Mexico.—Dr. H. Jeffreys: (*a*) On the Stresses in the Earth's Crust required to support Surface Inequalities; (*b*) The Deformation of the Earth due to Asymmetrical Cooling.

Royal Institution of Great Britain, at 9.—Prof. C. G. Darwin: The Uncertainty Principle in Modern Physics.

SATURDAY, FEBRUARY 27

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford of Nelson: Discovery and Properties of the Electron (1).

Public Lectures

FRIDAY, FEBRUARY 19

UNIVERSITY COLLEGE, at 5.30.—Sir E. Denison Ross: The Unification of Asia under the Monguls.

ROYAL VETERINARY COLLEGE, at 5.30.—T. M. Doyle: Diseases of Birds due to Filterable Viruses (1).

SATURDAY, FEBRUARY 20

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College for Women), at 3.—Discussion of Members' Topics.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Nature Studies on the Sussex Coast.

MONDAY, FEBRUARY 22

GUY'S HOSPITAL (in Physiological Theatre), at 5.—Prof. A. E. Barclay: The Use of X-Rays in Physiological Investigations (2): The Anatomy of the Abdominal Viscera.

KING'S COLLEGE, LONDON, at 5.30.—Prof. T. H. Robinson: The Myth and Ritual of the Old Testament and the Culture Patterns of the Ancient East (5): Hebrew Myths.

TUESDAY, FEBRUARY 23

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.15.—Dr. Dorothy Russell: Intracranial Tumours (1).

WEDNESDAY, FEBRUARY 24

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. W. S. C. Copeman: The Control of Industrial Rheumatic Diseases in the Future.

BELFAST MUSEUM AND ART GALLERY, at 8.—R. G. Baskett: Menus for Farm Animals.

THURSDAY, FEBRUARY 25

KING'S COLLEGE, LONDON, at 3.—C. J. Gadd: Assyrian Dealings with Israel.

UNIVERSITY COLLEGE, at 5.30.—Sir J. J. Thomson: Physical Lines of Electric Forces and their Application to the Interpretation of the Electromagnetic Field (2).

KING'S COLLEGE, LONDON (at 40 Torrington Square, W.C.1), at 6.—S. P. Turin: Economic Conditions in Russia To-day (6): Equality of Incomes.

FRIDAY, FEBRUARY 26

UNIVERSITY COLLEGE, at 5.15.—Prof. A. J. Clark: The Reaction between Drugs and the Cells (1).—At 5.30.—Sir E. Denison Ross: Persia, 1215–1720.

KING'S COLLEGE, LONDON, at 5.30.—The Brazilian Ambassador: Brazil and its Development.

ROYAL VETERINARY COLLEGE, at 5.30.—T. M. Doyle: Diseases of Birds due to Filterable Viruses (2).

SATURDAY, FEBRUARY 27

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. H. Driberg: Warrior-Herdsmen in East Africa.

Official Publications Received

BRITISH

Proceedings of the Linnean Society of London, Session 1931–32. Part 1. Pp. 16. (London.) 6*d*.

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