NATURE

SATURDAY, MARCH 31, 1928.

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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.

Modern Thought.

APPRECIATIVE reference has been made from time to time in our columns to volumes in two comprehensive and stimulating series in which theories and problems of ancient and modern life are surveyed, and suggestive ideas are presented. In one of these series, having the general title "To-day and To-morrow," about sixty volumes have now been published, while in the other—"Benn's Sixpenny Library"—about fifty have been issued, and apparently more than five times that number are eventually to appear. It is not practicable for every addition to these series to be noticed within the limits of space which a weekly journal of science is able to devote to reviews; nevertheless, we are glad to direct especial attention to the two series, because of the number of volumes in them dealing with scientific and other aspects of modern civilisation.

If the function of literature is to unify life and to show men its meaning, "Benn's Sixpenny Library" is a definite contribution to literature. It is also a distinct refutation of the suggestion that cheapness and nastiness are necessarily synonymous. Moreover, it is not an exaggeration to say that the series comprises, in clearly printed and useful form, the most interesting and advanced thought of to-day. The volumes on the atom and on relativity are typical examples of how modern scientific developments can be written so that he who runs may read. Through the whole range of the series there is clearly discernible the thread which binds human knowledge together in significant unity. Whatever may be our view of religion, either as divine inspiration or as mere guesswork concerning our origin and destiny, here are outlines of the great systems which have influenced, and are influencing, the world. Here, too, so that we may understand and pardon even those tendencies and qualities which may appear most unpleasing to us, are historical sketches of Italy, China, India, and Russia.

While, however, it is to history and religion that we may look for causes and explanations in the sense that we would examine more material environment, it is in that mirror of their laughter and tears and their strivings and failings which ordinarily we call literature, that we shall find presented the real character of a people. English, French, and Russian literatures form, therefore, an important part of the series. Intermingled with, growing out of, and in turn guiding all these expressions are the trades by which we

live and the political and economic ideas by which we are governed. None is wholly neglected. The books, therefore, give us a broad vision of human life investigating and modifying its environment, spinning its theories of life and death, recording its ambitions and its disappointments, and dreaming its dreams of the ultimate beauty it so blindly seeks.

The extraordinary progress made by science in increasing our control over Nature has been conditioned and deeply marked by an inevitable trend towards specialisation. More and more we come to see that, while specialisation is essential, it is full of danger. More and more power is placed in human hands, but those who discover that power frequently pay little attention to the ways in which it will be used. They have little time to observe what their fellows are about, and they have still less time to peer into the future and to attempt to visualise the kind of world their united efforts are making; and yet their responsibility as members of a civilised community is enormous. They would hesitate to present a bottle of nitric acid, prettily yellow and delectably fuming, to a nursery full of small children; but they offer equally dangerous gifts to an equally primitive world.

While these absorbed specialists may be so oblivious of the tremendous significance of their tasks, the confused, sprawling, and self-cancelling thing called public opinion is just as uninformed concerning the world which might be made out of such devoted labour. Neither man of science nor layman has the time or the opportunity fully to follow the intricacies of civilisation's myriad activities, and to form any adequate conception of where they are all leading.

It is not too much, therefore, to say that the "To-day and To-morrow" series (London: Kegan Paul and Co., Ltd., 2*s*. 6*d*. net each volume) is aptly named and fulfils a definite need. The books are not ponderous tomes crammed with the hieroglyphics and sometimes incomprehensible jargon of a jealously guarded technique. They are small, well printed, and deal in fascinating sweeps with what may yet be our destiny. It is difficult to select from them, but separate notices of several have already appeared in our columns: of those now before us, we would especially indicate the three which deal with the future of the Press, of Labour, and of Government. Upon the development of all three rests the attainment or otherwise of the dreams and aspirations of both scientific worker and layman.

Tempests and Man.

Great Storms. By Carr Laughton and V. Heddon. Pp. viii + 251 + 13 plates. (London: Philip Allan and Co., Ltd., 1927.) 10*s*. 6*d*. net.

WITHIN comparatively recent times, the calculating wisdom of man has progressed far in the process of rendering Nature innocuous in her evil moods; so far, indeed, that legends declaring her majesty and portraying man trembling on his own hearth, the sport of elements which he cannot restrain, are rapidly going out of fashion. A materialistic age is satisfied to substitute formulæ proving that Nature's latest gesture is only such another trick as might have been expected, and to devise rules by following which we may so fortify ourselves structurally as to give her only a remote and local chance of being dangerously unpleasant.

The shearing of romance and healthy superstition from Nature is to be regretted. Security for its own sake is not a good thing, and in Great Britain we have lately so far magnified our own importance in the universal scheme of things that an unduly wet summer fills the whole community with unrighteous indignation, and the overflowing of the Thames is considered not so much an act of God as a breach of faith on the part of the Government.

The present volume, which reverts to more romantic days, is welcome. It is beyond hope that it will fill the breast of the modern reader with that humility which was wont to be born in the wake of storms of old, but at least it will confirm what Nature is capable of doing, and what, in spite of man's ingenuity, she continues to do in those 'foreign parts' which are the special target of her fury.

As might be expected, the book has a strong flavour of the sea. Familiar titles appear among the twelve chapters—"Armada Gales," "The Last Voyage of the *Elizabeth*," and "After Trafalgar"; but the recounting of these naval epics by authors who are obviously well qualified to speak both for the sailor and the meteorologist is well worth while. What the large and then unknown factor of wind meant to the sailing ships of England, Spain, and Holland in their struggle for sea supremacy is described in vivid narrative, although to the landsman, inclined to be impatient with an era when ships of the line resembled in shape alone the giants of to-day, the authors may appear to have been so liberal with nautical detail that the main theme is from time to time submerged.

Reading of the unceremonious interventions of

the Storm King who in Armada days frequently converted a promising naval engagement into an ignominious *sauve qui peut*, we are led to speculate on the might-have-been in a less windy and weather-beaten world. A very interesting and instructive chapter—"Storms in History"—rather favours the opinion that the course of political development from the earliest civilisation has been oriented in a very minor degree, if at all, by tempests of whatever variety. This very debatable point is not now likely to be decided. It would be a fascinating research, however, granted a long enough span of life, to work out a probable map of the world based on the assumption that Noah had not been incommoded by a flood, or that fine and not stormy weather prevailed when certain historical battles were fought, or that, say, less vigorous convection had obtained at the time when hailstones resulted in the Treaty of Bretigny. Unfortunately, the effect of a severe storm on air navigation does not come within the scope of the book. Remembering the providential failure of a Zeppelin raid—a meteorological success in a negative sense—we cannot doubt that storms may yet make history.

There is an excellent account of what is rated the greatest storm ever experienced in the British Isles, that of November 1703. There seems to be every reason to suppose that this storm does take pride of place, but we would feel happier in our estimate if more official records and something resembling a Beaufort scale had been available to curb the overwrought imagination of the sufferers. The centre of that storm passed near to Liverpool. Lately, as a culmination of the furious gales already recorded in 1928, the wind at Liverpool attained a speed of 104 m.p.h., but this latter-day gale is unlikely to receive more than an honourable mention. It may be that the surface obstacles to-day are too many and too stout to give the wind a fair chance. However, the storm that introduced Addison to fame and incited Defoe to count 17,000 trees blown down in Kent, certainly merits a place in history.

In chapters dealing with the West Indian hurricanes, the China Seas typhoons, and the world's "Windy Corners," the meteorology of the winds is happily blended with descriptive narrative. An illuminating account of the Tay Bridge disaster and of the subsequent inquiry finds a suitable place. The theme is varied by a chapter on historical volcanic storms, in which Nature's most awe-inspiring and most destructive efforts are presented in realistic language.

A lighter note is struck in the final subject—winds and superstitions—an engrossing chapter on those mythological associations which for centuries have exercised the force of religion on the mind of the seaman.

The book adds the advantage of historical fact to the entertainment of a novel, and will make a general appeal. The meteorologist will find much of special interest and, incidentally, a vindication of his own calling if such were needed nowadays; for whereas to-day, with ships hundreds per cent. more seaworthy, weather reports and gale warnings are considered indispensable to navigation, it appears that the conservative skipper of Piddington's time, rather than accept that gentleman's Law of Storms and sail for safety, frequently sank both his pride and himself in a cyclone.

The prevalence of January and February in the dates associated with historic storms, and the fact that the worst damage could nearly always be attributed to the venom of a 'secondary,' suggest that, meteorologically, 1928 has upheld tradition. In the light of recent happenings, particular interest attaches to the reference to flood tides on p. 6, where the authors' remarks on the chance of a northerly gale driving water into the cod of the North Sea to cause a Thames flood seem to have been prophetic.

A uniformly high literary standard is combined with popular treatment and a wealth of detail which is highly diverting. The general presentation is excellent and the illustrations are well chosen. Mr. Cecil King, R.I., may have taken a rather rough view of the sea; but his drawings convey the required impression, and in the circumstances few will be found competent to offer authoritative criticism.

E. TAYLOR.

Physiology in Great Britain.

History of the Physiological Society during its first Fifty Years, 1876–1926. By Sir Edward Sharpey-Schafer. Pp. iv + 198. (Cambridge: At the University Press, 1927.) 15*s*. net.

THIS "History of the Physiological Society" has been written by its only surviving and still active original member, Sir Edward Sharpey-Schafer, who undertook it as a labour of love, and has succeeded in presenting a wonderfully attractive account full of biographical details and human touches. The thumb-nail sketches of deceased members are illustrated by small portraits let into the page in the position of an illuminated initial letter; many of the photographs of the earlier members present them with a youthful appearance

unfamiliar even to those who are now of an age when superannuation and retirement are in the near offing. The notices themselves have the charm conveyed by personal knowledge and kindly humour: thus, "Foster's success was, however, not due entirely to his influence over the younger Cambridge biologists (Gaskell, Balfour, Langley, Newell, Martin, and Sheridan Lea), but quite as much to the power he had of influencing senior members of the University, who were not long in recognizing that a prophet had arisen amongst them who would make the bones of biological science, which had become very dry in Cambridge, live again." The occasional reproduction of signatures at meetings and dinners adds a further interest to what is, among other things, a dictionary of physiological worthies.

This story of the Society and its members, with a general record of its scientific activities, begins by showing how British physiology, which in the middle of the nineteenth century was far behind that of France and Germany, began to rise to its present high position. Prof. William Sharpey (1802–1880), anxious to improve the teaching of physiology at University College, London, enlisted Michael Foster's services as professor of practical physiology; this appointment of "the actual begetter of the Physiological Society" was pregnant with importance to the future of physiology in England. In 1870, Foster went to Trinity College, Cambridge, as prælector in physiology, and Burdon-Sanderson took his place at University College, succeeding Sharpey in 1874.

The conception of the Physiological Society two years later was primarily the result of the anti-vivisection agitation, an example of *Ex malo bonum*. Its object as defined in the first rules was to promote the advancement of physiology, and to facilitate the intercourse of physiologists, which it has done in a remarkable manner by providing opportunities for preliminary discussion and helpful criticism of work and the formation of pleasant friendships. The influence thus exerted by intimate personal contact and overcoming the disadvantages inherent in the otherwise inevitable system of work in the lonely furrow must obviously have been most valuable. Michael Foster's genial personality was a great asset in bringing together workers not only in Great Britain, but also from abroad, and as bearing on this, Sir E. Sharpey-Schafer's account may be quoted of Foster, when president of the British Association at Dover in 1889, welcoming and saluting *more gallico* the president of the corresponding French Association.

Among the founders of the Physiological Society were George Henry Lewis, who, with George Eliot, was concerned in the establishment of the prælectorship in physiology at Trinity College, Cambridge, Francis Galton, William Bowman, T. H. Huxley, F. W. Pavy, W. H. Gaskell, F. M. Balfour, Gamgee, Klein, Langley, and G. J. Romanes, who, at one time intent on taking orders, veered round to entire scepticism, and eventually returned to religious orthodoxy. A very important outcome of the Society's enthusiasm was the *Journal of Physiology*, which, largely by the liberality of the late A. G. Dew-Smith, was started in 1878 and first edited by Foster; it was taken over in 1893 by J. N. Langley, who also became its proprietor and was a model editor until his lamented death in 1925, when the financial responsibility was resumed by the Society, and an editorial board of four members, with Sir Charles Sherrington as chairman, was appointed.

At the end of 1880, the most important feature of the Society—the special afternoon meetings for the demonstration of physiological work—was instituted; at first it was understood that there should not be any sort of publication of these activities, which were to be private and confidential, and more intended to elicit remarks and criticisms of work in progress than with any idea of preliminary publication of accomplished research. Later, in 1883, it was resolved to print and publish as the *Proceedings of the Physiological Society* any communications which members might desire in the *Journal of Physiology*. These *Proceedings* show that all important advances in physiology made in Great Britain during its existence have in the first instance been brought before the Society, and thus form a record of which any society might be proud.

The Kinetic Theory.

Statistical Mechanics with Applications to Physics and Chemistry. By Prof. Richard C. Tolman. (American Chemical Society Monograph Series.) Pp. 334. (New York: The Chemical Catalog Co., Inc., 1927.) 7 dollars.

THE younger generation is not infrequently reproached with lack of respect for its scientific fathers. The complaint is probably unfounded, but, even if it were a just one, the younger chemists at least might plead that they had in some ways been set a bad example. The atomic theory is the keystone of chemistry: two generations ago the mechanics of atoms and molecules was worked out with the very minimum of assumptions which increasing knowledge might invalidate, but the results

of this great achievement were more or less ignored for a generation. Only now are the kinetic theory and statistical methods coming into their own; and yet this branch of knowledge is a peculiarly important one. Nearly everyone, with or without particular philosophical reservations which his attitude towards the theory of knowledge may dictate, believes in the existence of molecules which move and in some way exert influences upon one another. Moreover, even idealists will admit that within the narrow confines of scientific realism a certain coherence may be achieved by introducing a quantity called energy. Statistical mechanics, which provides a means of determining such important matters as the distribution of energy among molecules, and its rate of transfer, without intimate knowledge of the nature of molecular interactions, is a magnificent compromise between the rather cold agnosticism of thermodynamics and that kind of more detailed theory which at present would be premature and doomed to failure.

Prof. Tolman's book contains both a systematic derivation of the principal results of the kinetic theory and an account of many applications. It differs from most other books on the subject in giving special prominence to the discussion of chemical reaction velocity.

Many methods of treatment are possible: the method of statistical mechanics in its classical form, the exposition of which is the first object of the book, is the most general, and in many ways the most rigid and fruitful, but it is, of course, not the least abstract. The important statistical laws are sometimes more easily derivable in special forms. Perhaps for this reason the book may appeal more to physicists interested in chemical problems that to chemists anxious to equip themselves with an important weapon. However, the first two chapters begin at the beginning: and in Chap. ii. there is a brief treatment of general dynamical principles, including Lagrange's function and Hamilton's equations. This part would be made much more useful by a little illustrative expansion.

The third chapter deals with phase spaces, ensembles, and Liouville's theorem. The ergodic hypothesis is discussed in an interesting way—illustrating that physical intuition can seldom be dispensed with in mathematical physics. In the following three chapters the Maxwell-Boltzmann law is derived and applied. Points of special interest here are the discussion of the approximation involved in introducing Stirling's theorem, an illuminating account of deviations from the most probable distribution, and a neat treatment of equipartition.

The remaining eighteen chapters are grouped by the author under the headings: Introduction of the quantum theory; application to molecular processes; the rate of physical-chemical change; and conclusion.

One of the most pleasing things about the book is the amount of actual physical and chemical information contained in the sections devoted to the applications of the fundamental method. The style is lucid, and there is a welcome frankness about underlying assumptions. Nothing makes for obscurity more than their surreptitious introduction, the reader being left to infer a logical necessity. The Einstein treatment of radiation is, for example, often given in a very puzzling form. Tolman, in the course of an excellent section on radiation, discusses clearly the nature of the assumptions made in introducing the two emission coefficients.

A great chemist once said "Physical Chemistry is all very well but it does not apply to organic substances." On p. 152, Prof. Tolman is to be observed giving the chloroform molecule three hydrogen atoms and one chlorine atom—without invalidating his argument; which is something of a *revanche*!

Research in the Cotton Industry.

Research in the Cotton Industry: a Review of the Work of the British Cotton Industry Research Association up to the end of 1926, carried out under the direction of the late Dr. Arthur William Crossley. Edited by Dr. Robert H. Pickard. Pp. xv + 80 + 10 plates. (Manchester: Shirley Institute, 1927.) 5*s*.

THIS book is a very readable report of five years' progress in industrial research carried out by the British Cotton Industry Research Association under the direction of the late Dr. A. W. Crossley, and may be considered as a memorial and tribute to him, who devoted the last days of his life to one of the most arduous of tasks, namely, the focusing of scientific talent on the problems of an industry in which the field of such endeavour is anything but clear.

The chief difficulty with which the industrial, as distinct from the academic, research worker has to contend is the suitable propounding of the result of his work; for not only must he provide a complete record for the benefit of other workers on his subject, but he must also endeavour to see that in some way the practical information made available may be comprehensible to the non-scientific industrialist. Unfortunately, these two objects cannot easily be

reconciled, as each requires its own particular treatment, and compromise is practically impossible. Hitherto, the Shirley Institute memoirs have taken the form of scientific papers, and those who have read the publications of them in the *Journal of the Textile Institute* will no doubt appreciate the difficulty experienced by the layman in picking out the salient points of such reports, cloaked, as they must be, in scientific terms, and written in a precise but, to him, somewhat dull manner. The language of the research worker is not the language of the man in industry. The need, therefore, has been for what one might call a 'popular' exposition of the results achieved in connexion with the various problems that have been tackled; and the book under review satisfies this need in a most successful manner, and is a credit to those responsible for its publication.

In the introduction reference is made to various special cases of difficulty which have been successfully dealt with, and it is at once made clear what a very large field of fundamental research has had to be covered. Two of the most important factors governing the quality of textiles are uniformity and consistency, and it is natural, therefore, that a considerable amount of time should have been given to determining to what extent the shortcomings in these respects can be attributed to the raw material itself. The physical and chemical characteristics of a great variety of cottons have accordingly been investigated (Chap. i.), and, in addition, problems appertaining to bacterial and fungal infection during conditioning have been tackled.

The researches in spinning and doubling (Chap. ii.) have been largely devoted to studies of the effect of various processes on the physical properties of the products, and attention has also been given to devising improved methods of carding and drafting.

Good sizing is of very great importance to the weaver and to the finisher, and has received its fair share of attention. Reference is made (Chap. iii.) to investigations carried out to determine what factors influence successful treatment of the material, and how the danger of mildew infection can be reduced to a minimum.

Chap. iv. may disappoint some because of its brevity; but the Association appears, rightly, to have deferred work on weaving proper until the fundamental properties of cottons and yarns have first been systematically studied. Even so, it is recorded that work on the problems of the manufacturing section of the industry is now in hand, and would seem to give promise of some interesting results.

Chaps. v., vi., and vii. refer to researches on bleaching, dyeing, and finishing, among which might be mentioned those on the loss of weight in scouring; the removal of oil, rust, and other stains; the causes of tendering during bleaching; the effect of mercerisation on hair dimensions; the effect of variations in raw material on its reaction to dyeing and finishing; and on the schreinering process.

In Chap. viii. are described some of the instruments that have been designed and made at the Institute to enable the work outlined in this book to be prosecuted. W. E. MORTON.

Our Bookshelf.

Flora of West Tropical Africa: the British West African Colonies, British Cameroons, the French and Portuguese Colonies south of the Tropic of Cancer to Lake Chad, and Fernando Po. By J. Hutchinson and Dr. J. M. Dalziel. Prepared at the Herbarium, Royal Botanic Gardens, Kew, under the supervision of the Director. Published under the Authority of the Secretary of State for the Colonies. Vol. 1, Part 1. Pp. x+246. (London: The Crown Agents for the Colonies, 1927.) 8*s.* 6*d.*

THIS new work, the result of the collaboration of two officers of the Kew Herbarium, will be very welcome to all interested in the flora of west tropical Africa, as well as to systematic botanists in general. In its handy form it will be in greater daily use by the field worker in that region than the monumental "Flora of Tropical Africa," indispensable as that work is for reference. The area covered is a wide one, and includes not only British possessions and mandated territories, but also some administered by the French and the State of Liberia.

The present part contains the Gymnosperms (two only) and rather more than half the families of the Dicotyledons. The systematic arrangement adopted is that devised by one of the authors, Mr. J. Hutchinson, which was published in 1927 in his book "The Families of Flowering Plants." The system is explained in a brief note on p. 42, and its sequence displayed on pp. 43 and 44.

The descriptive part has been condensed by adopting the arrangement, already in use in several similar works, of descriptive keys for the genera and species. This is a convenient method for the field worker and has the merit of saving space, a very desirable quality in unsettled countries where transport facilities are lacking. The value of the work is greatly enhanced by about a hundred excellent detailed figures illustrating the most typical plants of the more important genera. Some of these are from drawings by Mr. Hutchinson, but the majority are the work of Mr. W. E. Trevithick.

An outline map indicates the area comprised. Several pages of the preamble are devoted to an interesting record of botanical exploration in

the several countries included, and it also offers a comprehensive bibliography. Finally, one is thankful for a handy glossary of botanical terms illustrated with a number of illuminating figures.

The key to the families is entirely artificial, and follows that, now becoming familiar, devised by Mr. Hutchinson and employed in his earlier work already referred to above. C. E. C. F.

La question eugénique dans les divers pays. Par Dr. M. T. Nisot. Vol. 1. Pp. 513. (Brussels: Librairie Falk Fils, 1927.)

DR. NISOT has had the useful idea of collecting all the available information on eugenic activities and tabulating it by countries. The present volume contains the information for Great Britain, the United States, and France, and is introduced by a comprehensive historical sketch. Volume 2 is promised shortly, and will include the facts for most other nations.

The author has, it must be confessed, thrown her net rather widely. Not only does she include eugenics in the usually accepted sense of attempts to improve the germplasm of the race; not only birth-control, and the regulation of immigration, which both obviously can have potent effects for good or for evil upon that germplasm; but also all sorts of activities devoted to improving the health and conditions of the individual, such as organisations for combating venereal disease, tuberculosis or alcoholism, the education of mentally subnormal children, infant welfare centres, and so forth. It seems a pity that these were included. For one thing, they have no direct eugenic bearing in any proper sense of the word, and for another, if they are included, why are not all organisations aimed at ameliorating the conditions of life included? Venereal disease, in spite of the possible transmission of the causative agent to the offspring, is not an affair of eugenics, but of public health; and if the education of mentally deficient children is included, why not education in general? As matters stand, the presence of these sections in the book only confuses the issue.

On the side of eugenics proper and of the associated topics of birth-control and immigration control, however, the book will be found very useful. It is extremely desirable to have such sources of information available. The historical account for each country, though brief, is valuable; and nowhere else in convenient form will be found a statement of what organisations exist in each country.

O povaze věcí. Napsal Sir William Bragg. Přeložili Prof. Dr. Antonín Šimek a Dr. Hannah Šimková-Kadlcová. Pp. 136 + 32 tabulky. (Prague: Jednota Ceskoslovenských matematiků a fysiků, 1927.) Kč. 22.80.

OF the three Czechoslovak universities, those at Prague and Brno possess faculties of science. The University of Prague dates from 1347, but the Masaryk University of Brno, at which Dr. Šimek is professor of physical chemistry, was only founded after the War. It has therefore no traditions, and before schools of research are established it has been necessary for such leaders as Prof. Šimek to inculcate the spirit of scientific inquiry both by their academic lectures and by presenting the students with a literature in their own language.

Instead of writing a new book, Prof. Šimek has elected to translate Sir William Bragg's "Concerning the Nature of Things," which was the subject of his Royal Institution juvenile lectures in 1923. These lectures, Prof. and Mrs. Šimek point out in the preface to their translation, were inaugurated by Michael Faraday, and are models of approaching the subject to young minds since they retain and stimulate scientific accuracy. The high standard set by Faraday, for example, in his "Chemical History of a Candle," has been maintained by his successors, and Prof. Šimek was so impressed with the inspiration to be derived from those by Sir William Bragg that he decided to translate the book for the benefit of his own students.

Of additional interest is the fact that the last chapter on the nature of crystals deals with the results obtained by Sir William and Prof. W. L. Bragg in their X-ray studies of crystal structure. Prof. Šimek enthusiastically compares the lectures to Lucretius's poem "De rerum natura," with the important difference that the present work is no idle fantasy, but rests upon the sure foundation of scientific fact. J. G. F. DRUCE.

Elementary General Physical Science. By W. R. Jamieson. Pp. xi + 63 + 88 + 147 + x + 16 plates. (Melbourne and London: Macmillan and Co., Ltd., 1927.) 8*s.* 6*d.* net.

'SCIENCE for All' is the reaction against undue specialisation in the schools, but there is the danger of making the subject so discursive that it ceases to be science. Mr. Jamieson's attempt to provide a broader survey of science for Australian schools consists in the main of an account of some of the great discoveries in chemistry, physics, and astronomy, with adequate and interesting historical details; while every opportunity is seized to introduce pieces of information. Thus, thirty-seven pages on energy include the spectrum, voltaic cells, Gay Lussac's law of volumes, oxidising agents, hydrocarbons, isomorphism, magnetism, galvanometers, dynamos, radium, lenses and telescopes, and end with the periscope of a submarine. While much can be said in favour of such a course, we suggest that to sacrifice depth of culture to obtain breadth is not a scientific method of producing a good harvest.

Chemistry. By W. H. Barrett. (Clarendon Science Series.) Pp. viii + 151. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 5*s.* net.

MR. BARRETT'S book gives a clear account of some of the simpler chapters of chemistry, with indications of their bearing on everyday life. There is a good chapter at the end on the modern theory of atomic structure. The book is suitable for the general reader who wishes to obtain some idea of modern chemistry.

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.*]

Liquid Stars and Atomic Volume.

THE problem of the general state of matter at high temperature is so fundamental in stellar physics that I venture to pursue the discussion with Dr. Jeans (NATURE, Feb. 25, p. 278). I would first thank him for his reply to my letter, which, though I differ from it on a number of points, deals fairly with the questions raised. I still believe I was not exaggerating in saying that Jeans's theory requires that the ions (in giant *M* stars) should be so large that they jam at densities $\frac{1}{100}$ that of air. Jeans wishes to amend this to 80 × air. But my figure represents the order of magnitude of the central density of Betelgeuse according to the usual gas model, and he has himself said that the star contracts as a gas until there are substantial deviations from the gas laws in the central regions. To form his liquid core of higher density it would seem that Betelgeuse must have contracted as a gas to $\frac{1}{20}$ its present radius, and then for unexplained reasons thrown out a gaseous envelope filling the present volume. Or starting from his liquid core of density 80 × air, we have to face the problem of balancing on this a gaseous atmosphere containing much less mass and subject initially to 8000 times the gravitation of the ordinary model. I think that to achieve this Dr. Jeans will have to depart much more widely from current theory than he intended.

Again, Dr. Jeans favours the hypothesis that long-period variables are pulsating stars. Like others, he finds this supported by the relation of period to density. It is well known that the periods and densities fit approximately if the usual densities are accepted; but the agreement will not be maintained if the dynamical behaviour is determined by a liquid core of density 8000 times greater. The high density and comparative incompressibility would make the period much too short.

Accordingly, I do not give up my point that Dr. Jeans requires the ions to have diameters 50 times greater than the ordinary neutral atoms. For the rest of this letter, I am content to accept his own estimate of diameters 50-80 times the diameter of the electron system in the Bohr model, which he agrees is "a bit perplexing," but will not admit as "certainly wrong." May I protest that the words "certainly wrong" were not used in this connexion in my letter? They were applied to one of his defences (or suggestions) beginning with "we might, in any case, expect," referring therefore to current knowledge and not to unforeseen developments of atomic theory. The expectation was one which would seem very plausible to most readers, who naturally think that the classical electrostatic repulsions between the ions, by tending to prevent unduly close approaches, have effect equivalent to atomic volume. When, however, the attractions between ions and electrons are included and the whole correction to the pressure is calculated according to the general methods (set forth clearly in Jeans's "Dynamical Theory of Gases"), it is at once found that the electrostatic forces actually give the reverse effect to atomic volume. The material accordingly remains as compressible as (or more compressible than) a perfect gas until the density is so great that non-classical reactions become important. There we come to more doubtful ground, but the general cause of the atomic volume effect in ordinary gas seems fairly clear. It is not the ions, but the bound electrons which set a limit to the packing. One quantum orbit or one unit cell of phase-space is required for each electron. With increasing density the cells become filled, and ultimately we should be unable to proceed further without squeezing electrons out of the material. Alternatively, if the electrons are endowed with high energy extra cells of phase-space corresponding to high velocities become available, and the congestion is relieved. In this way high temperature obviates the congestion that gives rise to atomic volume effects.

With ions distant 50-80 times their own diameter and any number of intervening quantum orbits lying vacant, there is no approach to the congested condition. I think that a quantum physicist confronted with such a problem would not hesitate to treat it by classical perturbations in accordance with the Correspondence Principle. Dr. Jeans seems to be demanding something which goes against not the details, but the broadest principles of the quantum theory. Even the broadest principles may of course need amendment, and it would be rather pleasing if astronomical results were definite enough to dictate amendment; but I have devoted part of my former letter to challenging Jeans's argument that considerations of stability make the liquid star theory *compulsory*. To my mind the main interest in the theory of the constitution of the stars lies in connecting the laws and conclusions reached by physicists with those discovered in astronomy; if once we begin modifying the former, the investigation loses definite aim and takes on a speculative character. If a new astronomical theory provides its own rules for atomic volume, it may equally well provide its own rules for the absorption coefficient, etc.

With regard to the significant features of the Russell diagram, which Jeans believes to be explained by his theory, I admit his counter charge that I am waiting for something to turn up. It is possible in cosmical theories to be too precipitate.

A. S. EDDINGTON.

Observatory, Cambridge,
Mar. 7.

I CAN only adhere to my original views as to atomic diameters. Prof. Eddington tries to challenge my position by arguments based on "the usual gas model." By this I think he means his own gas model, which is of a very special and restricted type, and by no means characteristic of the general gaseous configurations of a star. I believe his difficulties arise solely from the defects of his own model.

Eddington's model is developed from the assumption that the generation of energy per unit mass G is connected with the coefficient of opacity k by the relation

$$G = \frac{1}{\rho r^2}\frac{d}{dr}\left[\frac{1}{k}\int_0^r \rho r^2 dr\right] \times \text{constant}.$$

This seems to me an extraordinarily artificial relation. As Russell has repeatedly pointed out, it makes G violently negative in the outer layers of the star, so that these re-destroy the energy created in the inner layers, only a small balance escaping from the star as radiation. I think I am right that the reason why Eddington adopted this surprising value for G was merely that it makes the equations integrate out with amazing ease—in fact, just like a Tripos problem.

When this special value for G is discarded, the problem of gaseous stars becomes far more complex. I have given partial solutions in the *Monthly Notices of the Royal Astronomical Society* (1925 and 1926), and a fuller solution appears in a book, "Astronomy and

Cosmogony," shortly to be published. Eddington's model gives a central density uniformly equal to 54·4 times the mean density. My general solution shows that with energy generated fairly uniformly throughout the star's mass, this factor is increased to anything from 88 to infinity, according to the star's mass. A very rough calculation (*Mon. Not. R.A.S.*, **87**, p. 40) gave the central density of a gaseous Betelgeuse as 2, or 1600 times that of air, as against the $\frac{1}{1000}$ that of air given by Eddington's model. This was before I was contemplating liquid stars, and I was worried to find that the density was inconsistent with the gas laws being obeyed. I lay no stress on the actual value; indeed, other calculations have given 0·1 and 0·04. My point is that when the special restrictions of Eddington's model are discarded, his dynamical case against liquid stars disappears. No gaseous envelope need be "thrown out," for it is already there in a gaseous star with any reasonable generation of energy, and is 'balanced,' not only against 8000 times but even against 160,000 times the gravitation of Eddington's restricted model.

The high central density is a consequence of the large mass of Betelgeuse. If Eddington had produced a star of low mean density and small mass, I could not have met his objections. It is, I think, significant that no such stars exist. The theory of liquid stars explains that such stars cannot exist, because they would be unstable, and so accounts for the observed gap between giants and dwarfs.

Similar considerations apply to the long-period variables, since these also are very massive. The density is more uniform in a liquid star than in a gaseous star, so that the period–density law is better obeyed. I think that Eddington's argument as to "dynamical behaviour" contains a further fallacy, as can be seen by passing to the limiting case of an incompressible core of high density; the pulsations become purely atmospheric and have long, not very short, periods.

I agree with Eddington about the electrostatic forces and quantum dynamics. I never meant, however, to suggest that, other things being unchanged, rising temperature could increase effective diameters. What I had meant to suggest, as a conjecture, was that, as successive ionisations occurred, it might increase the ratio of effective diameter to Bohr-diameter, this being all I needed. I am sorry if I did not make this clear. If, as I think, stability considerations rule out gaseous stars, then all this becomes unimportant; the theory of liquid stars is also freed from the speculative taint Eddington sees attached to it. Indeed, it becomes the obvious high road of progress, as is also suggested by the fact that stars break up under rotation in the manner of liquids, not of gases.

J. H. JEANS.

A New Injection Mass—Rubber Latex.

THE principle applied in the utilisation of rubber latex as an injection mass is the fact that the latex of the rubber tree—*Hevea brasiliensis*—coagulates to form rubber in the presence of dilute organic acids such as acetic or formic. After tapping the rubber tree, the collected latex may be preserved in a fluid condition by the addition of ammonia, and I believe it is exported from Ceylon preserved in this way. The latex which I used in my first injections was obtained more than three years ago, when ammonia to the extent of 5 per cent. was added to it, and although, standing so long, it had become creamy at the surface, it regained its normal fluidity on shaking. Latex is of the consistency of milk, so no difficulty arises in its introduction into blood-vessels or its penetration into the finer capillaries.

It is advisable to wash the blood out of the vessels of a newly killed animal with normal saline to which a trace of sodium bicarbonate has been added. The latex may then be injected with a syringe, glass injection-pipette, or in the case of small animals with a hypodermic syringe. When the injection is complete the canula or needle is withdrawn from the vessel, and a drop of acetic acid on the wound will close it with a clot of coagulated rubber. Also, if any small vessels have been cut in the preliminary dissection to expose the vessel for injection, bleeding can be stopped by sponging the cut part with acetic acid. The injected fluid is converted into rubber on the immersion of the animal in dilute acetic acid, which quickly penetrates the tissues and coagulates the latex. Although general coagulation commences so soon as the latex is acid to phenolphthalein, it is not complete until there is a slight excess of acid; and I find that in the case of whole animals the process is hastened by pouring 20 per cent. acetic acid into the body cavity. In this way the fluid mass is converted into an elastic solid, which, even in the smaller vessels, possesses amazing strength and elasticity.

If pure latex is used the resulting injections are white, but better results may be obtained by using it as a vehicle for different colouring masses. Carmine dissolved in ammonia and added to the latex gives very good results. Prussian blue becomes grey when mixed with ammoniacal latex, but regains its blue colour when the acid is added for coagulation. Specimens injected with Prussian blue are best preserved in spirit, for the colour tends to transude in formalin and stain the surrounding tissues. Methyl blue gives good results, but methylene blue and methylene green cause coagulation of the latex. As latex is not a viscous fluid, the use of solid precipitates such as French blue, red-lead, or mercuric iodide as colouring masses presents difficulties, for if much precipitate is added the physical action of the finely divided solid causes coagulation, and if a little is added it quickly precipitates itself, either before use or to one side of the blood-vessel. These difficulties may be overcome by adding glycerine to the latex. One volume of glycerine to three or four of latex gives a medium sufficiently viscous to prevent rapid sedimentation and of a sufficiently high rubber content. The colouring mass should be mixed with the glycerine first, and this mixture stirred into the latex.

The following are a few of the formulæ I have found useful:

Carmine Latex Mass.

Carmine	2 gm.
Ammonia	5 c.c.
Water	5 c.c.

Break the carmine up to a fine powder in a mortar and add the ammonia and water, stirring until a dark but clear solution is obtained. 1 c.c. of this carmine solution should be added to every 30 c.c. of latex required, and an injection mass is obtained which will keep indefinitely. I find this the most useful injection mass.

Methyl Blue Latex Mass.—5 c.c. of a 2½ per cent. solution of methyl blue in water should be added to every 25 c.c. of latex. The injection mass is of a pale blue colour, but becomes bright on the addition of the acetic acid.

Prussian Blue Latex Mass.

Prussian Blue	1 gm.
Glycerine	5 c.c.
Latex	25 c.c.

Prepare Prussian blue by adding a strong solution of ferric chloride gradually to a concentrated solution of potassium ferrocyanide, filter the precipitate through fine silk, wash in water, and dry. 1 gm. of the dry solid should be ground up in a mortar with 5 c.c. glycerine, which mixture should be stirred into the latex.

My preparations have been mainly of those vertebrates used in my practical classes—frogs, lizards, pigeons, and rats, and one invertebrate which I injected —*Achatina fulica*, the giant African land snail—made a successful preparation. Prof. A. G. Smith, professor of anatomy at the Ceylon Medical College, assisted me in the injection with carmine-latex of a human fore-limb which had been previously injected with formalin by the method usually adopted for such subjects. He has dissected the preparation and finds that the latex injection shows up the vessels as well as the ordinary red lead method, with the additional advantage that the smallest vessels can be dissected to their ultimate distribution without breaking. On account of the formic acid present in commercial formalin, specimens which can only be injected after preservation should be preserved in non-acid formalin, prepared by the addition of 5 gm. borax to every litre (W. R. G. Atkins, *Jour. Marine Bio. Ass.*, **12**, No. 4, 1922).

A few of the advantages of this technique are the following: There is no danger of solidification of the mass before the injection is complete, as so often happens with warm injection masses; the injection mass does not extravasate; the vessels are strengthened without rigidity, allowing an extensive dissection or exploration after injection; and, even if the walls of the vessel are damaged in the subsequent dissection, the solid rubber core of the vessels remains. From one point of view this method is like de Fol's metagelatin method, but coagulation is much easier with latex, and the resulting rubber is strong and elastic. It does not appear to be applicable to material for sectioning, but I have found it ideal in the preparation of museum specimens, for class demonstrations, and ordinary dissections of vascular systems.

I have to thank Mr. E. C. de Fonseka, Colombo, for supplies of latex, and also the Rubber Research Scheme here for latex, and in particular its chemist, Mr. T. E. H. O'Brien, for information regarding coagulation. He says, regarding supplies of latex, that it is doubtful whether there are any general importers into England, except to fulfil specific orders, but he thinks that the Rubber Growers' Association, Incorporated, 2 Idol Lane, Cheapside, E.C.3, would be willing to supply or arrange for supplies for experimental purposes.

D. R. R. BURT.

Ceylon University College,
Colombo, Feb. 22.

The Ovarian Hormone.

THE problem of the prevention and interruption of pregnancy by physiological means is attracting considerable attention at the present time, and several investigators are reporting results of importance. Some, however, would seem to be unaware of similar work already carried out. It was in 1925 that I first reported that pregnancy could be interrupted by the injection of the so-called œstrous hormone (*Biol. Ges. zu Wien*, Dec. 7, 1925). At that time I was using extracts prepared by Heinlein and Hohlweg, and others prepared and used by Steinach, Heinlein, and Wiesner in earlier investigations. Fellner (*Wr. klin. Wschrift*, 1926) raised the objection that the effect of these extracts might be due to the action of non-specific substances included therein. By using highly purified extracts, prepared for the most part by Dohrn and his co-workers, I was able to remove this objection, since abortion was produced in rats, guinea-pigs, and mice, even when small doses, 0·0002 mgm., were administered. Injections of many times this quantity of other substances (lipoids) produced no effect. Since more units (mouse-units) are required when moderately pure extracts are used, it is reasonable to assume that in these cases the effect was due to the specific action of the hormone.

The working hypothesis which has guided me in this work is that there exists a certain correspondence between the phases of the sexual cycle and the level of the œstrous hormone. It will be recalled that the genitalia of those animals which have a diphasic sexual cycle (rats, mice, guinea-pigs, cattle, sheep, dogs, etc.) exhibit two successive states. The uterus and other organs first pass through the sexual (œstrous) phase and then through the reproductive phase (pregnancy or pseudo-pregnancy). As both phases are occasioned by the endocrine functioning of the ovary (as is definitely proven in the case of pseudo-pregnancy), the question arises as to what the mechanism is that is responsible for the change from the first to the second phase. Two possibilities present themselves. There might be a change either in the quality of the ovarian hormone or else in the manner in which the uterus and other genitalia react to the follicular hormone.

During preliminary experiments, it was found to be impossible to provoke the typical phenomena of the first or sexual phase by injection of œstrous hormone during pregnancy. This result seemed to indicate that the change from first to second phase was due to an altered power of reaction on the part of the genitalia to the follicular hormone. But in the spayed female it was found to be impossible to provoke the exhibition of the phenomena of the reproductive phase even when using large quantities of œstrous hormone and under conditions similar to those that operate in the case of the normal animal (coitus, etc.). It was assumed, therefore, that this œstrous hormone is but one of the factors constituting the ovarian hormone—the α-factor—and that for the production of the second phase the action of another factor, the β-factor, is required. The α-factor certainly plays a certain rôle in the production of the second phase, since it can be demonstrated that the genitalia react to it in a specific fashion during the second phase. It would seem to follow from this that the greatest production of œstrous hormone occurs during that stage when no œstrus appears (*i.e.* pregnancy), and that with the progress of pregnancy the amount increases. The indications are that there appears to be both a change in the production of hormone with the incoming of the β-factor, and also in the manner in which the genitalia react to the α-factor.

Since any stage of pregnancy (embryonic development) depends on a certain anatomical and functional state of the uterus, and since this state of the uterus depends on the hormonic level, any artificial raising of the hormonic level will produce a state within the uterus which is unfitted to the stage of development reached by the fœtus. For this reason abortion follows injection of one of the factors of the ovarian hormone.

By the same means it is possible to inhibit pregnancy. The first phase can be prolonged by injection of the α-factor, with the result that the uterus does not pass into the second phase, and so no preparation is made for the arrival of the ovum.

These observations apply only to the case of animals with a diphasic cycle. They do not hold in the case of man, monkey, and rabbit, forms with a

monophasic cycle, for no separate first phase exists in these, the whole cycle consisting of a series of changes comparable only with pseudo-pregnancy. Menstruation is nothing else than the termination of pseudo-pregnancy, and has nothing whatsoever to do with œstrus and œstrous bleeding. The complete monophasic cycle is to be compared with the second phase of the diphasic cycle.

In all monophasic animals, however, the α-factor plays an important rôle. Every stage of pseudo-pregnancy (pre-menstruum) and pregnancy corresponds to a certain level of the α-factor (Zondek, Smith, etc.). By raising the level of the α-factor artificially, there is produced a stage more advanced than that appropriate to the stage of development of the embryo.

B. P. WIESNER.

Animal Breeding Research Department,
University of Edinburgh.

Prices of Periodical Scientific Publications.

THE high prices that are being charged by certain Continental publishers for scientific journals issued by them brings up the very serious question of the steps which must be taken by learned societies, institutions, and individuals against these extraordinary prices. The journals are wanted for reference by research workers all over the world, but their prohibitive prices are in many cases making it impossible for most institutions to continue subscribing to them, while for a great majority of individual workers to purchase single volumes at £7 7*s*. to £8 8*s*. is absolutely out of the question. A great amount of material is apparently available for publication, as three to four volumes of various journals are issued every year. The prices for subscription of different volumes are not on a regular rate, but an arbitrary price is fixed for each part of the different volumes. This results in the subscription for various journals amounting to as much as £20 a year.

I give below a few cases with the actual printed prices of the volumes for the year 1927. *Ergebnisse der Anatomie und Entwicklungsgeschichte*, which up to vol. 22 for 1914 (issued in 1916) was published by J. F. Bergmann, Wiesbaden, and was taken over by the combine of publishing firms of J. F. Bergmann, Munich, and Julius Springer, Berlin. It now forms the third part of *Zeitschrift für die gesamte Anatomie*. The last volume, 27, issued in November 1927, consists of 1104 pages with 271 text-figures; there are no plates. The price of this volume is 168 Reichsmarks, or roughly £8 8*s*. The price of three volumes of *Zeitschrift für Anatomie und Entwicklungsgeschichte*, issued during 1927 and forming part 1 of the above-mentioned series, comes to Reichsmarks 405, or £20 5*s*.; the price per volume would work out roughly at £7. The volumes of *Wilhelm Rouxs Archiv für Entwicklungsmechanik*, issued during 1927, cost Reichsmarks 380, or £19, and the price of a single volume varies between £5 5*s*. and £7. The two volumes of *Zeitschrift für Zellforschung und mikroskopische Anatomie*, issued during 1927, cost Reichsmarks 240, or £12.

The above publications are all issued either by Bergmann and Springer or by Springer alone. The case of *Archiv für Naturgeschichte*, issued by the Nicolaische Verlag, Berlin, is no better. Of the two volumes of this serial, more than a dozen parts are issued every year at an average price of Reichsmarks 30 to 36, and the average cost of the serial works out at about £20 a year. For comparison one might refer to journals like *Zoologische Jahrbücher* or *Archiv für Protistenkunde*, prices for the different volumes of which vary between 60 and 80 marks, or £3 to £4. The size of text and number of illustrations, both in the form of text figures and plates of these serials, would compare very favourably with any of the journals mentioned above.

The cost of printing has undoubtedly gone up since the War, but are these exorbitant prices justified? And can various institutes and societies, with their moderate grants or income, continue subscribing to these journals? I am afraid it is practically impossible for many institutions, like the Zoological Survey of India, which has complete sets of all the journals mentioned above, to continue subscribing to them much longer, unless the prices are materially reduced or their library grants are increased. In the interest of workers, could not various bodies like the Royal Society of London, the Zoological Society of London, and other similar institutions, take up the matter and consider what steps can possibly be taken to deal with the difficult situation?

BAINI PRASHAD.

Zoological Survey of India,
Indian Museum, Calcutta.

The Oldoway Skull.

I HAVE recently returned from Germany, where by the kindness of Dr Hans Reck I was enabled to examine the Oldoway skull and skeleton found by him in 1913 in what was then German East Africa—now Tanganyika Territory—and I have also fully discussed the geological and palæontological evidence as to its age with Dr. Reck himself.

The object of my visit was to see how nearly the Oldoway skull compared with, or how it differed from, the fossil human skulls which I brought back from Elmenteita, Kenya Colony (see NATURE, July 16, 1927, p. 85).

With Dr. Reck's permission I am able to make the following statement about the Oldoway skull, though of course I may not give any measurements, as Prof. Mollison of Munich is now preparing a detailed report of the skull and skeleton for publication.

All the following statements are the result of my own personal examination of the skull and of my discussion with Dr. Reck.

(1) The Oldoway skeleton lay in a crouched position on its right side beneath undisturbed alluvial deposits belonging to the last pluvial period. The crouched position of the body certainly suggests burial, but if it was a burial it was quite certainly not from the present land surface, but from an earlier surface, for at least 3 metres of undisturbed alluvial strata lay above it. Dr. Reck inclines to the idea that the body became embedded when the deposits were forming under marshy conditions, for no trace of even a shallow grave was found.

(2) The undisturbed deposits lying above and below the skeleton were very rich indeed in mammalian remains. These, while including a number of forms such as eland and oryx, which are indistinguishable from living species, nevertheless consist—so Dr. Reck tells me—to more than 50 per cent. of extinct fauna. The latter includes a number of hitherto unknown genera and species of antelope; a new sheep; numerous remains of an elephant closely allied to *Elephas antiquus* which has been named *Elephas antiquus Recki*; extinct hippopotamus and rhinoceros; and a three-toed horse closely allied to hipparion. Despite the last-mentioned animal—which he considers as a survival from Pliocene or earlier times—Reck regards the deposit as belonging to the end of the Pleistocene.

(3) The human skull from Oldoway very closely resembles some of my fossil skulls from Elmenteita, which, I suggest, also belong at latest to the beginning

of the last pluvial period. It is most decidedly non-negroid, having a long leptorrhine nose, a very long upper-face and a premaxilla of unusual length, with a correspondingly deep palate. All of these characters are found in my Elmenteita skulls.

(4) I could see no sign at all of the suggested artificial chipping of the teeth which is one of the reasons why the Oldoway skull has been considered by many as a recent Bantu burial in fossiliferous deposits. I was only able to examine the upper jaw, as Dr Mollison was away from Munich at the time of my visit and the lower jaw was locked up in his room. Recent photographs of the mandible, however, betray no evidence of chipping at all.

It is thus clear that Dr. Reck's find is in close agreement with the Elmenteita evidence, and it indeed looks as though an early form of *Homo sapiens* lived in East Africa before the last pluvial period, accompanied by numerous animals now extinct.

A full report dealing with the human remains and the associated industries found during last year's expedition is in course of preparation.

L. S. B. LEAKEY.

Feb. 28.

Strong Electrolytes.

IN the original form of the Debye-Hückel theory, the solvent enters only as the medium, having a certain dielectric constant, through which the electric forces between the ions act. In his extension of the theory to concentrated solutions (*Physikal. Zeitschrift*, **26**, 93; 1925) Hückel discussed at some length the effect of the electric field of the ions on the solvent molecules, and pointed out that polarisable molecules tend to congregate round an ion where the electric field strength is greatest, thereby tending to displace other ions from its vicinity. Hückel considered that the effect of this behaviour was obtained by introducing into the equations "the phenomenological law that the dielectric constant of the solution diminishes with increasing electrolyte concentration." While his equations were capable of reproducing the activity coefficients of salts, even in concentrated solutions, using constants obtained from the data themselves, it is doubtful whether these constants have the postulated relation with the dielectric constant lowerings actually produced by electrolytes (*cf.* Harned, *J. Amer. Chem. Soc.*, **48**, 326; 1926).

A more direct calculation might be made by making use of the result (*see* G. H. Livens, "Theory of Electricity," 1926, p. 82) that the work done by an element of dielectric of volume δv, in going from a position where the electric field is zero to one in which the field strength is E and the polarisation P, is

$$\delta v \int P dE = \frac{\epsilon - 1}{2} E^2 . \delta v,$$

assuming proportionality between P and E.

When an ion is brought up from a great distance to a point in the vicinity of a given ion it displaces a quantity of solvent molecules having the same volume. Thus the total work done by an ion of volume Δv in reaching a point where the potential is ψ is

$$e_1\psi + \frac{\epsilon - 1}{2} . E^2 . \Delta v,$$

and the Debye equation

$$n_1 = n_{10} e^{-\frac{e_1\psi}{kT}}$$

is replaced by

$$n_1 = n_{10} e^{-\left(\frac{e_1\psi}{kT} + \frac{\epsilon - 1}{2} . \Delta v . \frac{E^2}{kT}\right)}.$$

By the use of Poisson's equation we get

$$\nabla^2\psi = -4\pi\Sigma e_1 n_{10} e^{-\left(\frac{e_1\psi}{kT} + \frac{\epsilon - 1}{2} . \Delta v . \frac{E^2}{kT}\right)},$$

or to a first approximation

$$\nabla^2\phi = \kappa^2\psi . e^{-\lambda(\nabla\psi)^2},$$

where κ has the usual meaning and $\lambda = \frac{\epsilon - 1}{2kT} . \Delta v$.

I have been unable to obtain a solution to this equation, and I should be grateful for any suggestion as to how a solution (approximate or otherwise) might be obtained.

J. A. V. BUTLER.

King's Buildings,
West Mains Road,
Edinburgh.

The Atomic Spectral Lines Associated with the Band Fluorescence of Alkali Metals.

THE band spectrum of sodium in the visible region consists of two systems, one in the red on the longer wave-length side of the yellow D lines, and another stronger one in the green on the shorter wave-length side of these lines (R. W. Wood, *Phil. Mag.*, **18**, p. 530; 1909). Potassium possesses two similar band systems (J. C. McLennan and Ainslie, *Proc. Roy. Soc.*, **103**, p. 304; 1923). It is now known that the bands on the red side belong to a triplet system, $^3P \rightarrow {}^1S$, and those on the blue side to a singlet system, $^1P \rightarrow {}^1S$. This results from alkali *molecules* having in their normal state two outer electrons like the *atoms* of the alkaline earths.

These band groups can be obtained on the spectrograms of the light emitted by metal vapours that have been rendered fluorescent. By illuminating sodium vapour with the blue-green radiation of sunlight, for example, the light giving the bands on the short wave-length side of the D lines is emitted throughout the vapour. When spectrograms are taken of this emitted fluorescent light, it is always found that they include the yellow *atomic* lines of sodium in addition to the *molecular* fluorescence bands. This feature characterises the fluorescence spectrum of sodium even when the incident light stimulating the fluorescence is wholly free of the wave-lengths 589 and 330 $\mu\mu$, and therefore could not *directly excite the atomic lines*.

A still more remarkable feature of these fluorescence spectrograms is that the D lines appearing on them are very broad even at low temperatures (200°-300°) and at moderate pressures ($p < 1$ mm. at 300° C.).

The information recently acquired regarding the dissociation of homœopolar molecules through the investigation of band spectra enables us to account satisfactorily for these features. The emission of the atomic resonance lines is the result of the dissociation of the excited molecules. Molecular dissociation can take place when the energy associated with a quantum of the absorbed light is greater than the energy, V_r, corresponding to the atomic resonance potential plus the energy, D_r, representing the heat of dissociation.

In the case of sodium, D_r amounts to the equivalent of 1·3 volts, and in the case of potassium to 0·6 volts. If U be the energy equivalent of the quantum of the light absorbed, the excess energy represented by $U - (V_r + D_r)$ would appear in molecular dissociation as kinetic energy of the atomic products of such dissociation, and this kinetic energy in turn would account for the abnormal width of the D lines.

The considerations presented above also afford an explanation of why the absorption of red and green

spark-line radiation does not bring about the emission of the yellow *D* lines from sodium vapour. Work is in progress to develop the ideas expressed above.

J. C. McLENNAN.
RICHARD RUEDY.

The Physical Laboratory,
University of Toronto,
Feb. 7.

The Sligo Artefacts.

A LETTER in NATURE of Jan. 28 definitely establishes the human origin of the Sligo flakes, but the last sentence of the letter seems to suggest some mystery concerning their cultural age. In view of this it may not be superfluous to refer to the accompanying photograph (Fig. 1) which Mr. A. W. Stelfox has kindly lent us. The photograph (Fig. 1) was taken by Mr. R. W. Welch and shows a primitive limestone anchor similar to many that are still manufactured and used by the fishermen on the west coast of Galway. These anchors are made near the coast, and the resulting flakes are left lying about along

FIG. 1.—Primitive anchor, a heavy stone in wooden clamp, still used by Aran Islanders, west coast of Galway.

with larger discarded stones, all showing traces of their undoubted 'humanity.' Although no such anchors are now made at Rosses Point, it is highly probable, if not certain, that such stone anchors were made there, and also at many other parts of the Irish coasts one or two hundred years ago. In all probability the present beach on which the Sligo specimens were found was not in existence even a thousand years ago, so the possibility of the Sligo flakes being debris from primitive stone anchors should be taken into consideration when attempting to fix their cultural age.

These facts are no doubt known to the five signatories of the letter referred to, yet we think it worth while to place on record any evidence which might assist in the elucidation of the cultural age of the artefacts in question.

L. S. PALMER.
J. WILFRID JACKSON.
W. O'B. PIERCE.

College of Technology,
Manchester, Mar. 1.

Factors which determine the Occurrence of the Green Ray.

THE recent discussion of the green ray which has been appearing in NATURE prompts me to put on record a new theory of the phenomenon which occurred to me several years ago, but which I have refrained from publishing in the hope of securing proof. First let me say most emphatically that the phenomenon is real and not an illusion or after-image. No person trained in the observation of optical effects, both real and subjective, who has seen the phenomenon at its best, will have any doubt about its reality. There is also no question in my mind but that the usual explanation (atmospheric dispersion) is quite correct. The main question to answer is, Why is it seen so seldom, even under conditions which appear to be the most favourable?

I have crossed the ocean some thirty times and have looked for the 'ray' at every favourable opportunity, by which I mean clear sky, no haze or clouds on the horizon at sunset, and a calm sea, and yet I have observed it on only three or four occasions, and only once when it was really striking. This occasion was on an eastward trip of the *Homeric*, sailing from New York on June 6, 1925. The colour of the vanishing edge of the sun at sunset was a vivid emerald green, about the colour of a railroad signal light. On other occasions on which I have observed evidence of the phenomenon, the colour change was from red or orange to lemon yellow.

It seems possible that the determining factor is the relative temperature of the air and the ocean. Warm water and cool air would flatten the trajectory of the light rays, and cause the sun to set abnormally early. This is the type of refraction in cases of desert mirage, in which case the curvature of the rays is reversed. With cold water and warm air, on the contrary, the normal gradient of refractive index would be increased, the curvature of the rays augmented, and sunset would be delayed, giving a greater opportunity for atmospheric dispersion to come into play.

Through the courtesy of Capt. Parker, of the *Homeric*, I have been furnished with data regarding the air and water temperatures on this trip. On the day on which we observed the ray, the temperatures of air and water were practically the same at sunset. On the other three favourable evenings, on which we failed to see any trace of the phenomenon, the ocean was from twelve to fourteen degrees warmer than the air at sunset. I hope that this note may prompt future observers of the green ray to secure data on the air and water temperature, both for occasions on which it is not seen, as well as those on which it is well marked.

R. W. WOOD.

Johns Hopkins University,
Baltimore.

A New Type of Secondary Radiation.

IF we assume that the X-ray scattering of the 'unmodified' type observed by Prof. Compton corresponds to the normal or average state of the atoms and molecules, while the 'modified' scattering of altered wave-length corresponds to their fluctuations from that state, it would follow that we should expect also in the case of ordinary light two types of scattering, one determined by the normal optical properties of the atoms or molecules, and another representing the effect of their fluctuations from their normal state. It accordingly becomes necessary to test whether this is actually the case. The experiments we have made have confirmed this anticipation, and

shown that in every case in which light is scattered by the molecules in dust-free liquids or gases, the diffuse radiation of the ordinary kind, having the same wave-length as the incident beam, is accompanied by a modified scattered radiation of degraded frequency.

The new type of light scattering discovered by us naturally requires very powerful illumination for its observation. In our experiments, a beam of sunlight was converged successively by a telescope objective of 18 cm. aperture and 230 cm. focal length, and by a second lens of 5 cm. focal length. At the focus of the second lens was placed the scattering material, which is either a liquid (carefully purified by repeated distillation *in vacuo*) or its dust-free vapour. To detect the presence of a modified scattered radiation, the method of complementary light-filters was used. A blue-violet filter, when coupled with a yellow-green filter and placed in the incident light, completely extinguished the track of the light through the liquid or vapour. The reappearance of the track when the yellow filter is transferred to a place between it and the observer's eye is proof of the existence of a modified scattered radiation. Spectroscopic confirmation is also available.

Some sixty different common liquids have been examined in this way, and every one of them showed the effect in greater or less degree. That the effect is a true scattering and not a fluorescence is indicated in the first place by its feebleness in comparison with the ordinary scattering, and secondly by its polarisation, which is in many cases quite strong and comparable with the polarisation of the ordinary scattering. The investigation is naturally much more difficult in the case of gases and vapours, owing to the excessive feebleness of the effect. Nevertheless, when the vapour is of sufficient density, for example with ether or amylene, the modified scattering is readily demonstrable.

C. V. RAMAN.
K. S. KRISHNAN.

210 Bowbazar Street,
Calcutta, India,
Feb. 16.

Land-locked Salmon.

THE term 'land-locked' is generally used for fresh-water colonies of salmon, such as that from the River Otra described in NATURE of Mar. 17, and from Lakes Wenern and Ladoga, and even for the Canadian Ouananiche. The word is, in my opinion, misleading, indicating that the colony is cut off from the sea, which is not always true, and that it owes its formation to this circumstance.

The fact that Lake Wenern has a stock of salmon indicates that it was formerly accessible from the sea; when the falls first became impassable to ascending fish they could scarcely have prevented fish from descending had they wished, so that none would be left. It seems clear that in the days when the lake was accessible from the sea, and salmon went through it to spawn in its tributaries, some of the smolts that descended into the lake found it to be a sufficiently good substitute for the sea to stay there, and so founded a non-migratory race, which became isolated later. Similarly with the River Otra; some of the smolts reaching the Bygglandsfiord were tempted to stay and feed on the abundant pelagic crustacea, and founded a dwarfed race of lake-salmon, that was isolated when the falls became impassable.

The trout forms fresh-water colonies in every river and lake that it enters, and for this species the term 'land-locked' is never used. On this side of the Atlantic the salmon generally leaves such colonisation to the trout, and itself forms fresh-water colonies only in exceptional circumstances, either in very large lakes with abundance of fishes, or in rivers or lakes with such quantities of parr-food that it is tempted to prolong the parr life. In America, when there are no trout, the salmon form fresh-water colonies more readily.

C. TATE REGAN.

British Museum (Natural History),
S.W.7, Mar. 17.

Anomalous Groups in the Periodic System of Elements.

IN a paper which will shortly appear in the *Rend. Accad. Lincei*, I have calculated the distribution of the electrons in a heavy atom. The electrons were considered as forming an atmosphere of *completely degenerated* gas held in proximity to the nucleus by the attraction of the nuclear charge screened by the electrons. Formulæ were given for the density of the electrons and the potential as functions of the distance r from the nucleus.

In continuation of the previous work, I have applied the same method to the study of the formation of anomalous groups in the periodic system of elements. From the density of the electrons and their velocity distribution, one can easily calculate how many electrons have a given angular momentum in their motion about the nucleus, that is, how many electrons have a given azimuthal quantum number k.

It is known, for example, that the formation of the group of the rare earths corresponds to the bounding of electrons in 4_4 orbits, that is, to the presence in the atom of electrons with $k=4$. Now it follows from the theory that electrons with $k=4$ exist in the normal state only for atoms with atomic number $z \geq 55$. This agrees well with the empirical result that the group of the rare earths begins at $z=58$ (cerium).

Similarly, the bounding of 3_3 electrons with $k=3$ corresponds to the anomaly of the first great period beginning at $z=21$ (scandium); according to the theory, electrons with $k=3$ should appear in the atom just at $z=21$.

Further details will be published later.

E. FERMI.

Physical Institute of the University,
Rome.

Activation of Ergosterol at −180° C.

WITH reference to the letter in NATURE of Mar. 24, p. 452, from Dr. Bills and Mr. Brickwedde, on the activation of cholesterol at liquid oxygen temperature, we may mention that we are now studying the production of vitamin D from ergosterol by ultra-violet radiation at various temperatures, and have obtained intensely active products at −180° C. from weak alcoholic solutions immersed in liquid oxygen, as well as at higher temperatures up to +78° C. Details will be published shortly. Our results therefore are similar to those of Bills and Brickwedde, and are made with the pure provitamin instead of with 'cholesterol.'

T. A. WEBSTER.
R. B. BOURDILLON.

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Recent Progress in Theoretical Physics.

By H. F. BIGGS.

WHEN an army is making a rapid advance over fresh ground it is not the time to make an elaborate survey of the territory conquered, but on the other hand sketch maps, however provisional and imperfect, of the main lines of advance and the chief points of attack, are all the more useful to the soldier in the field and interesting to the newspaper reader at home. What follows is an attempt to draw such a sketch map for some important recent work in physics.

The most remarkable thing about present-day physical theories is the strange dual nature all the components of matter and energy seem to exhibit. Thus no sooner does Bose (*Zts. f. Phys.*, **26**, 178; 1924) show that Planck's law of temperature radiation can be derived by treating quanta $h\nu$ as if they were particles with momentum $h\nu/c$, than Einstein (*Berl. Ber.*, 261; 1924) follows suit by applying Bose's method to the molecules of a material gas, supporting his procedure by treating his molecules as equivalent to wave-trains after the fashion of L. de Broglie. A new statistical principle is introduced by Bose, but it will be easier to explain this after we have considered the rival principle commonly called the Fermi-Dirac statistics. This latter principle may be stated in a few words as the extension to quantised translational motion of Pauli's prohibition, by which no two electrons in an atom can have exactly the same set of quantum numbers.

But how are translational motions of particles to be quantised? This question can be most easily answered by considering the de Broglie waves of our particles (L. de Broglie, *Ann. de Phys.*, **3**, 22; 1925; or Biggs, "Wave Mechanics," p. 22). A moving particle is equivalent to a train of waves (ψ-waves) the wave-number of which is p/h, where p is the momentum of the particle and h is Planck's constant. The components, too, of the momentum are proportional to the wave-numbers along the co-ordinate axes, that is, to the number of waves per centimetre cut by the axes respectively. Thus we write

$$N_x = p_x/h,\ N_y = p_y/h,\ N_z = p_z/h \quad . \quad (1)$$

The elastic rebound of a molecule from a boundary wall is now equivalent to the reflection of ψ-waves from the wall, since the laws for angles are the same, and thus an ideal gas in an enclosure with perfectly elastic walls is replaced by a field of ψ-waves in an enclosure the walls of which are perfectly reflecting for these waves. This only means that if there is to be no progressive motion of particles or radiation through any surface drawn in a gas, the wave-system must be a stationary system such as would be formed by trains of waves reflected to and fro at the surface. The problem of velocity distribution in a gas is then closely related to the Rayleigh-Jeans problem of finding the number of degrees of freedom or modes of oscillation in a given volume of a continuous medium. (See Jeans, "Dynamical Theory of Gases," chap. xvi.; 1921.)

A less mathematical argument than the usual one may be used, and is more appropriate to the case in hand. Let the oblique lines in the diagram (Fig. 1) be the traces of wave-fronts in the original train and in a train formed by reflection at some vertical wall, the full lines representing crests and the dotted lines troughs. Then the reflecting walls must be either in positions such as w, w, if at nodes of the standing waves, or W, W, if at antinodes. In either case, a line drawn normal to the planes must cut a whole number of *half*-waves. Thus in a rectangular box, with edges a, b, c, cm. parallel to the axes, $2aN_x$, $2bN_y$, $2cN_z$ must be whole numbers,

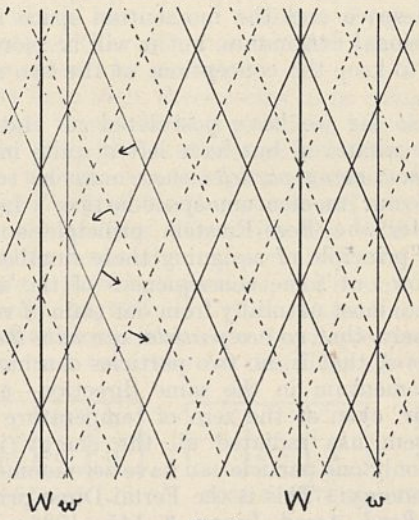

FIG. 1.

where N_x, N_y, N_z are positive quantities giving the wave-numbers without regard to sign. If we then represent the possible wave-trains each by a point the rectangular co-ordinates of which are $2aN_x$, $2bN_y$, $2cN_z$, we obtain a cubic space-lattice in the positive octant of space alone the constant of which is one unit; if, however, we take N_x, N_y, N_z themselves as co-ordinates, the unit cell of our representative space-lattice will be a rectangular parallelepiped of dimensions $1/2a$, $1/2b$, $1/2c$, and finally by (1), the possible *momenta* of particles in the box will be represented as to the absolute magnitude of the components by the points of a space-lattice in the positive octant the unit cell of which measures $h/2a$ by $h/2b$ by $h/2c$.

It will be noticed that we have thus quantised the linear momentum of a particle in our box in almost the same way as de Broglie quantised the angular momentum of an electron describing a circular orbit. In our case, it is the number of half-waves along the length, breadth, or depth of the box that must be a whole number; in de Broglie's case, it is the number of waves counted 'round the orbit.' In both cases quantisation expresses the

existence of a steady state, or, from another point of view, the existence of a single-valued function ψ.

We can now see clearly how we are going to get the theory into relation with classical and 'classical-quantum' statistical dynamics. But first we must take a rather different space-lattice for our possible momentum-points, not occupying only the positive octant of space but also extending symmetrically on all sides of the origin. We evidently get the same number of points up to a given maximum value P of the momentum if we take, instead of a spherical octant of radius P, a whole sphere of radius P, provided we multiply the volume of our unit momentum cell by 8, making its edges now $h/a, h/b, h/c$, instead of half these lengths. Then the unit cell in the momentum-space for a particle in a box abc will have the volume h^3/abc, and the unit cell of the 6-dimensional phase-space with co-ordinates x, y, z, p_x, p_y, p_z, will have the volume h^3. It will not be necessary, however, for our purposes to fuse the real space and the momentum space into a 6-dimensional continuum, but it will be more convenient to keep the conceptions of the two spaces distinct.

Now so far we have postulated no statistical principle whatever, but have left it quite indeterminate *how many particles* there may be to each point of our momentum space-lattice. Leaving until later the Bose-Einstein principle and the classical principle of assigning these numbers, we will follow out some consequences of the answer that arises most naturally from our train of reasoning, namely, that *no two particles can have the same lattice point*, that is, no two particles can have the same momentum in the same direction—and in particular, even at the zero of temperature when the system has radiated all the energy it can radiate, only one particle can have zero momentum or zero energy. This is the Fermi-Dirac principle (Fermi, *Rend. Accad. Lincei*, **3**, 145; 1926; Dirac, *Proc. Roy. Soc.*, A, **112**, 661; 1926). It must hold for the same reason that the similar Pauli principle holds for the electrons in an atom, though what this reason may be is a puzzle. One may perhaps hazard the guess that if two molecules or two electrons had the same wave-trains, or oscillations the same in all but phase, they would no longer be the distinct entities of our experience, the discreteness of motions being thus very intimately bound up with the atomic nature of matter itself.

This reasoning of course is quite right only for *structureless* particles which alone can be fully represented by the oscillation of a scalar such as ψ; it should hold, therefore, for a monatomic gas for all phenomena that are not influenced by atomic structure, but for the spinning electron there may be *two* electrons instead of one per lattice point, as in the Stoner atomic scheme. The statistical principle is just the same, but the representation loses a little in *Anschaulichkeit*.

For a true particle we may now state the principle thus: *The product of the real space available per particle and the least momentum space which must be assigned to each particle is* h^3. The first consequence of this is that at the zero of temperature the actual momenta of the particles will not be zero, but their representative points will be close-packed, occupying all those points of our lattice which lie closest to the origin or zero of momentum with one cell of volume h^3/V per particle. Thus, if we have N particles confined within V cubic centimetres, their momentum space will have the volume Nh^3/V; and since the shape of this volume will presumably be spherical (for N large), we can easily calculate the energy. For if P be the radius of this sphere, we have, to find P

$$(4\pi/3)P^3 = Nh^3/V,$$

and the kinetic energy of a particle with momentum p is $p^2/2m$, so that dividing the total energy

$$\frac{V}{h^3}\int_0^P 4\pi p^2 dp \frac{p^2}{2m}$$

by the number of particles

$$\frac{V}{h^3}\int_0^P 4\pi p^2 dp, \text{ we get for the mean energy}$$

$$\frac{1}{2m}\cdot\frac{3}{5}P^2 \text{ or } \frac{3h^2}{10m}\left(\frac{3N}{4\pi V}\right)^{\frac{2}{3}}.$$

A striking application of this result was made by R. H. Fowler (*Mon. Not. Roy. Astr. Soc.*, **87**, 114; 1926; see also Eddington: "Stars and Atoms," Oxford, 1927, Appendix) to the dense matter of the companion of Sirius, showing that even when such matter has radiated all the energy it can, and has cooled down to the absolute zero, the 'free' electrons, of which (as regards number and energy) it is chiefly composed, have a mean energy corresponding to equipartition energies at something like 10^8 degrees.

Some of the mysteries of matter in its more familiar forms can also be illuminated by this principle in the most hopeful way. Thus Pauli (*Zts. f. Phys.*, **41**, 81; 1926) shows that the small paramagnetism of metals can be accounted for by treating the free electrons as magnetic molecules of a gas near the absolute zero. For corresponding temperatures are inversely as the masses of the particles concerned, so that to the helium molecule at 5° abs. corresponds electron gas at about 36,000°. If then we start filling up the lattice points with electrons, two go to each point, and these have opposite orientations, so that the resultant magnetic moment must be zero, to the first approximation. Pauli pursues the analysis further and derives Curie's law (kT = const.) for the susceptibility and finds absolute values which promise to agree well with observation when we know better the intrinsic diamagnetism to be assigned to the various atoms.

More recently, Sommerfeld (*Naturwiss.*, **15**, 825; 1927) has attacked other hitherto baffling problems of electronic phenomena in metals with very promising results, building on the Drude treatment by mean free paths, but using the Fermi-Dirac statistics instead of the Maxwell statistics of Lorentz. The great stumbling-block of the negligible contribution of the electrons to the specific heat is surmounted at the first stride, since the degradation or high quantisation of the electronic motions gives a value for the specific heat which

vanishes at 0° abs. (in accordance with Nernst's theorem) and at ordinary temperatures is only of the order $R/100$, which is quite compatible with observation. The formulæ for the electric and the thermal conductivity depend on the mean free path and cannot yet be satisfactorily checked, but in their ratio, the Wiedemann-Franz coefficient, this unknown divides out, and the result, $\frac{\pi^2}{3}\left(\frac{h}{e}\right)^2 T$, which is the classical formula with the numerical factor $\pi^2/3$ instead of 2, agrees exactly with the observed mean for the various metals. This, however, is not quite so conclusive as it sounds, since even the seven best metals differ among themselves by 8 per cent. Still more convincing are the results for thermoelectric phenomena, which all come out of the right order, where the classical theory is wrong by very large factors on any reasonable assumptions.

It should be noted that Sommerfeld introduces no arbitrary quantities at all, and the only quantity he uses which varies from metal to metal is the number of electrons per cubic centimetre, which he puts equal to the known number of atoms. One interesting result of this procedure is that the contact potentials come out, for the most part, correct in magnitude but wrong in sign. In other words, an electron would escape from its fellow electrons alone at the given density with a *positive* energy equal to the *work that must be done* to get it out from an actual metal containing the same number of positive atoms with the electrons. Thus, with an obvious notation,

$$W_e = W_a - W_e, \text{ or } W_a = 2W_e.$$

This at once suggests an analogy with the familiar theorem that the potential energy is minus twice the kinetic energy for particles obeying the inverse square law (Sommerfeld, "Atombau," Appendix). For the interactions (if this word can be used at all) of the electrons which cause them to obey this new statistics seem to have nothing to do with their ordinary electrostatic repulsions, so that W_e calculated by the statistics will presumably correspond to kinetic energy, and W_a to potential energy.

There can be no doubt that this paper of Sommerfeld's forms the first [1] step in the true theory of metallic conduction, and that the preponderating factor in these phenomena depends on this statistical behaviour of the electrons without regard even to the structure of the metallic crystals. The next step, as Sommerfeld remarks, will be to improve on the assumption of a constant mean free path and to discover how this quantity depends on the velocity of the electrons and on the temperature.

Let us now return to the question of the different possible statistical principles and trace out the connexion between them. All statistical problems can be regarded as depending on the number of ways a number of objects can be put into a number of boxes with different labels under various rules. For gases the objects have until now been molecules and the boxes cells of phase space. Classically, the cells are taken equal in size, the intrinsic probability of a molecule being in one of these cells is the same for any cell, and finally the cells are made infinitely small. In the classical quantum theory of Nernst and many other workers, the only difference is that the cells are not made infinitely small but have the finite size h^3; they still are regions of equal size and of equal probability. But for both the new statistical principles the point of view is entirely different; we consider, not into which cell we put a particle, but how many particles a cell contains. On the Fermi principle, each cell may contain one particle, but not more, and it is further assumed that to contain one particle and to contain no particle are equally probable states for a given cell. In terms of objects and boxes, it is the cells that are now the objects, and there are only two boxes, which have equal chances of receiving a given object (*i.e.* cell), one labelled 'no particle' and the other 'one particle.'

As we have seen, there seems to be some sort of intelligible reason for this principle, but the Bose-Einstein principle is thoroughly baffling [2] as to reasons, though easy enough to express. It runs: *It is equally probable that a cell will contain any number of particles.* Or, with the cells still as objects, the boxes of equal probability are labelled 0 *particle*, 1 *particle*, 2 *particles*, and so on. Jordan (*Naturwiss.*, **15**, 636; 1927) [3] illustrates the application of the three principles to the simple case of two particles and two cells by this diagram (Fig. 2).

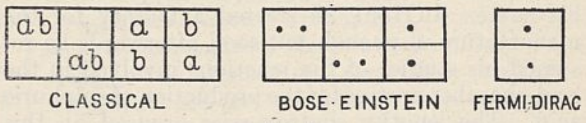

FIG. 2.

In the classical quantum theory we can suppose the particles named *a* and *b*. Then the arrangements with both in the first cell and with both in the second cell will have one complexion each and will be equally probable, while the arrangement with one in each cell will have two complexions and will therefore be twice as probable. On the Bose principle, on the contrary, the particles have lost all individual distinction and can be represented by mere dots. The arrangement with one particle in each cell has then only one complexion and has the same probability as either of the arrangements with both particles in one cell. On the Fermi principle the only possible arrangement is with one particle in each cell. Then, on any theory, once

[1] This is not quite fair to Lindemann, who some time ago suggested that the electrons form a nearly rigid space-lattice among themselves (F. A. Lindemann, *Phil. Mag.*, **29**, 127; 1915). So they do, but it is in the momentum space, not the real space.

[2] See, however, a short and most suggestive paper by Brillouin (*Comptes rendus*, **184**, 589; 1927), in which he shows that in the Bose scheme the probability of a quantum getting into a cell is *greater* the more quanta there are already in that cell. It is like the game of chain-tig, in which the more boys there are in the chain the greater is the chance of their adding to their number. This is only a fanciful way of putting the fact that the greater the radiation density corresponding to a certain energy-jump, the greater is the probability of the radiation provoking another such jump, as in Einstein's proof of Planck's law in 1917.

[3] In this and a paper in the previous number Jordan gives a most comprehensive review of the progress of the new theories in the last two years, with a full bibliography.

the intrinsic probability is settled, the steady state of maximum probability can be found by the familiar methods.

We have seen that the Fermi principle can be used for electrons not attached to particular atoms, and Fermi in his original paper (*l.c.*) showed that it gave what is probably the true equation of state for a monatomic gas at low temperatures, while Einstein's application of Bose's statistics to gases led to curious results not confirmed by experiment. It seems, therefore, that Bose's original application of his statistical principle to quanta is the only permissible one. Why quanta indistinguishable in every respect should be capable of coexisting when electrons are not is by no means obvious. Quanta seem to be much more indifferent to each other's existence than material particles, which perhaps has something to do with their own indifference to life, or rather their readiness to undergo metempsychosis.

Obituary.

DR. F. RASCHIG.

DR. FRIEDRICH RASCHIG, whose numerous scientific investigations in the domain of chemical technology covered a remarkably wide range and whose interests were not restricted to purely technical problems but were devoted to public welfare, passed away on Feb. 4 at the comparatively early age of sixty-four years.

We are indebted to the *Chemiker-Zeitung* for some points in Dr. Raschig's life. Born on June 8, 1863, at Brandenburg, Raschig's interest in scientific work was awakened while still at the *Realgymnasium*, where he came under the influence of Prof. Müller, director of the *Zeitschrift für physikalischen und chemischen Unterricht*. After studying at the Universities of Berlin and Heidelberg, he became assistant in the University chemical laboratories in Berlin and was afterwards appointed chemist to the Badische Anilin und Soda Fabrik. During this period many publications, dealing chiefly with compounds of nitrogen and sulphur, appeared under his name. In 1891 he started a factory for the manufacture of phenol, but soon afterwards he resumed his studies of the reactions involved in the lead-chamber process for the production of sulphuric acid. The lengthy controversies aroused by this work no doubt did much to stimulate further research in this important field. He also devoted much attention to the reactions of sulphurous anhydride and the sulphites.

Dr. Raschig discovered a technical method of preparing hydroxylamine, and his investigation of chloramine led to his well-known process for the manufacture of hydrazine, a compound of considerable interest, which had previously been discovered by Curtius, whose death occurred only a few days after that of Raschig. The latter also elaborated many useful volumetric methods of analysis and was an authority on the manufacture of synthetic phenol and the distillation of coal-tar. Dr. Raschig took an active part in municipal and political life, and in 1924 was elected a member of the Reichstag.

THE issue of the *Physikalische Zeitschrift* for Dec. 15 contains a photograph and a short account of the life and work of the late Prof. A. Gockel, of Freiberge, Switzerland. Gockel was born in November 1860 at Stockach in Baden, where his father was a secretary in the Post Office. After attending the Gymnasium at Constance he was in turn a student at the Universities of Freiburg in Baden, Würtzburg, Carlsruhe, and Heidelberg. He graduated in 1885 and held teaching posts in secondary schools for ten years. In 1895 he became assistant to Prof. Kowalsky at the University of Freiberge, Switzerland, and in 1901 was appointed lecturer, two years later extra professor, and in 1910 ordinary professor of cosmical physics. In 1921–22 he acted as Rector of the University. He died on Mar. 4 of last year. He married in 1902 the daughter of his colleague Baumhauer, professor of mineralogy. The whole of his scientific publications deal with atmospheric phenomena such as thunderstorms, radiation, and electromagnetic waves, and his work carried him to the shores of the Mediterranean and into the Sahara. His papers are characterised by the carefulness of their deductions.

WE regret to announce the following deaths:

Prof. W. Steadman Aldis, formerly professor of mathematics and principal of the College of Science, Newcastle-on-Tyne, and later of Auckland College, New Zealand, on Mar. 7, aged eighty-nine years.

Mr. W. B. Croft, who taught mathematics at Winchester College for many years, and was widely known for his interest in early work on radio-telegraphy and in optics, on Mar. 23, aged seventy-six years.

Prof. W. W. H. Gee, formerly professor of pure and applied physics at the College of Technology, Manchester, and author of papers and text-books on physics and electro-chemistry, on Mar. 3, aged seventy years.

Dr. F. S. Luther, emeritus president and formerly professor of mathematics of Trinity College, Connecticut, on Jan. 4, aged seventy-seven years.

Mr. E. W. Maunder, for many years Superintendent of the Solar Department of the Royal Observatory, Greenwich, on Mar. 21, aged seventy-six years.

Dr. Richard Pribram, emeritus professor of chemistry in the University of Prague, whose work on the optical rotation of organic substances and on the relationship between physical properties and chemical constitution is well known, aged eighty years.

Prof. Herbert M. Richards, professor of botany in Barnard College, Columbia University, and scientific director of the New York Botanical Garden, on Jan. 9, aged fifty-six years.

Mr. A. Shoolbred, author of "The Flora of Chepstow" (1920), a well-known local botanist and horticulturist, on Jan. 25, aged seventy-five years.

Prof. Eilhard Wiedemann, well known for his writings on the history of physics and formerly professor at the University of Erlangen, at the age of seventy-six years.

News and Views.

SUNDAY next, April 1, is the three hundred and fiftieth anniversary of the birth of William Harvey, of imperishable memory, physician and student, prophet of a new world of knowledge through his demonstration of the mechanism of pulsation of the heart in man and animals. Of yeoman parentage, born at Folkestone, Harvey died at Lambeth on June 3, 1657. He was buried at Hempstead, in Essex. Let us not forget, also, that the present year marks the three hundredth anniversary of the issue of Harvey's immortal work, "Exercitatio anatomica de motu cordis et sanguinis in animalibus," published at Frankfort in 1628. It was a small quarto, in Latin, of seventy-two pages, and from the press of William Fitzer, of Frankfort. Previously, Harvey had, in his Lumleian lectures, delivered before the Royal College of Physicians, London, in the spring of 1616, explained his discovery of the circulation of the blood. But his views met with such mixed reception that he was deterred from publishing any treatise on the subject until much later. In this connexion Aubrey tells us that he had heard Harvey say "that he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained and all the physitians were against him." In the year 1648 another edition in Latin, of 215 pages, appeared at Rotterdam. Afterwards, spreading the wonderful news still farther, came a book of 123 pages in small octavo—"The anatomical exercises of William Harvey concerning the motion of the heart and blood, with the preface of Zachariah Wood, physician of Roterdam. To which is added Dr. James De Back, his discourse of the heart, physician in ordinary to the town of Roterdam. London, 1653"; and the tide of issue rose until all civilised centres and all the teachers knew what had happened. So began, after long delay, man's intimate acquaintance with himself.

THE tercentenary of the birth of Harvey, alumnus of Caius College, Cambridge, and the University of Padua, was celebrated in London fifty years ago by the Royal College of Physicians at a banquet given in their own apartments in Pall Mall. There it was that Huxley, in a remarkable speech, full of tender sympathy and enthusiasm, referred to Harvey's book as "that little essay of fifty pages which no physiologist of the present day can read without wonder and delight." Our readers will find an account of the proceedings in NATURE of June 6, 1878. It may here be mentioned, also, that a statue of the great physician, executed by Mr. Albert Bruce Joy, was unveiled at Folkestone and dedicated to the town by Prof. (afterwards Sir Richard) Owen, on Aug. 6, 1881. There is a famous portrait of Harvey in the possession of the Royal College of Physicians, by Cornelius Jonson van Ceulen; a copy of this hangs in the apartments of the Royal College of Surgeons. The Royal Society also has a portrait, after De Reyn. The National Portrait Gallery has a portrait by an unknown painter.

IN Great Britain and in the United States, numberless friends and admirers of Major-General A. W. Greely, arctic explorer, join in congratulations on the celebration of his eighty-fourth birthday, which occurred on Tuesday last, Mar. 27. Born at Newburyport, Mass., he was educated there at a high school. In early youth Greely enlisted as a volunteer private soldier, serving in the Civil War, 1861–65; afterwards he joined the regular army and was appointed to the signal branch. Following prolonged work of distinction, he succeeded General W. B. Hazen in 1887 as chief signal officer, with the rank of brigadier-general. Under Greely's supervision an enormous amount of telegraphic installation was carried out in Alaska in 1900–1904. General Greely is the author of many technical and popular works in geographical science, meteorology, and climatology.

So far back as 1881, Lieut. Greely, as he then was, took command of an Arctic expedition organised to meet the plan of establishing circumpolar stations in accordance with recommendations adopted at the International Geographical Congress held at Hamburg in 1879. During two years the party, comprising a complement of twenty-five, made their headquarters at Discovery Harbour, Grinnell Land, crossing thence to the Polar Sea and reaching farther north than previously recorded. But disaster attended these pioneers. The vessels of the third relief expedition, which arrived at St. John's, Newfoundland, on July 7, 1884, carried only seven survivors of those who had long been without succour from the outer world in Smith Sound, and had, one by one, succumbed to hunger and hardship. All journals and observational data had been carefully preserved. The Royal Geographical Society recognised Greely's eminent services for science by the award of its Founder's gold medal. The Marquis of Lorne, then president, entrusted the gift at the Society's anniversary meeting in 1886 to Mr. Phelps, the United States Minister, who emphasised that the story of the heroic effort by which the medal had been won would not pass away with his generation, nor perish with the memory of living witnesses; it would remain on the page of history.

PROF. H. BRERETON BAKER selected an experimental theme for his presidential address before the Chemical Society at its annual general meeting on Mar. 22, the title of his discourse being "Constitution of Liquids: some new Experiments." Determinations of the vapour density of liquids which have been dried with phosphorus pentoxide for periods varying from two to ten years show quite clearly that the process of drying results in an increased molecular aggregation; thus the molecular weight of bromine rises from 160 to 242, of benzene from 78 to 126, of carbon disulphide from 76 to 137, of methyl alcohol from 32 to 90, etc. Believing that the molecular aggregation of the bulk of the liquid is even greater than that represented by the vapour density, on account of fractional distillation, Prof. Baker has also developed a modification of Berthelot's method of determining the latent heat of evaporation of a dry liquid, whereby the liquid does not come into contact

with the atmosphere. The latent heat for dry benzene per gram was found to be 58 instead of 83, and the boiling-point was 94° C., so that by the application of Trouton's rule the molecular weight of the dry benzene was 136 instead of 78. The view that the removal of water from liquids leads to increased molecular complexity is thus supported by four classes of experimental data, namely, rise of boiling-point, change of surface tension, increase of vapour density, and increase of latent heat of evaporation.

DISCUSSING the reason for these manifestations, Prof. Baker referred to Sir J. J. Thomson's hypothesis of the variation in the attractive force between the constituents of a molecule, due to the proximity of a drop of a liquid with a high specific inductive capacity. Since ionisation favours drop formation, the effect of heating such ionisation-producing substances as lime, thoria, or radium bromide in a reactive gaseous mixture containing traces of water should be to promote combination, an assumption which was found to be justified when a mixture of hydrogen and nitrous oxide was examined in this way. Further, it should be possible, even in the presence of water but in the absence of facilities for its condensation, to stabilise large molecules and to increase the number thereof above that corresponding normally with a given temperature. The application of a potential difference of 400 volts between platinum plates immersed in benzene has, indeed, been found to produce this effect, the benzene then boiling at 92° instead of 79·6°, and having a molecular weight two or three times as great as the normal value; hexane and carbon disulphide behave similarly. Prof. Baker emphasised the preliminary nature of the experiments which he described, but it is evident that if further work on these lines is confirmatory we shall have, for the first time, an explanation of the rôle played by water in changes of molecular association in liquids. Prof. Baker is succeeded in the presidential chair of the Chemical Society by Prof. J. F. Thorpe.

APPROXIMATELY 550,000,000 acres, or 28·9 per cent. of the total land surface of 1,903,200,000 acres in continental United States, exclusive of Alaska, is classed as forest land. It must not be supposed, however, that the whole of this area produces timber at the present day. The estimate includes vast areas which have been so devastated by careless lumbering and by fires that decades must elapse before they are likely to produce crops of economic value. This class of land includes roughly 81,000,000 acres widely scattered over the country, particularly in the northern and south-eastern States. Of the other 469,000,000 acres, about 80,000,000 acres is woodland, covered with a more or less open stand of poor growth which yields fuel, fencing, and some building material. It is not considered that these areas will ever be capable of producing saw timber on a commercial scale. The productive forest, according to this estimate, covers more than 389,000,000 acres, though this area must have been considerably reduced in the last few years. When the English first settled in the country, three centuries ago, the extent of forest was far greater, especially in the eastern, south-eastern, and central States. About 822,000,000 acres were originally covered with timber forest, and another 1,000,000 acres were lightly wooded with juniper, piñon pine, mesquite, stunted oak, and other species.

THESE figures are of interest in connexion with the afforestation work now being undertaken in the United States. According to a *Daily Science News Bulletin* issued by Science Service of Washington, the area of the national forests was increased during the past fiscal year by 41,214 acres net. With the separation of the Ocala National Forest, formerly a division of the Florida National Forest, as a distinct unit, there are now 160 national forests in the country, situated in 32 States, Alaska and Porto Rico. The total net gain in national forest area was not so large as in several preceding years, due partly to the fact that a considerable acreage was transferred by special Acts of Congress to national parks. Net reductions in area were shown in Alaska, California, Colorado, Nevada, New York, and South Dakota. The largest increase was in Pennsylvania, amounting to 65,274 acres. Washington was second with 63,084 acres, and Wyoming third with 42,494 acres. The figures demonstrate the scale of the task before the United States if a forest area at all commensurate with the requirements and the consumption of the people is to be built up.

MR. FRANCIS RODD has published in the *Times* of Mar. 19 and 20 a brief account of fresh evidence bearing upon the origin of the Tuareg which he has obtained on a recent expedition to Air in the Sahara. This journey was undertaken with the object of investigating the ethnology of these veiled nomads for whom in his previous researches, of which the results were published in 1926, he had suggested the possibility of a derivation from the eastern Mediterranean, and further, that they had moved southward to the Air Mountains from a more northerly position and assumed their characteristic veil somewhere between 600 and 1000 B.C. The evidence now brought to bear upon this question is, in part, that of rock drawings at Air which have now been examined for the first time. The suggested eastern Mediterranean origin was based upon the identification as Tuareg of certain of the Libyans captives in Egyptian paintings and of certain Libyan tribes in Egyptian records from the Fifth to Nineteenth Dynasties as ancestors of the Tuareg on the ground of identity of names. One of the difficulties hitherto felt in the identification, for example, of a Nineteenth Dynasty picture of a captured Libyan chief, has been the fact that a headdress of ostrich feathers is worn instead of the veil. The petroglyphs of Air now show what is apparently an identical headdress. Further, the association of Tifinagh, the Tuareg script, with the petroglyphs, connects them definitely with the Tuareg and not with the previous negroid population of Air. The inscriptions are almost certainly names and patronymics. It follows that so late as the tenth century A.D., the Tuareg, then recently come to Air, were drawing portraits of themselves similar to those

drawn by the Egyptians of the Nineteenth Dynasty of the North African peoples west of the Nile.

THE electricity scheme for Central England has now been published. It is the third scheme which the Electricity Commissioners have devised and communicated to the Central Electricity Board. The area covered is more than 7000 square miles and has a population of five million. It extends from Stoke-on-Trent and Mansfield on the north to Tewkesbury and Buckingham on the south, and from Newark and Oundle on the east to Shrewsbury and the Welsh border on the west. There are 46 public generating stations in the area. These include the large stations of the Birmingham Corporation and the stations of the Shropshire, Leicestershire, and West Midlands Power Companies. The problem of the Electricity Board is to consolidate, standardise, and improve these networks. In this area the sale of electricity per head of the population last year was about 146 units. Assuming that the present rate of growth continues, then in 1940 the output will have reached 540 units per head. Of the 46 generating stations in the area, 19 are taken as 'selected' stations. In order that the networks may be most advantageously interconnected by underground cables or overhead wires, it is necessary that the frequency of their supplies should be standardised. The standard frequency is 50, but both the Birmingham Corporation and the Shropshire Power Company generate at 25. It has been agreed to allow for the present the 25 frequency supply to a few generating stations, but when circumstances make it desirable, the change over to the standard frequency will gradually take place. Sir John Snell has stated that from 1925 to 1926 the average price of supply in this area was 1·48*d.* per unit, and that in three or four years it would be less than a penny. It has to be remembered, however, that when large industrial undertakings can be supplied direct from the power-stations through high-voltage lines, the ordinary house consumer has his supply through these lines and in addition through machinery which reduces the pressure and through low-pressure distributing mains. He may look forward to getting his electricity at 3*d.* or 4*d.* a unit, but the industrial consumer may get his at less than ½*d.* per unit.

AT the present time electrical energy is generated in Great Britain mainly in two ways. The first and commoner method is to use steam turbines and coal-fired boilers. The other is done from waste-heat stations which employ gas engines worked from blast furnaces or from coke-oven gas. Sometimes also steam turbines are worked from waste-heat boilers. In a paper read to the Institution of Electrical Engineers on Mar. 15, W. T. Townend pointed out the advantages of combining the production of electrical energy with that of coal by-products. Waste-heat stations are now fairly common on the north-east coast and in the midland mining centre of England. The Electricity Act of 1926 will have a far-reaching influence on the prosperity of the country, as it will doubtless lead to cheaper electricity and to a greater use of the coalfields. There is a possibility of reducing unemployment by encouraging the mining industry to co-operate not only in the supply of fuels but also in that of surplus electrical energy. It has been suggested that if a large increase be made in the quantity of by-products, the world's markets will become saturated and the selling-price would be reduced. If, however, the public be convinced that electricity provides the cheapest and cleanest mode of cooking, there is little doubt that its use would become almost universal. This would save household coal, but hot water would still be required. This could be generated by any well-known type of slow-combustion stove capable of burning coke. Mr. Townend gave other considerations to show that the disposal of coke in the future need not present great difficulties. The attitude of the British Government towards the pre-treatment of coal is generally supposed to be that if the process is a success then private capital will be rapidly forthcoming for its development. Mr. Townend thinks it illogical for the coal distillation industry not to be given State support, seeing that by the 1926 Act the State has given guarantees in connexion with the capital required for the 'grid' mains. In his opinion both are for the common good.

THE New Zealand Institute publishes a *Reference List* of the Scientific Periodicals in the Libraries of New Zealand. The list is compiled by Gilbert Archey, the Curator of the Auckland Museum. By co-operation with those in charge of the principal libraries in New Zealand, thirty-one in number, the compiler is able to state, in regard to each of the periodicals indexed, in which libraries the volumes may be found, and whether each set is complete. We are told that certain sets are incomplete, but are not told which are the missing volumes or parts. It would not have been difficult to add this information. The compiler states, however, that the libraries are gradually acquiring the missing volumes needed to complete their sets. The arrangement of the *Reference List* is in the first place geographical by Continents and States in alphabetical order. It is only within each country that the references are arranged according to subjects. It would have been much more convenient had the various sciences been taken as the primary subdivisions. As the list stands, it will be difficult for anyone to be sure that he has found all the periodicals dealing with a particular subject. As an example: An entomologist will find 37 journals devoted to entomology distributed under the headings United States, Hawaii, New York, Belgium, France, Germany, Great Britain, Italy, Russia and Switzerland. But without careful scrutiny, he will never be certain that he has not overlooked some entomological journals. We congratulate the Curator of the Auckland Museum, however, on a useful piece of work carefully executed.

THE Department of Entomology of the British Museum (Natural History) has received from Capt. K. J. Hayward, of Villa Ana, Argentina, a fine specimen of *Megasoma janus*, one of the giant horned beetles, of which it is believed that only two examples, both imperfect, have ever before reached Great

Britain. The legs of this insect, when fully extended, cover a space of about six inches from front to rear. Acquisitions in the Department of Geology include type-specimens of Carboniferous Corals from Yorkshire, presented by Prof. R. G. S. Hudson; three plaster casts of type-specimens of starfishes from the Lower Devonian, near Goslar, presented by the Director of the Preussische Geologische Landesanstalt, Berlin; type and figured specimens of Ammonites from the Gault of Southern England, presented by Dr. L. F. Spath. The most important recent addition to the mineral collection is a set of very large specimens of crystallised spar from the Snailbeach mine near Minsterley, Shrewsbury, bequeathed by the late Mr. William Oldfield. They were set up in his garden, but not having been piled up to form a rockery or built into walls, as is often the fate of such specimens, the crystals have not been bruised and damaged. The eight specimens, with a total weight of just over 23½ cwt., consist of slabs measuring up to 5 ft. 6 in. by 3 ft. 6 in. These are covered with two-inch cubes of galena, together with smaller crystals of zinc-blende and copper-pyrites. Only in exceptional cases are specimens of this size raised, for they have no metal value.

AN important development of research in the Antarctic regions is announced in the *Norges Handels og Sjöfartstidende* for Feb. 18. Consul Lars Christensen has decided to establish a radio and meteorological station on Bouvet Island, with the co-operation of the Norwegian Meteorological Institute. This will be an important step in the direction of carrying out Mr. R. C. Mossman's plan for supplementing the South Orkneys meteorological station (established by him on Dr. Bruce's *Scotia* expedition in 1903 and taken over by the Argentine Meteorological Department) by similar permanent observatories on Bouvet Island, the Crozets, and Kerguelen. The same paper says that the cruise of the *Norwegia* towards Enderby Land has had to be postponed, as the damage the vessel received off Bouvet Island cannot be repaired in time for the present Antarctic summer. The *Norwegia* found that the Falkland Island seal (*Phoca Falklandica*) still breeds on Bouvet Island, though it was practically exterminated in its original haunts by the sealers of a hundred years ago.

WE have recently received from the Section of Geodesy of the International Union for Geodesy and Geophysics several issues (Nos. 8, 10-13) of its organ (nominally issued quarterly), the *Bulletin Géodésique*, for the years 1925–1927. They represent a considerable and very useful addition to the literature of international interest to workers in the subject. They contain papers, mainly printed in French, on theoretical and instrumental questions, reports on work executed or projected in the various parts of the world, biographical notices and bibliographies, and a chronicle of current events relating to the science. Among the principal general topics dealt with in the issues named are questions connected with an international ellipsoid of reference; the centre of gravity and the moments of inertia of the oceans; the mean density of the earth; errors in high-precision levelling; and an international inquiry (with answers to a questionnaire) on the trustworthiness of invar wires and tapes.

THE annual report of the Smithsonian Institution of Washington for the year ending June 30, 1926, which has recently been issued, is presumably the last of the long series of these volumes to bear the name of the late Dr. C. D. Walcott. We have already referred to the presentation of this report (NATURE, April 2, 1927, p. 505) and it will be sufficient to direct attention to the valuable general appendix, which, as usual, accompanies the published report. This appendix consists of no less than thirty-one articles, some of them reprints of recent papers and others original; among those of general interest we may mention the papers by Dr. J. H. Jeans on the new outlook in cosmogony, Dr. C. G. Abbot on the influence of the sun's rays on plants and animals, M. Lucien Rudaux on conditions on the moon and the planets, Prof. R. A. Millikan on cosmic rays, Prof. E. Newton Harvey on 'cold' light, Dr. Arthur D. Little on carbon, Dr. John M. Coulter on the history of organic evolution, Dr. L. O. Howard on the control of injurious insects by parasites, and obituary notices of the late Dr. W. Bateson, by Prof. T. H. Morgan, and of Prof. Kamerlingh Onnes, by Dr. F. A. Freeth, the latter being reprinted from NATURE.

THE Ministry of Agriculture and Fisheries has just published a small volume on "Poisonous Plants of the Farm," by H. C. Long (*Miscellaneous Publications, No. 57*, London: H.M. Stationery Office. 2*s*. net). Though the number of wild plants which are seriously poisonous is perhaps small compared with the total number of species included in the British flora, yet there are many of very common occurrence which may occasionally cause serious losses to farm stock, and also illness and death to human beings, particularly children. In cases where poisonous plants occur in quantity, they may be unavoidably harvested, and later given to stock, or they may be eaten in the green state in the open fields or along the hedgerows. There are also numerous cultivated plants and trees which are poisonous and often responsible for trouble with live stock. Sometimes the effect is merely irritant, sometimes it is poisonous. Mr. Long deals with a large number of species, and the toxicology of each is discussed in a simple way. The book is written in non-technical language, is well illustrated by many full-page illustrations, and should be widely welcomed by farmers and those engaged in agricultural instruction.

THE estimates for Civil Services (Class IV., Education, Science, and Art) for the year ending Mar. 31, 1929, include the sum of £225,085 for scientific investigation, etc., and £1,579,400 for Universities and Colleges, Great Britain, and Intermediate Education, Wales.

A VERY large earthquake was recorded at Kew Observatory on Mar. 22 at 4 hr. 29 min. 17 sec.

G.M.T. The epicentre is estimated to have been 5780 miles away, and was probably near the Pacific Coast of Mexico. This disturbance was the most violent shock which has been recorded at Kew since the great Chinese earthquake of May 22 of last year.

THE last meeting of the one hundred and twenty-sixth session of the Royal Philosophical Society of Glasgow was held on Mar. 21. Prof. Graham Kerr, in vacating the president's chair which he had occupied for three years, reviewed the work of the session, and intimated that as great interest in the Society had been shown by women by reading papers and by attending the meetings, it had been agreed that their interest should be recognised by welcoming women to full membership. The following officers were then elected: *President*, Mr. George A. Mitchell; *Vice-Presidents*, Prof. Peter Bennett and Dr. Henry L. G. Leask; *Hon. Treasurer*, Sir John Mann; *Hon. Librarian*, Dr. James Knight; *Hon. Secretary*, Dr. Charles R. Gibson; *Hon. Auditors*, Mr. Alex. Murdoch and Mr. David A. Richmond; *Acting Secretary*, Dr. James M. Macaulay.

AT the annual general meeting of the Ray Society, held on Mar. 22, the following officers were re-elected: *President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Mr. J. Spedan Lewis was elected a vice-president, and Mr. D. J. Scourfield and Mr. A. W. Sheppard were elected new members of council. It was announced that the first volume of Dr. T. A. Stephenson's "Monograph of the British Sea-Anemones" would shortly be issued to subscribers for 1927. The year 1927 being the tercentenary of the birth of John Ray, the Council has accepted the offer of Dr. R. T. Gunther to prepare, as a commemorative volume, a series of unpublished letters of Ray which are preserved in the Bodleian Library and in the British Museum. This volume is in the press and, together with the third and final volume of Messrs. Soar and Williamson's "British Hydracarina," will form the issue for 1928.

AT the annual general meeting of the Institute of Chemistry, held on Mar. 1, the Meldola Medal for 1927 was presented to Dr. J. H. Quastel, fellow of Trinity College, Cambridge. In making the presentation, Mr. E. R. Bolton, vice-president of the Institute, said that Dr. Quastel has advanced the knowledge of reduction–oxidation systems following on the pioneer work which resulted in the discovery of glutathione by Sir Frederick Gowland Hopkins, and has introduced new methods into the study of living cells as represented by bacteria. He has also thrown some light, for the first time, on the mechanism of the activation of molecules by a living organism. It will be recalled that the Meldola Medal is presented by the Society of Maccabæans in commemoration of Prof. Raphael Meldola, president of the Institute of Chemistry (1912–15) and of the Society of Maccabæans (1911–15), and is awarded for meritorious work in chemistry during the year.

THE ninety-sixth annual meeting of the British Medical Association will be held at Cardiff on July 20–28, under the presidency of Sir Ewen Maclean, who will deliver his address on the evening of July 24. The annual exhibition of surgical appliances, foods, drugs, and books will be open on July 23–27. A pathological museum is also being arranged by Drs. J. B. Duguid and J. Mills, Department of Pathology and Bacteriology, Welsh National School of Medicine, The Parade, Cardiff. The following presidents of sections are announced in the provisional programme: Sir Thomas Lewis (*Medicine*), Prof. A. W. Sheen (*Surgery*), Dr. T. Watts Eden (*Obstetrics and Gynæcology*), Prof. E. H. Kettle (*Pathology and Bacteriology*), Dr. E. Goodall (*Mental Diseases and Neurology*), Sir John Lynn-Thomas (*Orthopædics*), Dr. A. Howell (*Diseases of Children*), Mr. F. P. S. Cresswell (*Ophthalmology*), Dr. D. R. Paterson (*Laryngology and Otology*), Dr. H. M. Davies (*Tuberculosis*), Dr. O. L. Rhys (*Radiology and Physio-Therapeutics*), Dr. E. C. Williams (*Preventive Medicine*), Mr. R. M. F. Picken (*Public Health*), Dr. W. E. Thomas (*Medical Sociology*), Dr. Philip H. Manson-Bahr (*Tropical Medicine*), Mr. Walter G. Spencer (*History of Medicine*), Dr. W. Langdon Brown (*Therapeutics and Pharmacology*), Sir Robert Bolam (*Dermatology*). The honorary local general secretary for the meeting is Dr. G. I. Strachan, 20 Windsor Place, Cardiff.

THE Ministry of Health has published the Seventh Report of the Advisory Committee on the Welfare of the Blind, 1926–27. The returns show that there were 46,822 blind persons in England and Wales in 1927. Much information is given on the education and employment of the blind, their distribution in administrative districts and by age periods, their earnings, grants for their welfare, etc.

Bulletin No. 59 (1927) of the National Research Council, Washington, contains in five papers the report of a committee on chemiluminescence. The facts and theories of this extensive subject are conveniently summarised in the report, and are discussed from various points of view ranging from the purely physical to the biological. The members of the committee and authors of the papers are E. Q. Adams, A. D. Garrison, A. H. Pfund, and H. S. Taylor, under the chairmanship of E. N. Harvey.

The new volume of *Ergebnisse der exakten Naturwissenschaften* (No. 6), published by Julius Springer, Berlin (price 24 gold marks), contains articles on the structure and development of stars, by Prof. Vogt; on the sources of stellar energy, by Prof. Freundlich; on photometry, by Prof. Brodhun; on ferromagnetism, by Dr. Steinhaus; on the optical determination of the heats of dissociation of gases, by Dr. Sponer; on adsorption, by Dr. Cassel; on the equation of state for solids, by Dr. Braunbeck; on the theory of strong electrolytes, by Dr. Orthmann; on active hydrogen, by Dr. Boenhoffer; on the element rhenium, by Drs. I. Tacke and W. Noddack; and on photographic methods of measurement, by Mr. P. Seliger. Most of the sections have a bibliography of other literature dealing with the same subject, and the volume includes in addition the index for the present and five preceding issues.

A CATALOGUE of nearly 400 second-hand works, mainly on natural history subjects, but some on historical medicine and on mechanical arts, has just been circulated by Mr. J. H. Knowles, 92 Solon Road, S.W.2.

THE industrial uses of sand are numerous and varied. Those interested will welcome a new edition of the trade catalogue of sands, which include certain clays, flint, and other non-metallic minerals, issued by Mr. A. L. Curtis and obtainable from him (price 1*s.*) at Westmoor Laboratory, Chatteris.

AN important catalogue of some 1500 works relating to Australia, Tasmania, New Zealand, and the Islands of the Pacific Ocean has been received from Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1. Included are many rare volumes, and a series of original water-colour drawings of Sydney and its Harbour, by Conrad Martens.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—Two junior assistants under the Safety in Mines Research Board, for research, respectively, in connexion with colliery wire ropes research, and on materials and structures used for the support of underground workings—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 7). A temporary demonstrator in pharmacy, and an assistant lecturer in preparing, combing, and spinning, and yarn manufacture, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (April 11). A secretary to the Institution of Municipal and County Engineers—The Secretary, Institution of Municipal and County Engineers, 92 Victoria Street, S.W.1 (April 11). A professor of anatomy in the University of Lucknow—The Registrar, The University, Lucknow, India (April 23). A professor of engineering in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (April 28). A lecturer in geography at Birkbeck College—The Secretary, Birkbeck College, Breams Buildings, Fetter Lane, E.C.4 (May 1). A senior lecturer in zoology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (May 4). A lecturer in mathematics at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 5). A senior entomologist for noxious weeds investigation, a senior entomologist for noxious insects investigation, and a senior entomologist at Canberra for advice and technical assistance in various branches of investigation and to take charge of the museum. Each post under the Entomological Section of the Australian Council of Scientific and Industrial Research—F. L. McDougall, Esq., Australia House, Strand, W.C.2 (May 31). A professor of therapeutics, pharmacology, and materia medica, at University College, Galway—The Secretary, University College, Galway (June 15). A research chemist for work in connexion with fastness tests for dyed materials—The Secretary, Colour Supervisory Committee, British Research Association for the Woollen and Worsted Industries, Torridon, Headingly, Leeds. A lecturer in estate management subjects at the Royal Agricultural College, Cirencester—The Principal.

Our Astronomical Column.

COMETS.—M. Giacobini, who is already known as the discoverer of twelve comets, including two short-period ones, but whose name has not appeared in the list of discoverers since 1907, reports a new comet of the eleventh magnitude, the position of which on Mar. 17, at 22 h. 14 m. U.T., was R.A. 5 h. 50 m.; N. Decl. 14° 35′; rapid motion southward. It would appear that the discovery was made by photography, and that the image was not noticed for some days. It is to be feared that there may be some difficulty in locating the object, without more definite knowledge of its motion.

The following is the latest position to hand of Reinmuth's Comet (1928*a*), made at Babelsberg by G. Struve :

Mar. 19 d. 22 h. 19 m. 24 s. U.T., R.A. (1928·0) 9 h. 18 m. 28·60 s., N. Decl. 23° 35′ 5·5″.

Prof. A. O. Leuschner suggests the possible identity of this comet with that of Taylor (1916 I). There are considerable difficulties in accepting this, but it must be remembered that Taylor's comet divided into two portions, like that of Biela. This brings a measure of uncertainty into the forecasts of its motion. Mr. F. R. Cripps found next October as the probable date of perihelion of Taylor's comet (*B.A.A. Handbook*, 1928).

OSCILLATIONS IN THE PERIOD OF BETA LYRÆ.—Miss M. A. Blagg contributed papers on this star to the *Mon. Not. Roy. Ast. Soc.*, vols. 84 and 85 (1924 and 1925). These announced the detection of a long-period fluctuation in the time of minimum, taking more than nine years to complete its cycle. She contributes a further paper on the subject to the January number of *Monthly Notices*, in which she utilises additional material derived from observations by Rev. J. G. Hagen, Mr. E. F. Sawyer, and several members of the Variable Star Section of the B.A.A. The result confirms her previous conclusions, with slight alterations in the numerical values. Her formula for principal minimum is $2398590{\cdot}57 + 12{\cdot}908006\,E + 0{\cdot}000003914\,E^2$. On this is superposed a *B* wave given by $2407136{\cdot}12 + 6{\cdot}584\,E + 0{\cdot}00000308\,E^2$. It will be noticed that the period of this wave is nearly, but not exactly, half that of the main wave, and that both periods are increasing, as shown by the terms in E^2.

Allusion is made in the paper to a research by S. Tcherny in *Ast. Nach.* of May last, in which he finds by theory a fluctuation of 3439·543 days, which is within 3 days of Miss Blagg's period. His suggestion is that rotation is not quite synchronous with revolution, which produces a gradual change in the presentment at minimum. The research is a hopeful one for finding out more about the exact circumstances of this interesting star. Now that the phenomenon is known, observations can be made more systematic than before. They were sometimes missing at critical stages.

Research Items.

EXCAVATIONS AT THE HIPPODROME, CONSTANTINOPLE.—Mr. S. Casson in *Discovery* for March surveys the progress which has been made in the excavation of the Hippodrome at Constantinople in the two seasons since work was first begun. His task was complicated by the fact that the dimensions of the building were entirely unknown, and estimates by experts of its extent varied by hundreds of feet. All that was left visible were the three monuments down the centre, one of them the bronze serpent column which celebrated the Greek victory over the Persians at Platæa in 479 B.C., and was brought from Delphi by Constantine. It is interesting to note that an examination of these three monuments, of which two, the Column of Constantine Porphyrogenitus and the Serpent Column proved to have been used as fountains, revealed that the spina or dividing wall, which, it had been held, must run down the centre of the Hippodrome and upon which the monuments were supposed to stand, had no existence. In the Sphendone, the substructure at the end of the building, which was originally used for storing apparatus and animals for the games, were found twenty-five chambers, each opening out of a wide corridor which ran the length of the building. These in later and more troubled time were converted into cisterns for storing the water-supply, a purpose for which part is still used. The excavations here made it possible to determine the width of the building as 117·5 metres. Trial excavations to determine the length, brought to light a building which is probably the Baths of Zeuxippos. The total length was found to be 480 metres. A Turkish wall composed almost entirely of marble fragments from the Hippodrome furnished material from which it has been possible to reconstruct a general idea of what the Hippodrome looked like.

MILK PASTEURISATION AND THE TUBERCLE BACILLUS.—Many investigations have been made on the thermal death point of the tubercle bacillus in milk, but owing to the difficulty of obtaining satisfactory samples of naturally infected milk, a large proportion of the experiments have been carried out with artificially infected milk. Mr. L. J. Meanwell has recently conducted a research into the effect of pasteurisation in destroying the tubercle bacillus in naturally infected milk. It was found that a temperature of 62·8° C. (145° F.) acting for 30 minutes does not invariably kill the tubercle bacillus, though in most cases it is effective (*Jour. Hyg.*, vol. 26, p. 392; 1927). The temperature and time are those commonly employed in pasteurisation, but the apparatus used consisted of a vessel containing only about 1000 c.c. of milk, heated in a water-bath, and we still seem to lack experimental information of the efficiency of a *commercial* pasteurising plant for destroying the tubercle bacillus in naturally infected milk.

WEST AFRICAN MYRIAPODA.—Ralph V. Chamberlin has described the Chilopoda and Diplopoda collected by the American Museum of Natural History Congo Expedition (*Bull. Am. Mus. Nat. Hist.*, **57**, pp. 177-249; 1927). The west African Diplopod fauna is rich and varied and largely a distinct and peculiar one. As was to be expected, it proves to have little in common with the north African fauna, and it is also now certain that it has little similarity to the fauna of east and south Africa. With the exception of five species of widespread chilopods, no species are common to east and west Africa, and many of the west African genera are likewise peculiar, such as all those constituting the family Prepodesmidæ as well as many other polydesmoids and certain spirostreptoids. Noteworthy is the apparently complete lack in the west African fauna of any representatives of the Oniscomorpha, members of which are common in south Africa as well as in Asia and Australia.

HYBRIDS BETWEEN SPECIES OF UNIO.—When, two years ago, A. S. Kennard, A. E. Salisbury, and B. B. Woodward published (*Proc. Malac. Soc. Lond.*, vol. 16) the first part of their monograph on the "British Post-Pliocene Unionidæ," they described a form of Unio which in their opinion could only be a hybrid between *Unio pictorum* (Linn.) and *U. tumidus*, Retzius. All that was then known was that the specimen was British and had been in the possession of the well-known dealer, W. Rich. Since then the non-marine portion of the late P. B. Mason's collection has passed into the hands of A. S. Kennard and proved to contain a series of similar Unios coming from Repton Park, Derbyshire (*Proc. Malac. Soc. Lond.*, vol. 17), and since Mason was shown to have been in correspondence with Rich, there is no doubt as to the identity of the locality of the first described specimen. The interesting point is that whereas the two species are frequently found dwelling together, no case of hybridisation has hitherto been recorded. Out of the 89 specimens of Unio from Repton Park, 31 being normal *U. pictorum* and 25 normal, with 14 malformed *U. tumidus*, there were 19 hybrids. These last, whilst showing individually a mixture of the characters of the two parent species, could not be sorted out into classes, or analysed into Mendelian factors. The authors tabulate the varying combinations of characters in 15 of the examples and figure both these and the normal forms very fully on thirteen photographic plates, which they were enabled to do (in this as in the first part) by aid from the Government Publication Grant administered by the Royal Society. In an appendix, H. H. Bloomer describes the present condition of the locality. In both parts of their monograph the authors make an important departure in employing the internal characters of the shell instead of relying, as usually the case with other writers, on the extremely variable external form for purposes of distinction, whilst at the same time stressing the value of the umbonal ridges.

PRODUCTION OF POLYPLOID PLANTS.—The Solanum chimæras of Winkler, produced by cross-grafting, are well known. Some of these gave rise to tetraploid forms, but the latter were rare—only three among several thousand. Mr. C. A. Jorgensen (*Jour. of Genetics*, vol. 19, No. 2) has now found that the grafting is unnecessary and that tetraploid and occasional triploid shoots will appear when plants of various Solanum species are simply decapitated and allowed to regenerate. He points out the not infrequent occurrence of binucleate tissue cells in plants and attributes the origin of tetraploid shoots to the fusion of the two nuclei in such cells during mitosis, a process which he calls endo-duplication. Haploid *Solanum nigrum* has also been obtained by pollinating it with *S. luteum*. The sperms from the foreign pollen tubes enter the egg cell and there disintegrate, while the egg develops parthenogenetically. Apparently the number of chromosomes is usually doubled later in the embryo, for 28 diploid and 7 haploid plants of *S. nigrum* were obtained in this way, and a single true hybrid with *S. luteum*. The various heteroploid forms obtained are compared with each other morphologically, many of the differ-

ences, *e.g.*, in flower size, leaf-shape, and pollen grains, corresponding to those already known in polyploid Œnotheras and Daturas. Some of the work was done in conjunction with Mr. M. B. Crane. It is interesting that in the haploid *S. nigrum*, which has 36 chromosomes, these show some pairing in meiosis, such as occurs in triploid hybrids. This suggests that the hexaploid *S. nigrum* may have arisen as a hybrid between a diploid and a tetraploid species, which afterwards doubled its chromosomes.

SHORE LINE TOPOGRAPHY.—A striking phenomenon on the shores of many of the English lakes is the line of large boulders ranged along the water's edge with a remarkable uniformity of line. Their position has been explained as that of the heavy part of the detritus rolling down the slopes to the lake, which stops with the reduction of gradient on the beach. But in a lecture to the Royal Geographical Society on the shore topography of the English lakes on Mar. 12, Mr. T. Hay amplified this explanation, which he has found untenable in those lakes which have gentle slopes around them. A striking example is the western side of Ullswater between Glencoin and Gowbarrow. The boulders are clearly of glacial origin and are the remnants of a moraine of which the lighter materials have been carried away by wave action. Thus they are the rocky skeleton of a vanished strip of hillside, and so are regularly arranged on the beach. Another type of shore lake to which Mr. Hay directed attention is marked by rounded protuberances of boulder clay projecting into the water like delta fronts. They are, however, not deltaic in origin, but are due to the cutting action of the waves on stretches of boulder clay that have not been subjected to excavation by running water. At the mouths of streams, except where deltas grow, the coast lines tend to show great landward bites as the waves have an easier task in excavation.

SURVEY OF ST. KILDA.—Mr. J. Mathieson, who, with Mr. A. M. Cockburn, spent five months on St. Kilda last year while engaged in a survey of the island, has received the great compliment of having his work accepted by the officials of the Ordnance Survey, who have published his map of the main island and neighbouring islets as a sheet of the 6 in. to 1 mile map. The sheet shows as an inset the village and landing-place on the scale of 1/2500. Copies of the map are being distributed with the issue of the *Scottish Geographical Magazine* for Mar. 15, which contains an article by Mr. Mathieson on the group, accompanied by notes on the geology by Mr. A. M. Cockburn, the flora by Mr. John Gladstone, and the birds by Mr. Seton Gordon. The article is illustrated by a very fine series of photographs, those showing the magnificent cliffs of the island being particularly impressive. It gives an authoritative account of all the objects of interest in the group, and includes notes on the inhabitants, who now number 48 in all. Though the island is often visited during the summer season and has been the subject of various investigations, it has never before been surveyed accurately and in detail. It will be a source of general satisfaction in Scotland that this long-delayed survey has now been carried out entirely by unassisted individual effort, and yet with a care which has received official recognition and acceptance. The publication of Mr. Mathieson's photographs and description also add greatly to the value and interest of the map.

GEOLOGY OF BRITISH GUIANA.—A valuable contribution to our knowledge of the country north and south of the famous Kaieteur Falls has been made by Smith Bracewell in his "Report on the Preliminary Geological Survey of the Potaro-Ireng District of British Guiana" (*B.G. Combined Court*, No. 21/1927). The falls have a vertical drop of 740 feet at the head of a sixteen-mile gorge cut in the great scarp of the Kaieteur Sedimentary Series. The latter consists of shale, conglomerate, and sandstone, and lithologically the series can be matched with similar Brazilian beds ranging in age from Devonian to Triassic. In the absence of fossils no closer comparison is possible. The remarkable association of diamond-bearing alluvium with the edge of the scarp suggests that the diamonds are probably derived from the Kaieteur conglomerate. The whole region of the plateau is injected with thick sills and dykes of gabbros, norites, and dolerites which resemble the post-Triassic intrusions of Brazil. It has been thought that these may have been in some way responsible for the diamonds, but the associations of the latter do not support this view. They do, however, seem to have contributed to the gold resources of the district, for auriferous aplites occur which are specially rich near contacts with the later basic rocks. Below the escarpment the basement rocks, like those of the Brazilian shield, include a great variety of gneisses and schists and granites. Highly folded sedimentary formations trending north and south also occur. Economically, the study of the country justifies increased optimism as regards the mineral resources and their successful exploitation.

A WORK-METER.—Messrs. Lewenz and Wilkinson, Ltd., of 25 Victoria Street, S.W.1, have sent us a pamphlet describing their 'work-meter.' This instrument is an electrical recording mechanism which registers continuously by means of a 'time–space' graph the performance of any machine to which it is connected. The chart shows at any moment whether the machine is working at full output or not, while the complete chart enables the production efficiency of the machine to be computed. In this way an accurate record can be obtained of the working of every machine in the factory, and thus the engineer can control the speeds so as to get the maximum economy.

THE ESTIMATION OF FIREDAMP.—The most convenient method for the estimation of firedamp in coal mines is still the observance of the 'cap' which it produces on the flame of a safety-lamp. Different types of lamp show different heights of cap for the same amount of firedamp, and hence it is necessary to issue a series of pictorial reproductions of the flame-caps to be expected with any given type. Existing methods of obtaining these pictures have proved unsatisfactory and a new process is described in *Paper No. 37* of the Safety in Mines Research Board (London: H.M. Stationery Office). This method is photographic, the prints finally obtained being dyed a deep blue. The paper contains a number of reproductions of such photographs.

RARE EARTH MATERIALS AND ELEMENT NO. 72.—Since zirconium and thorium are closely related to element No. 72 (hafnium or celtium) and are frequently found in rare earth materials, it would seem probable that element No. 72 should also be present in these minerals. W. B. Holton and B. S. Hopkins have therefore examined the most soluble fractions of fractional crystallisations of materials of the yttrium group by X-ray analysis. These fractions contained most of the thorium and zirconium, but it was found that the concentration of element No. 72 was not greater than 1 part in 1000. Various rare earth materials, including gadolinite from Norway, were

also investigated by photographing their arc spectra, but only in one case were indications of the presence of hafnium found.

THE SEPARATION OF OIL FROM CONDENSATION WATER BY ELECTROLYSIS.—Most of the oil which is used for the lubrication of steam pistons and gearing is atomised and carried away in the waste steam. This causes a milky emulsion, which is very stable, to form on the condensed water. Even after standing a long time the separation of the oil from the water is very imperfect. Were it not for this, it would be equal in quality to distilled water, and would be most useful for manufacturing purposes as well as for feeding the boiler. Mechanical oil separators are only moderately successful, and when the condensed water is used for the boiler, appreciable quantities of oil pass into it. With hard water this combines with the boiler scale to form a solid mass which settles on the walls of the boilers and leads to overheating of the plates. In *Helios* for Jan. 29, Fritz Hoyer describes how electrolysis has been successfully employed to purify condensed water. A direct electric current passes through the water, collects the oil in foamy flakes, destroying the emulsion, and so renders filtration possible. The consumption of energy is about one kilowatt hour for five cubic metres of water. The apparatus is automatic, no special attendance being required.

POZZOLANAS.—*Bulletin No. 2* of the Building Research Station of the Department of Scientific and Industrial Research (London: H.M. Stationery Office) deals with the subject of pozzolanas. A pozzolana is a substance which is mixed with lime mortar in addition to, or in partial substitution for, sand, in order to increase the strength of the mortar. To achieve this, the pozzolana must be capable of combining with hydrated lime in the presence of moisture to form insoluble compounds which act as cements. The use of such substances was the so-called secret of the old Roman builders, and Vitruvius mentions the use of volcanic ash for this purpose. Other suitable natural materials are trass, a volcanic rock found in Germany, and various forms of diatomaceous earth (such as kieselguhr) or 'celite' as it is termed in the United States. Artificial pozzolanas are also employed, the more important being burnt clay, granulated slag, certain clinkers, and spent oil shale. The pozzolana reacts with the lime to form insoluble silicates and aluminates and hence pozzolanic mixtures can set under water, and in the absence of carbon dioxide, the presence of which is essential for the hardening of ordinary mortars. Such mixtures are also more resistant to sea water and acid, but the time required for effective setting varies enormously according to the nature and degree of fineness of the pozzolana.

NITROGEN FIXATION.—Prof. G. Senn, of Basle, has published a very useful review of the work on which our present knowledge of the assimilation of atmospheric nitrogen by lower plants is based (*Biol. Reviews*, vol. 3, No. 1, 1928, and also in *Verh. d. Schweiz. Naturf. Gesell.*, Jahresversammlung 108, 1927). One merit of the work is that it takes account of several continental researches not often cited in British lists of references on the subject. Besides the well-known free-living and symbiotic bacteria which fix free nitrogen, attention is directed to several species of fungi which perform the same function. The number of known forms of these nitrogen-fixing fungi has been increased by the work of some of Dr. Senn's pupils. Some controversial points regarding the energy relations of nitrogen fixation emerge from this paper. From the data of Ternetz and others, nitrogen fixation is regarded as a function requiring free energy, which can be procured by the respiration of large quantities of carbohydrates. Recently, the energy relations of nitrogen fixation have been carefully worked out by Dean Burk, and his results are published in a paper not noted by the present author (see *Jour. Gen. Physiol.*, vol. 10, No. 4). Burk finds that fixation of nitrogen even with liberation of energy will take place if either oxygen or hydrogen or other substances, the standard free energies of which are close to zero, are involved in the formation of either nitrates, ammonia, or other compounds. It is pointed out that there are two, and only two, general conditions where nitrogen fixation can require energy. These are, first, if nitrogen reacts with some compound like water with an already high negative free energy of formation and where negligible oxidation of nitrogen takes place; secondly, if the metabolism of the plant is not carried on at the concentrations where the process would yield free energy.

THE PRESSURES PRODUCED BY ELECTRIC ARCS IN CLOSED VESSELS.—A paper (No. 39) by G. Allsop and R. V. Wheeler, published by the Safety of Mines Research Board (London: H.M. Stationery Office), describes the results of experiments on the pressures produced by arcing in closed vessels during switching operations. When a disruptive electric discharge occurs, a pressure wave or pressure pulse is undoubtedly produced. But as disruptive discharges in air at voltages less than 350 are impossible, it was of importance to find out whether the arcs formed when breaking the circuit necessarily produced a pressure wave. In the first set of experiments the enclosure had a volume of 10·8 cub. in., the supply voltages varied from 220 to 260, and the currents from 12 to 136 amperes. The mean power expended in the arc varied from 0·38 to 5·88 kilowatts, and its duration from 0·4 to 0·6 of a second. The pressure in pounds per square inch increased fairly regularly with the power from about 1 to 12. Experiments with a voltage of 570 and with alternating voltages were also made. The results show that with voltages up to 250 and currents up to 200 amperes, no pressure wave could be detected. With 1350 amperes at 575 volts, no pressure wave was detected by a manometer situated six inches from the arc. Dangerous pressures are only produced when the arcing is prolonged. For example, a $\frac{3}{4}$-in. arc lasting for half a second gave rise to a pressure of 140 lb. per square inch. It is also clearly shown by the experiments that when alternating currents are used, the arcing effects are much less severe. Dangers from rise of pressure as the result of arcing are much greater with direct than with alternating currents.

THE NATURE OF ACTIVE NITROGEN.—Further information concerning the nature of active nitrogen and obtained by a study of the synthesis of ammonia from the elements is described by B. Lewis in the *Journal of the American Chemical Society* for January. It can be shown that the formation of ammonia from mixtures of unactivated nitrogen and atomic hydrogen, activated nitrogen *molecules* and atomic hydrogen, or active nitrogen and unactivated hydrogen, involves more than two successive and selective collisions. With *atomic* nitrogen and atomic hydrogen only two collisions would be required: $N + H = NH$; $NH + H_2 = NH_3$. The results obtained appear to show that ammonia is formed only when active nitrogen and atomic hydrogen are mixed, and, with the assumption that no tri-atomic hydrogen is present, it is inferred that active nitrogen contains atomic nitrogen.

Vitamin B.

ALTHOUGH our knowledge of the constitution and nature of vitamin D is greater than our knowledge of the chemical composition of the other accessory factors, recent work suggests that it will not be long before it has advanced to a comparable stage. Progress has been particularly striking in the case of vitamin B, and has followed two lines: the physiological function of this compound in the animal economy has been investigated by a number of observers, whilst at the same time much information has been obtained as to its chemical nature and properties.

In this connexion the most important recent development is the confirmation of suggestive previous researches, which indicated that the substance which we call 'vitamin B,' consists of at least two compounds with different chemical properties and different physiological functions. In this point vitamin B is following the example set by vitamin A, and although at first sight this splitting of a compound of unknown chemical constitution into two similarly unknown bodies may seem to hamper further advances, yet the opposite is probably more nearly true, at any rate if we may take the differentiation of vitamin D from vitamin A, followed by the early recognition of the sterol nature of the former, as an example of what may be expected to occur in the future in the case of vitamin B.

Our present knowledge indicates that deficiency of vitamin B in the diet is associated with human beriberi and pellagra and avian polyneuritis: the latter disease is usually held to be the equivalent of human beriberi. The association of pellagra with deficiency of vitamin B has only recently been conclusively demonstrated by Goldberger and his co-workers. How a deficiency of the vitamin produces symptoms is not known, although many suggestions, based on experimental work, have been made. Recent investigations into its physiology have included both a direct attack on the problem and also an examination of its relationship to the three chief classes of foodstuffs, the proteins, fats, and carbohydrates, in the diet.

J. C. Drummond and G. F. Marrian (*Biochem. Jour.*, vol. 20, p. 1229; 1926), after a scrutiny of the literature, found that the only definite function attributed to vitamin B was that of stimulating tissue oxidations, based on a decrease in oxidative power of the body in conditions of vitamin deficiency. In a series of experiments the authors investigated this alleged function and definitely demonstrated that vitamin B bears no relationship to tissue oxidations. Thus muscles obtained from pigeons or rats suffering from vitamin B deficiency, decolorised methylene blue under anærobic conditions to the same extent as the equivalent muscles from normal birds or animals: and the oxygen consumption of pigeon breast muscle or liver was the same, whether the tissue had been obtained from normal birds or from those suffering from polyneuritis. The oxygen consumption of rats kept on a complete diet was compared with that of animals kept on a vitamin B deficient diet, and no difference between the two was detected until the rats in the latter group were almost moribund: for these experiments the animals were lightly anæsthetised with amytal to eliminate variations in the oxygen consumption due to movements and placed in a modified form of the closed-circuit type of apparatus for estimating the respiratory exchange.

Now the early symptoms of vitamin B deficiency in the animals used by Drummond and Marrian are loss of appetite, constipation, and lassitude: the last stage of lowered body temperature, laboured respirations, inco-ordination of the hind limbs and convulsions only lasts about twenty-four hours, and the fall in oxygen consumption is only observed when the body temperature has fallen below 33° C: if the animal is warmed up, the body temperature and the oxygen consumption return towards their usual level, with a temporary improvement in the animal's condition. These effects, however, are not peculiar to vitamin B deficiency itself, but occur in animals starved completely of food or kept undernourished on a complete diet, the fall in body temperature and oxygen consumption occurring as above as a terminal event.

The conditions of starvation and vitamin B deficiency also produce similar effects on the blood sugar, which is raised from 0·082 per cent. to 0·125 per cent. during the earlier stages of the experiment but falls to 0·02-0·03 per cent. with the fall in body temperature. From these experiments the authors conclude that the relationship between vitamin B and appetite is the most important factor in producing the results observed, and that oxidation processes are normal in vitamin B deficiency: the majority of the symptoms are due simply to starvation, following the loss of appetite. That the oxidation processes of the body are normal in vitamin B deficiency, except when starvation enters into the picture, has also been shown by B. A. Lavrov and S. M. Matsko (*Jour. de Biol. et de Méd. Experiment*, No. 9, p. 71; 1926).

Since pigeons have so often been used for experimental work on vitamin B, Drummond, working with S. K. Kon, has investigated the relationship of the symptoms of vitamin B deficiency to those of simple undernutrition in these birds also (*Biochem. Jour.*, vol. 21, p. 632; 1927). Each bird on the vitamin-deficient diet was controlled by another, which was only given to eat as much food as the former had consumed during the previous twenty-four hours, but was provided daily also with a liberal supply of vitamin B: in this way it was hoped to differentiate between the symptoms due to vitamin B deficiency and those due to simple undernutrition.

Of all the various symptoms observed by Drummond and Kon in these experiments, only the loss of appetite and the nervous symptoms appeared to be specifically caused by absence of vitamin B from the diet. Nervous symptoms appeared in 79 per cent. of the birds within a month, and in 47 per cent. a temporary spontaneous improvement was noted (Kon, *ibid.* p. 834): in these experiments the birds were kept on a synthetic diet of the type used in experiments with rats: on a polished rice diet, 60 per cent. developed symptoms, which were speedily followed by death, no remissions being observed. The failure of appetite is associated with delay in the emptying of the crop: if forcibly fed, the crop still fails to empty normally, and the major portion of the food is vomited, so that the birds obtain no more nourishment than if left to feed themselves. The authors offer as explanation of the temporary improvement of the symptoms in so many birds on a synthetic diet, the suggestion that the convulsions in some way liberate vitamin B from the tissues and so make it available to subserve its function in nutrition.

The cause of the nervous symptoms is obscure: the organic lesion can only be slight, since injection of a preparation containing the vitamin will restore a pigeon to a normal condition in a few hours. The characteristic head retraction in this bird bears some resemblance to the forced movements or attitudes which can be obtained by stimulation of the labyrinth or its central connexions, but the nervous symptoms occur in birds in which the labyrinth has been

destroyed (L. A. Tscherkes and T. M. Kuperman, *Jour. Biol. et Med. Exper.*, No. 8, p. 13; 1926). Nervous lesions demonstrable histologically have been described in both birds and rats. In the fowl, P. G. Culley (*Quart. Jour. Exp. Physiol.*, vol. 17, p. 65; 1927) has found that the myelin sheath of the affected nerves shows irregular swelling and fragmentation, but that the axis cylinder is not affected until polyneuritic symptoms appear: the changes resemble those occurring after section of a nerve, except that the alteration in the axis cylinder is considerably delayed. In the rat, H. H. Woollard (*Jour. Anat.*, vol. 61, p. 283; 1927) has only found lesions in the nerve-endings, both sensory and motor, of the voluntary muscles and in the intramuscular nerve fibres: they take the form of swelling of the nerve endings and fragmentation of the myelin in the sheaths of the nerve fibres, but the nerve axons remain intact. Similar, but less generalised, lesions occur in animals starved for a few days, and they can still be found even if vitamin B has been administered during the period of starvation. No lesions were observed in any other parts of the nervous system, central or peripheral.

It appears, then, that the lesions observed cannot be directly the cause of the symptoms, since they are too extensive to be abolished in a few hours, but they probably lead to a change in the axis cylinders or nerve-endings not demonstrable by present histological technique, which can be prevented or cured by administering the vitamin: the position is, however, rendered obscure by the fact that similar gross lesions are observed in starvation, and it is possible that starvation rather than vitamin B deficiency *per se* is the primary cause of both lesions and symptoms, the appearance of the latter, however, depending on the length of time the animal can live on the deficient diet, as compared with the short duration of a complete starvation experiment.

The actual amount of the vitamin required in the diet depends both on the diet and on the physiological condition of the animal. Thus Gladys A. Hartwell has shown that the rat requires about four times more vitamin B in the diet when rearing young than for growth or reproduction (*Biochem. Jour.*, vol. 19, p. 1074; 1925), whilst Drummond and Plimmer and their co-workers have demonstrated a relationship between the amounts of some of the other constituents of the diet and the vitamin B, which must be adhered to if optimal conditions for growth and maintenance are to be obtained (J. C. Drummond with Vera Reader, *ibid.*, vol. 20, p. 1256; 1926: and with A. Hassan, vol. 21, p. 653; 1927: R. H. A. Plimmer, J. L. Rosedale, and W. H. Raymond, *ibid.*, vol. 21, p. 913).

It is well known that the onset of symptoms of polyneuritis in birds is earlier in those which consume more of the deficient diet, and in those kept on a diet consisting chiefly of corbohydrates, whilst the onset is latest when the chief constituent of the diet is fat. Using young chicks or ducks, and, in the case of the carbohydrate diets, pigeons and rats also, Plimmer and his associates have succeeded in demonstrating a definite dependence of the vitamin B content of the diet upon the amounts of the other three chief constituents present if maximal growth and health are to be obtained.

The plan of the experiments was to feed diets consisting chiefly of protein, fat, or carbohydrate, together with salts and vitamins, and vary the relationship of the vitamin B to the main dietary constituent until satisfactory growth was obtained. The authors found that the ratio of dried yeast (as source of vitamin B) to the total calories in the diet was a constant and varied from 1 : 40 in the case of the chick, for a predominantly fat or carbohydrate diet, to 1 : 80 in the pigeon and 1 : 160 in the rat. Young animals require more than adults. The authors advance the suggestion that vitamin B is a constituent of the nucleus of every cell (perhaps a pyrimidine or purine compound), and thus the amount required depends on the total metabolism of the animal.

Drummond, working with rats, has observed that the ratio between the protein content and the yeast extract of the diet must be in the neighbourhood of 5, if growth is to be normal: with ratios of 18, growth was poor. He was unable to trace any relationship between the calories or the carbohydrate of the diet and the vitamin B content, thus failing to confirm the conclusions to which Plimmer was led by his experiments. The diet used by the latter for his rats contained no less than 94 per cent. of white flour, 5 per cent. fishmeal and 1 per cent. cod-liver oil completing it together with varying amounts of yeast extract: in none of Drummond's diets was the starch, as source of carbohydrate, higher than 70 per cent., nor did the protein content, in these experiments, caseinogen, fall below 20 per cent.: cod-liver oil, salts, lemon juice were also added, together with varying amounts of yeast extract, whilst fat sometimes replaced starch to increase the caloric value of the ration: in these differences between the diets used may lie the explanation of the somewhat different conclusions of the two observers.

That vitamin B really consists of two separate substances has been suggested by a number of different observations, but only recently has this differentiation become an established fact. Harriette Chick and Margaret H. Roscoe (*Biochem. Jour.*, vol. 21, p. 698; 1927) describe the two factors as the 'antineuritic,' which prevents polyneuritis in birds and paralysis in rats, and the 'pellagra-preventive' (of Goldberger), which prevents pellagra in rats, both together forming the water soluble vitamin B and both being necessary for normal growth. In a review of the literature, the authors point out that the two factors show certain differences in distribution; *e.g.* the antineuritic predominates in wheat embryo, but the antipellagrous in milk, meat, green leaves, etc., and that the antineuritic is more easily destroyed by a temperature of 120° C. and is more soluble in certain organic solvents such as alcohol, acetone, or benzene. In their experiments, the authors have confirmed the work of Goldberger and his associates on this subject.

The experiments were carried out on rats maintained on a synthetic diet: various preparations of yeast and wheat embryo were used as sources of the vitamins. On the basal diet alone, the animals died in a few weeks, usually without developing any symptoms: administration of dried yeast then permitted of growth and prevented death: if the yeast were first autoclaved, the animals died just as on the basal diet alone: if an alcoholic extract of yeast were given, the animals lived for some time, but without growth, and ultimately developed the symptoms of pellagra, characterised by ophthalmia, loss of fur, and dermatitis of the ears, paws, and neck. This condition could be cured, and at the same time growth restored, by the administration of autoclaved yeast. It is thus clear that the alcoholic extract of yeast contains the antineuritic factor, and the autoclaved yeast only the antipellagrous: growth occurs only when both are present together. The authors also confirmed the observation that wheat embryo contains mainly the antineuritic factor.

Hassan and Drummond have obtained similar results in their experiments (*loc. cit.*); thus rats kept on a high protein, low yeast, diet failed to grow satisfactorily until additional autoclaved yeast was added to the diet: but if only autoclaved yeast was used,

growth again failed to occur, but could be produced by the administration of small amounts of an alcoholic extract of yeast. The balancing of the protein in the diet appeared to be the function of the thermostable factor.

With this differentiation of vitamin B into two parts, greater knowledge of the chemistry of this vitamin should be soon obtained. Some light is thrown on the chemical nature and properties of the antineuritic factor by recent work by H. W. Kinnersley and R. A. Peters (*Biochem. Jour.*, vol. 21, p. 777 ; 1927, and by U. Suzuki and Y. Sahashi in Japan (*Scientific Papers, Inst. Physic. and Chem. Res.*, vol. 4, p. 295; 1926, and vol. 5, p. 191; 1927). Kinnersley and Peters have purified their yeast extract ('torulin') until only 0·15-0·3 mgm. per day is necessary to cure polyneuritis in pigeons.

The methods of extraction and purification used are briefly as follows: Yeast autolysed for three days at room temperature is extracted twice with boiling water: the combined filtrates are treated with neutral lead acetate, the precipitate removed and the filtrate treated with baryta. On filtration, a crystal clear yellow fluid is obtained containing 6000 doses of torulin from 14 lb. yeast. The barium is removed as sulphate and the filtrate treated with acid mercuric sulphate: after removal of the precipitate the reaction is adjusted to *p*H 7·0 and purified 'Norite' charcoal added. The charcoal adsorbs the torulin, which can be removed from it by extraction with hot 0·1 *N* hydrochloric acid, or with acid alcohol. About 60 per cent. of the torulin contained in the baryta filtrate is recovered. For prolonged feeding experiments, it is advisable to omit the mercuric sulphate stage: the solution can be cleared by 'Norite' charcoal, provided the *p*H is at 2·5, since at this reaction the torulin is not adsorbed, but remains in solution. Further purification may be affected by a prolonged alcohol fractionation, following removal of any traces of metals with hydrogen sulphide.

The purified material contains 15-25 per cent. nitrogen: it is soluble in absolute ethyl alcohol, but is not adsorbed on 'Norite' charcoal, like the impurer preparations, so that adsorption must be a property conferred on the torulin by some accompanying impurity. The Pauly reaction becomes less intense as the material is purified. The authors identify torulin with the thermolabile growth factor and consider that it is probably the same as the anti-beriberi vitamin. In view of the work previously discussed, the opinion that the antineuritic, antiberiberi, and thermolabile growth factors are the same substance appears to be justified at present, although future work may show the necessity of differentiating between them.

The Japanese workers have obtained a substance, which they call 'Oryzanin,' from rice-bran or yeast, which cures polyneuritis in pigeons in doses of about 5 mgm. The material was obtained from an alcoholic solution of rice-bran, by precipitating impurities with lead acetate and the active material with phosphotungstic acid, followed by silver nitrate. When boiled with dilute acids, the substance was split into glucose, choline, nicotinic and 2·6-dioxychinolin carboxylic acids. The latter has been found to have a stimulating effect upon the growth of yeast, whilst a closely related compound, 2·6-dioxychinolin hydrochloride, in doses of about 7·5 mgm. daily, injected intramuscularly, cures the polyneuritis of pigeons, but has no influence on their weight. The authors consider that these compounds are closely related to the active principles contained in rice-bran: caution must be exercised, however, in accepting this conclusion, since the substances isolated might be contaminated with minute traces of a very highly active compound, in the same way as the activity of irradiated cholesterol has been shown to be due to contamination with small amounts of ergosterol, the latter only being converted into vitamin D on irradiation.

The work reviewed above offers hope that the designation 'vitamin B' will soon have to be discarded in favour of the proper names of well-defined chemical compounds, and that their isolation will be followed by their synthesis in the laboratory.

Biology of the Gulf of Mannar.

THE recent *Bulletin* of the Madras Government Museum, edited by the Superintendent (The Littoral Fauna of Krusadai Island in the Gulf of Mannar. New Series. Natural History Section, vol. 1, No. 1. 1927. P. 196. Madras: Government Press. 8 rupees), is the first issue of a new series of Madras Government publications on the natural history of animals and plants, as distinct from a general section dealing with archæology, anthropology, and allied subjects. The treatment of the subject in this number is one intermediate between a text-book and a specialist's monograph. Descriptions of many common species of invertebrate animals found on Krusadai Island in the Gulf of Mannar and in neighbouring localities are given. The classification followed is either that of the "Oxford Zoology" or of the "Cambridge Natural History." A new genus is described, Pseudocaprellina, in the suborder Caprellidea. There are two appendices, the first on the vertebrate fauna and the second on the flora of the island.

The various authors, among whom Dr. F. H. Gravely and Dr. B. Sundara Raj are prominent, have adopted a useful system of describing the common species, of which no up-to-date account exists within the reach of the Indian student. They have illustrated their papers well and given good lists of literature under each group. This publication will be valuable to students not only as a preliminary guide to the fauna and flora of the Island, but also as a stimulus to collecting and to subsequent research in the biological world of India.

The southern side and the eastern part of the northern side of the Krusadai Island are entirely sandy; the western part of the northern shore is very muddy and fringed with mangroves. A salt marsh, bounded on its southern and eastern sides by high sand dunes, extends from the northern shore across the whole width of the island, a little to the east of the middle. Tolerably fresh water can be obtained from shallow pits dug in the sand. Swarms of anopheline larvæ have been found, but no mosquitoes have been seen in September or in April-May.

From this island there is an easy approach to collecting grounds in Shingle Island, Kutikāl Point on Rāmēswaram Island, Pāmban Channel, and Rāmēswaram. Shingle Island gives ample opportunities for observing corals in their natural surroundings; Kutikāl Point is a good place for collecting medusæ and other pelagic forms; the Pāmban Channel is extraordinarily rich in hydroids, polyzoa, ascidians; and Rāmēswaram is interesting, as its fauna is very different from anything yet found in the immediate neighbourhood. With such surroundings and the prospects of the establishment of a Marine Biological Station in Krusadai Island, there is every hope that much information of interest on tropical marine life will be forthcoming in the near future.

University and Educational Intelligence.

EDINBURGH.—Dr. A. E. Cameron, professor of zoology and entomology in the University of Saskatchewan, has been appointed lecturer in medical entomology in the Department of Zoology as from Oct. 1 next.

LIVERPOOL.—The University will celebrate the twenty-fifth anniversary of its Charter on May 10 and 11, when honorary degrees, including the following, will be conferred:—D.Litt.: Lord Crawford and Balcarres, Chancellor of the University of Manchester, for eminent services to art, literature, and education; Prof. T. Percy Nunn, professor of education in the University of London and principal of the London Day Training College, for distinguished contributions to philosophy and education. D.Sc.: Prof. J. E. Littlewood, Rouse Ball professor of mathematics in the University of Cambridge, for distinguished contributions to mathematical science; Prof. Robert Robinson, professor of organic chemistry in the University of Manchester, for eminence as an organic chemist. LL.D.: Mr. William M. Childs, Vice-Chancellor of the University of Reading, for eminent services to university education in England; the Right Hon. H. A. L. Fisher, Warden of New College, Oxford, for his distinction in scholarship and his services to education in England; Prof. J. W. Gregory, professor of geology in the University of Glasgow, for distinguished services to geology, geography, and exploration. D.Eng.: Prof. J. A. Fleming, emeritus professor of electrical engineering at University College, London, for distinguished services in the advance and application of electrical science.

LONDON.—As from the beginning of the session 1928–29, in place of the existing Department of Philosophy and Psychology at University College, a Department of Philosophy and a Department of Psychology have been instituted. Prof. C. E. Spearman, now Grote professor of philosophy of mind and logic, will be head of the Department of Psychology, his title being changed to professor of psychology in the University of London.

The title of assistant professor of mechanical engineering at University College has been conferred on Mr. B. J. Lloyd-Evans.

The following doctorates have been conferred: D.Sc. in Anatomy on Mr. W. E. Le Gros Clark, University professor of anatomy at St. Bartholomew's Hospital Medical College, for a thesis entitled "On the Anatomy of the Pentailed Treeshrew (*Ptilocercus Lowii*)"; D.Sc. in Biochemistry on Mr. F. W. Fox (Imperial College—Royal College of Science), for a thesis entitled "Some Studies in Sterol Metabolism"; D.Sc. in Chemistry on Mr. R. W. E. B. Harman (University College), for a thesis entitled "Aqueous Solutions of Sodium Silicates"; D.Sc. in Mathematics on Mr. R. G. Cooke (University and East London Colleges), for a thesis entitled (1) "On the Theory of Schlömilch Series," (2) "Gibbs's Phenomenon in Fourier-Bessel Series and Integrals," (3) "The Inversion Formulæ of Hardy and Titchmarsh"; D.Sc. in Statistics on Mr. John Wishart (University College), for a thesis entitled "1. On the Approximate Quadrature of Certain Skew Curves, with an Account of the Researches of Thomas Bayes. 2. The Generalised Product Moment Distribution in Samples from a Normal Multivariate Population."

The Petrie Medal for distinguished work in archæology has been awarded to Sir Aurel Stein.

OXFORD.—The outgoing Senior Proctor, Mr. E. Ll. Woodward, of All Souls', in the customary oration delivered on the expiry of his year of office, took occasion to remark on the scanty attendance at "the very centre of our self-governing society, the Congregation of the University." The younger masters, as he truly said, are rare visitors to this assembly. A remedy might be found if a time were allowed for questions. Speaking of the spaces in the Parks taken up by the rightful claims of the new sciences, he suggested that by way of compensation a new garden and plantations might be laid out in the University's land on the other side of the Cherwell.

ST. ANDREWS.—Dr. J. C. Earl has been appointed to the chair of organic chemistry, pure and applied, in the University of Sydney, in succession to Prof. Kenner. Dr. Earl, who has lectured on organic chemistry in the University since 1922, has conducted investigations on fibrous materials, essential oils, and other products of Australian origin.

AN interesting exhibition was held at the Battersea Polytechnic on Friday and Saturday, Mar. 23 and 24, when the institutes concerned with continued education in the Battersea and Wandsworth areas held a combined exhibition, showing the work done by their students and the facilities offered for such work. The exhibition was opened by Lord Riddell, and the chair was taken by Mr. Alexander Glegg, vice-chairman of the governing body of the Polytechnic. In a short address, Lord Riddell referred to the increasing importance of technical education as related to industry, and the vital need for the nation as a whole to realise that success and happiness can be achieved only by hard and regular work. After the inaugural meeting, the guests spent a considerable time in going round the various exhibits, and were not slow in expressing their astonishment at the nature and scope of the instruction obtainable in the various institutes of the district. The whole of the Polytechnic was open for inspection, and the work shown included engineering, woodwork, building construction, chemistry, physics, hygiene and physiology, art and crafts, domestic science, elocution and dramatics, music, physical training, and many other branches of education. A pleasing phase of the exhibition was the keen interest shown by the many hundreds of young people of both sexes who attended.

INDUSTRIAL Education in 1924–1926 is dealt with in a *Bulletin*, No. 29 of 1927, of the United States Bureau of Education, which will be read with interest in Great Britain in connexion with the Emmott Committee's report, recently published, on the relationships of technical education to other forms of education and to industry. Among other outstanding features of education in America are mentioned: a growing tendency to discriminate more effectively between manual arts courses and vocational courses, with a growing recognition of the former as a part of general education; marked increase in the number of schools offering some form of apprenticeship work, occupational information courses and systematic vocational guidance; increase in the use of the kinematograph and other visual aids in industrial schools; development of itinerant teachers' courses in manual arts and agricultural engineering in rural districts; rapid increase of a new type of organisation, known as the general shop, for teaching elementary work in a number of more or less related activities, such as wood-work, electrical plant, automobile repairing, forging, machine shop, and mechanical drawing; continued change in the emphasis of instruction in manual arts courses from skill in the use of tools and machinery to general elementary, fundamental, manipulative abilities.

Calendar of Customs and Festivals.

April 1.

ALL FOOLS' DAY.—The custom of sending anyone on a fruitless errand and consequently exposing them to ridicule, sometimes erroneously stated to be confined to England, though it occurs also in Continental countries, especially in France, Germany, and Sweden, has been variously explained as a survival of Roman festivals on which special licence prevailed, as a memory of the mockery of Christ by the Jews, or even as a memorial of the bootless errand of the first dove sent from the Ark by Noah. An etymology of 1656 explains the French phrase for April Fool—*poisson d'Avril*—as a corruption of Passion, connecting it with the manner in which Christ was sent from authority to authority before the crucifixion. The custom may be connected with the festival of the vernal equinox in the Celtic year, and it has been compared to the festival of that date in India which is traced to the ancient Persian calendar.

PALM SUNDAY.—The carrying of boughs in procession in church in commemoration of our Lord's entry into Jerusalem was one of the ceremonies specially exempt from the liturgical reforms of Henry VIII., although it was intermitted under Edward VI., and always abhorred by the stricter Protestants on account of its 'superstitious' character. This was due not only to the practice of hallowing the palms, but also to a number of beliefs and practices, many more probably popular than ecclesiastical in origin. In Roman Catholic countries and in England before the Reformation, box was the usual substitute for the palm. In the Domesday survey, a supply of box twigs on Palm Sunday was a condition of tenure of one of the Shropshire farms. Later, willow branches with their catkins, which are usually in flower, have generally been used, and the willow in bud is still called 'palm' in popular diction.

The palm used on Palm Sunday had special virtues. Barnabe Googe, in describing the procession of the wooden figure on a wooden ass, speaks of the people throwing branches before and on both the figure and the ass on its way to, and in, the church, which they then snatched up because of their special virtue. The use of the ashes of the previous year's palm on Ash Wednesday has already been mentioned. The custom of roasting eggs in the palm ashes was condemned in the Protestant Church. It was a belief of more than popular currency that the ashes were a sovereign remedy for disease, especially ague and worms. Roman Catholics carried small crosses made of palm in their purses, and at Little Colan, Cornwall, on Palm Sunday crosses of palm were thrown into Lady Nant's well and an offering made to the priest. If the crosses sank it betokened the death of the inquirer before the year was out.

Among the English peasantry, Palm Sunday was made an occasion for rejoicing, not only in the cutting and bringing in of the palms during the week before the actual day, but also on the day itself. At Kimpton in Hertfordshire it was an ancient custom to eat figs on this day, which was known as Fig Sunday, and to keep wassail, and there are several records beside that of Barnabe Googe, that after the Church procession boys sang and collected money, bread, and eggs from the people in the town or neighbourhood. Its possible connexion or confusion with an agricultural festival is shown by the fact that Mothering Sunday in Wales was celebrated on Palm Sunday.

April 5.

MAUNDY THURSDAY.—The day for the distribution of royal alms at Westminster, which in earlier days took the form not only of a dole but also of the washing of the feet of a number of poor persons by the reigning monarch, and sometimes of poor women also by his consort. In number originally 13, they were afterwards made to correspond with the years of the king's reign or of his life, as is first recorded of King John. In the earliest records of the custom, it was performed by the head of a monastery, the number of people equalling the number of monks. It is not confined to England, but is a custom of the Roman Catholic and the Greek Church, the ceremony being performed by the Pope and the reigning monarchs of the respective countries.

SHERE THURSDAY, an alternative name, probably refers to its character as one of the days of special solemnity in Holy Week, Shere being a mis-spelling of *Chare*, from Old German *Char*, although there is an explanation of some antiquity that on this day the hair and beard were cut to mark the end of Lent and as a preparation for the Easter festival.

In the Highlands of Scotland, if the stock of seaweed used as manure obtained by this day was still inadequate, a pot of porridge prepared with butter and other rich ingredients was taken to the shore and a portion poured into the sea from each headland with incantations.

April 6.

GOOD FRIDAY, OR GOD'S FRIDAY.—Certain special observances were enjoined upon the king as head of the State. He crept to the cross, which was laid upon a carpet, and kissed it. It was also the custom for him on this day to hallow a number of the rings called 'cramp rings'—a remedy for fits.

Cakes or small loaves of bread baked on Good Friday morning had certain special virtues. They were not intended to be eaten, but were put by until the next year. Fragments grated into water were sovereign remedies for certain ailments. The custom of marking this bread with a cross has been derived from the custom of the Greeks and Romans of marking their bread with crosses and intersecting lines. In the north of England a pudding containing leaves of the passion dock (*Polygonum bistorta*) was an indispensable dish.

In the Isle of Man and in the Highlands there was a special taboo on the use of iron on this day. In the Isle of Man no iron must be put in the fire; in the latter locality no iron was to enter the ground, and if a burial had to take place on this day, the grave was opened the day before and the earth replaced over the corpse with a wooden shovel.

According to an observer in about the year 1810, the sailors of South African and Portuguese ships in the London docks hanged a clothed wooden figure of Judas Iscariot to the rigging. On their return from church they lowered it to the deck, and dipped it in the dock three times. It was then beaten by all members of the crew until no clothes remained on its back.

April 7.

EASTER EVE.—On this day the paschal taper was lighted with flint and steel. In various parts of England, boys played games with hard-boiled eggs as balls and marched in procession with torches. In Ireland the day was made an occasion for feasting, and at 12 o'clock at night Lent was driven out with clapping of hands and shouts. Before dawn, everyone went out to see the sun dance in honour of the Resurrection. All clothes should be new for Easter, to ensure good luck.

Societies and Academies.

LONDON.

Geological Society, Mar. 7.—**Hilda K. Cargill, L. Hawkes, and Julia A. Ledeboer**: The major intrusions of south-east Iceland. The main plutonic intrusions into the Tertiary plateau-basalts of Iceland were discovered some forty-five years ago in the south-east of the island, but little is known of their field-relations or petrology; the present paper summarises the results obtained on summer visits to the more accessible localities. The outcrops are scattered; the largest one (the Slaufrudal Stock) is elongate in plan, and its area covers $1\frac{1}{2} \times 4\frac{3}{4}$ miles. The relationship of intrusives to country-rocks is a discordant one, the intrusions being stocks with steep-sided walls and domed roofs (not laccoliths as formerly suggested). The elongation of the stocks is parallel to the strike of the regional dykes, and intrusion clearly took place under, and was facilitated by, crustal tension. All intrusions are multiple: the common association is that of gabbro and granophyre. A horizontal layered structure of granite and granophyre is visible in the Slaufrudal stock, which seems to have grown by the injection of successive sills with intermittent subsidence of the replaced block. The rocks belong to the calc-alkaline suite, and comprise in the order of differentiation gabbro-peridotite, gabbro, diorite, granodiorite, granophyre, granite, quartz-vein. Eight new analyses are given. The suite, with the addition of granodiorite, is similar to that of the main plutonic intrusions of Tertiary age in Scotland. Comment is made on the absence of alkaline types in a region of 'Atlantic' tectonics. In the whole Icelandic area intermediate rocks are relatively unimportant in bulk, the extrusives are dominantly basic, and the intrusives dominantly acid: this may be related to the superior mobility of the basic magma. The absence of a sedimentary 'floor' in Iceland is noted, and it is suggested that the preservation of the Iceland-Faeroes remnant is due to the intrusion beneath it of an acid magma.

Society of Public Analysts, Mar. 7.—**T. P. Hilditch**: Composition of the fatty acids present as glycerides in elasmobranch oils. Whereas normal marine animal oils contain 30-40 per cent. of acids of the C_{20} and C_{22} groups, the fatty acids of shark-liver oils are of relatively low unsaturation. Apparently there is some connexion between the deficiency of these highly unsaturated acids and the presence of large amounts of the highly unsaturated squalene.—**R. T. Thomson**: Behaviour of indicators in the titration of ammonia, sodium and calcium phosphates, the methylamines, puridine bases, and boric acid. In commercial analysis, for ammonia and the methylamines methyl orange is the most satisfactory, and Congo Red for pyridine bases. Methyl orange is also to be preferred as an indicator for boric acid in quantities not exceeding 0·2 gm.—**H. R. Jensen**: Cacao tannin. As tannin is probably a principal cause of astringency in chocolate, the cinchonine method has been applied to the determination of tannin in cacao. The cinchonine tannate precipitate was found to contain 4·4 per cent. of nitrogen, which is similar to the 4·3 per cent. found in the hop and tea tannin compounds. The water-soluble tannin content of eleven samples of fully roasted cacao nibs ranged from 5·2 to 6·3 per cent.

Royal Meteorological Society, Mar. 21.—**H. W. Newton**: The sun's cycle of activity (Symons Memorial Lecture). The cycle of activity through which the sun passes in a period of about 11 years is shown by various solar phenomena. There is the well-known variation in the number of sunspots and in the concomitant phenomena of bright calcium and hydrogen flocculi at higher levels. Above these is the region of prominences and dark hydrogen markings which show only a partial relation to the spot zones. The extended and outermost envelope of the sun—the corona—also undergoes a cyclical change. The cause of this 11-year period, though seemingly within the sun, is not known, and phase and amplitude of a cycle ahead cannot be predicted with accuracy. Sunspots are probably vortical in origin and are the centres of strong magnetic fields, the polarities of which, when similar spots are compared, have been found to be opposite in successive 11-year cycles. A theory dealing with the sun's general circulation and that of spots in particular has been advanced by V. Bjerknes. Measures of the solar-constant and of the sun's ultra-violet radiation indicate a change with the solar cycle. A similar variation in the reception of radio signals is also suspected. The occurrence of terrestrial magnetic storms and the corresponding state of the sun is briefly considered.

CAMBRIDGE.

Philosophical Society, Feb. 27.—**J. A. Gaunt**: A theory of Hartree's atomic fields. The equations used by Dr. Hartree in calculating atomic fields are compared by means of perturbation theory with the exact equation for an atom with many electrons. Many of the correction terms cancel out.—**F. Hurn Constable**: (1) On the present position of the theory of centres of activity in heterogeneous catalysis. A critical discussion, with evidence from the oxidation of active centres on iron, leads to the conclusion that the energy store in the active centres is not greatly in excess of that possessed by the regular arrangement of atoms in the surface. The theory seems adequate as so far developed to explain the facts of catalysis, though the quantitative development is somewhat tentative. (2) A method of generalising the law of mass action for heterogeneous surface reactions. To the conditions of reaction in homogeneous systems is added yet another condition, the adsorption of the reactants on the centres of activity of the surface. The surface is treated as if it were homogeneous, reaction taking place as if only those centres on which the heat of activation is smallest, were responsible for chemical change. The general equation is worked out in terms of the rate of bombardment and the mean lives of the molecules on the surface. It is incidentally shown that the same areas associated with the forward reaction must inevitably catalyse the backward reaction. The general solution is impracticable, so the special cases of irreversible synthesis and decomposition are considered.—**A. F. Crossley**: Operational solution of some problems in viscous fluid motion. The solutions are given of some two-dimensional problems: (i) on the motion which arises when a lamina of unlimited extent moves in its own plane in a viscous fluid, either infinite or confined between parallel plane boundaries; (ii) on the motion of a viscous fluid contained in a circular cylinder rotating about its axis.—**R. W. Ditchburn**: The photo-electric threshold and the heat of dissociation of the potassium molecule. The energy of dissociation of the potassium molecule is considered to be $0{\cdot}50 \pm 0{\cdot}01$ volts. The wave-length of the photo-electric threshold is 2555 A. ± 25 A. The mechanism of the photo-ionisation process is discussed in connexion with the recent work of Franck and his colleagues.

DUBLIN.

Royal Dublin Society, Feb. 21.—**Rev. H. C. Browne**: Stereoscopic notes. The utility of stereoscopic photography is generally reduced by the lack of uniformity

of commercial apparatus. If full advantage is to be taken of stereoscopic principles, the stereoscope used must be designed to suit the camera. The adoption of definite, recognised standards is therefore desirable.—**J. H. J. Poole**: The measurement of the current flowing through a photo-electric cell by means of a neon lamp (*v.* NATURE, Feb. 25, p. 281).

Royal Irish Academy, Feb. 27.—**S. Young**: The boiling points of the normal paraffins at different pressures. The boiling points of the normal paraffins from methane to octane have been determined by various observers over a wide range of pressure, generally up to the critical point, and from nonane to nonadecane at a few pressures up to 760 mm.; and those of many of the higher homologues up to pentatriacosane, $C_{35}H_{72}$, at 15 mm. or a few pressures up to 25 or 30 mm. Three methods of calculation are employed: (1) The quite general formula $\Delta = A/T^B\sqrt{T}$ gives the approximate difference between the boiling points of any two consecutive homologues at any pressure. In this formula $\log A = 1{\cdot}92251 + 0{\cdot}026187 \log p + 0{\cdot}013987 (\log p)^2 + 0{\cdot}0013374 (\log p)^3$, and $B = 0{\cdot}01676 - 0{\cdot}000795 \log p$. (2) At any given pressure the boiling points of the normal paraffins may be calculated with fair accuracy by the formula $\log T = a + b \log n + c(\log n)^2 [+ d(\log n)^3]$, where n is the number of carbon atoms in the molecule. The fourth constant d was only required at the three lowest pressures for the complete series from CH_4 to $C_{35}H_{72}$. (3) In this method each paraffin is compared with one of them, hexane, taken as a standard, at a series of pressures the same for both. The equation is of the form $1/T'_B = 1/T'_A[a + bT'_A + cT'^2_A]$, where A represents hexane and B the other paraffin.

EDINBURGH.

Royal Society, Feb. 20.—**E. B. Bailey**: Schist geology: Braemar, Glen Clunie, and Glen Shee. The Ben Eagach schist outcrop of Caenlochan Glen continues by Glen Shee to Glen Clunie. It there comes into contact with Blair Atholl limestones: (1) at Newbigging cottage owing to faulting, and (2) southwest of Morrone owing to sliding. Differences of rock character at Glens Clunie and Caenlochan are attributed to metamorphism. The structure of the district includes refolded recumbent folds and slides.—**H. H. Read**: The Highland schists of Middle Deeside and East Glen Muick. The Highland schists of these areas are divided into three groups which are correlated with the Pitlochry schists, Loch Tay limestone and Ben Lui schists of Perthshire. There is no discontinuity of outcrop between Perthshire and Aberdeenshire, and structures in the two areas are continued on the equivalent horizons. The Deeside schists lie, in a northerly pitching anticline, far above a culmination recognised in Tarfside.—**C. Norman Kemp**: The X-ray examination of coal sections. The X-ray examination of coal has hitherto for the most part been carried out on comparatively small and irregular pieces. The special methods of sawing developed at H.M. Fuel Research Station for the production of coal sections having smooth, flat, and parallel surfaces are described. The resulting slices, of a thickness of about 1 cm., and measuring sometimes 20 cm. by 15 cm., were subjected to radiographic examination. Comparisons within and between radiographs acquire a new degree of precision, and, in marked contrast with former results, the negatives are so sharp that moderate degrees of enlargement may be employed for the study of finer structural details.—**Edward Henderson**: An X-ray examination of saturated dicarboxylic acids and amides of the fatty acid series. Additional members of the series of normal saturated dicarboxylic acids have been investigated and the results are in agreement with the conclusions already arrived at (*J.C.S.*, **129**, 2633; 1926). A number of mono- and di-alkyl malonic acids have been studied. Successive reflection planes are separated by the length of one molecule. The series of fatty acid amides resembles closely the series of fatty acids.—**W. L. Ferrar**: Generalised derivatives and integrals. The various definitions of $D^n f$, n not a positive integer, are considered. Pincherle's operator is a representation of the analytic function given by Riemann's definition. Limiting processes applied to $\Delta^n f$ lead to Liouville's, and not Riemann's, definition.

LEEDS.

Philosophical and Literary Society, Feb. 21.—**C. A. Ford**: Discontinuous fluid motion past an elliptic barrier.—**R. Stoneley**: A Rayleigh wave problem. The propagation of waves of the Rayleigh type is examined for a compressible elastic solid of finite depth, with one surface fixed. The wave-velocity depends on the wave-length, and may have any value greater than that of a simple Rayleigh wave in the medium. The wave-velocity equation is also deduced as a limiting case of Rayleigh waves in a surface layer.—**H. Jones** and **R. Whiddington**: Note on the energy losses of electrons passing through hydrogen. A brief introductory account of experiments using a photographic method in which radiation quantum losses are observed using 100 volt electrons in hydrogen at low pressure. The view is taken that the hydrogen molecule and H_3 are mainly concerned.—**R. Whiddington**: Some experiments with electrons passing through fine slits. Certain highly complicated energy changes have been observed when electrons of about 100 volts energy are passed in a good vacuum through a fine slit. The apparent occurrence of energies in excess of the greatest expected are due probably to an inherent instrumental effect.—**S. R. Pike**: The physical conditions in new stars. The corrections required to reduce the visual to the bolometric magnitudes of stars have been calculated for surface temperatures between 20,000° A. and 120,000° A., and are applied to show that the increase in brightness of a nova cannot be due to temperature changes alone, but must involve a large increase in radius. For Nova Aquilæ the rate of expansion of the photosphere can be found approximately, and it exceeds the parabolic velocity. Consideration of the degree of ionisation of the resultant expanding shell of gas yields information about its density, and about the temperature of the central star at various times.—**E. C. Stoner**: On the distribution of electrons among atomic levels. A number of unjustifiable applications have been made of a scheme previously put forward for the distribution of electrons among atomic levels. The classification of electrons in n, k groups is discussed and the spectroscopic significance of X-ray levels is considered. Electrons cannot be subdivided into grouplets specified by n, k, j values appropriate for X-ray levels.—**E. Percival** and **H. Whitehead**: Observations on the ova and oviposition of some Ephemeroptera and Plecoptera. The ova and oviposition of seven species of Plecoptera and four species of Ephemeroptera are described. The eggs of Perlodes and Perla are modified for attachment to the substratum. Three groups of eggs are to be separated, (*a*) those carried by the female, before oviposition, in masses held by a water-soluble cement, (*b*) those eggs held together by a water absorbent cement which is not soluble, (*c*) those which are attached directly to the substratum by the female,

which creeps down into the water. An attempt is made to correlate the behaviour in water of some eggs with that of sand grains.—**R. G. S. Hudson**: (1) The Lower Carboniferous corals: *Cravenia rhytoides* and *Cravenia tela*, gen. et spp. n. Among the Rugose corals of the Lower Viséan of the Central Province, there are various small cornute forms with a complex Clisiophyllid central column and a simple Caninoid septal area. In development these forms show early specialisation in a particular structure which later became the characteristic feature of the dominant Rugose corals of the Upper Viséan. (2) The Lower Carboniferous corals: development of *Lithostrotion cyathophylloides*, Vaughan. The structure of this species shows that it is not a Lithostrotion but a Cyathophyllid coral which has a Clisiophyllid trend, and in its late growth stages possesses a medial plate and arched tabellæ, thus approximating to the structure of Clisiophyllum.—**F. C. Stewart**: The maintenance of semi-permeability in the plant cell during leaching experiments. Leaching phenomena applied to living tissues do not afford a means of ascertaining the chemical nature of substances in the cell walls or limiting protoplasmic surface of plant cells. Protracted leaching experiments indicate that such treatment does not necessarily result in loss of semi-permeability. This is not in accordance with the view that leaching involves removal of those substances responsible for the permeability properties of living cells.

PARIS.

Academy of Sciences, Feb. 20.—**Gabriel Bertrand** and **L. Silberstein**: The proportions of barium contained in arable soil. The method of determining barium in soil is given in detail. The proportions found range from 0·008 per cent. to 0·17 per cent.—**Louis Roy**: The general equations of elastic surfaces.—**J. Le Bel**: A cyclic system connected with harmonic surfaces.—**B. Hostinsky**: Complement to the note on the probabilities relative to repeated transformations.—**R. Gosse**: The equations $s = qf(x,y,z,p)$.—**R. Wavre**: The permanent rotations of a heterogeneous fluid mass and geodesy.—**Seth B. Nicholson** and **Nicolas B. Perrakis**: The constitution of the solar atmosphere. It has been proved that a large number of known elements are absent from the solar atmosphere, and an attempt is made to see if these absences are accidental or depend on reasons connected with atomic structure. The solar atmosphere contains neither extremely stable elements, such as the rare gases, nor specially unstable elements, such as the radioactive bodies. The absences, apparent or real, occur periodically as the atomic number increases. The total, or almost total, absence of the heavy elements is difficult to explain.—**H. Deslandres**: Remarks on the preceding communication.—**Louis Kahn**: A conformal chart utilisable as an orthodromic chart for long routes.—**Winter**: Vibrating spaces.—**Mlle. Paule Collet** and **Francis Birch**: The magnetic moments of the cupric ion. The usual moment of the cupric ion is ten magnetons, but in one case nine magnetons were found.—**B. Cabrera**: Internuclear reactions.—**Henri Moureu**: The tautomerism of the α-diketones. Constitution of the two forms of methylbenzylglyoxal. One of the isomerides of methylbenzylglyoxal is a true α-diketone: the other has the keto-enolic form, $C_6H_5 . CH : C(OH) . CO . CH_3$.—**A. Demay**: The upper elements of the Cévenol tectonic complex, the Pilat and Laval strata, in the Pyfara face and in the Saint-Marcel synclinal.—**Conrad Kilian**: The presence of the Silurian to the east and south of Ahaggar.—**E. Bruet**: The conditions of formation and of conservation of the upper Pliocene of the Aujon valley.—**A. Guilliermond**: Remarks on the phylogeny of the Ascomycetes.—**Michel-Durand**: The physiological rôle of the pyrogallic tannins.—**Y. Volmar** and **A. Jermstad**: The essential oil of *Salvia Sclarea*. The results of a detailed physical and chemical examination of the essential oil of sage.—**D. Chouchak**: The presence of glycuronic acid in wines made from diseased or mouldy grapes. Wines produced from healthy grapes contain only traces of glycuronic acid: the determination of this acid in wine serves as a measure of the care taken with the grapes before fermentation.—**Georges Truffaut** and **N. Bezssonoff**: The usefulness of natural and soluble phosphates measured by a bacteriological method, and the effect on higher plants.—**Tsen-Cheng**: The histopathological modifications proved in the potato (*Solanum tuberosum*) attacked by degenerescence.—**A. Jullien**: The transformation of the blood cells of the cuttle fish (*Sepia off.*) in the course of aseptic inflammatory reactions.—**L. Mercier**: Contribution to the study of the loss of the power of flight in *Carnus hemapterus*.—**C. Dawydoff**: The embryology of the Protonemerta.—**Mme. Hélène Sorg-Matter**: The quantitative law of the minimum nitrogen consumption of the homœotherms: intraspecific validity.—**Angel Establier y Costa** and **Charles Kayser**: Analysis of the mechanism of hyperallantoinuria observed after the puncture of the fourth ventricle.—**Mme. M. Phisalix** and **F. Pasteur**: The action of ultra-violet light on the venom of *Vipera aspis*.—**Bordier**: The heat disengaged by diathermal d'Arsonvalisation with sponge electrodes: important disadvantages of these electrodes. Flexible metallic electrodes are preferable to sponges for making contact with the patient.—**Jean Saidman**: An automatic test for the sensibility of the skin.—**Barrien** and **Nemours-Auguste**: The technique and the results of the treatment of angina pectoris by radiotherapy. The treatment is absolutely without danger, provided care is taken to shield the thyroid gland. Out of seven cases there were five cures and one marked improvement.—**S. Metalnicov** and **V. Chorine**: Bacterial diseases in the larvæ of the maize moth, *Pyrausta nubilalis*.—**F. Picard**: The factors of geographical distribution of *Plasmodium vivax* and *Plasmodium præcox*.

VIENNA.

Academy of Sciences, Jan. 12.—**K. Beaucourt**: Condensation products of furfurol with acid amides.—**H. Mäe**: Sudden transitions of temperature in the Baltic. North or south winds blowing along the length of the Gulf of Bothnia induce a vertical circulation, bringing cold bottom water to the surface.—**W. Blabensteiner**: The application of the ash picture for the determination of barks used in pharmacy.—**C. A. Bobies**: Quartz gravel in the marine sediments of the eastern Triesting.—**H. Pettersson**: The disintegration of carbon (3). Graphite was bombarded with α-particles of reduced range from polonium. These cease to liberate H-particles of observable range from carbon at a reduced range which lies between 1 and 2 cm. of air. Apparently a higher minimum energy of the α-particle is required for disintegrating carbon than for aluminium.—**K. Menger**: A theorem of topology. Notes on the theory of dimensions. (1) A proposition supplementing the definition of dimensions, (2) weak n-dimensional spaces, (3) n-dimensional growths.—**K. Czapla**: Ash pictures of technically useful barks. Barks useful in tanning can be recognised in test sections. The ash products were examined microscopically for crystals and use made of micro-chemical staining reagents.—**R. Wagner**: Anisophylly and partial inflorescences in *Salvia sclarea*.

Official Publications Received.

BRITISH.

Proceedings of the Fourteenth Indian Science Congress, Lahore 1927. (Second Circuit.) Pp. xxiv+384. (Calcutta: Asiatic Society of Bengal.)

Australasian Association for the Advancement of Science (Australia and New Zealand). Programme, Hobart Meeting, January 1928. Pp. 29. Handbook to Tasmania: prepared for the Members of the Australasian Association for the Advancement of Science on the Occasion of its Meeting in Hobart, January 1928. Pp. ii+135+17 plates. 3s. (Sydney, N.S.W.)

Metropolitan Boroughs of Wandsworth and Battersea. Guide to the Exhibition of Continued Education, Friday and Saturday, March 23rd and 24th, 1928. Pp. 40. (London: Battersea Polytechnic.) 2d.

Memoirs of the Asiatic Society of Bengal. Vol. 9, No. 4: Geographic and Oceanographic Research in Indian Waters. By Lieut.-Col. R. B. Seymour Sewell. Part iv: The Temperature and Salinity of the Coastal Water of the Andaman Sea. Pp. 131-206. (Calcutta.) 2.13 rupees.

Transactions of the Geological Society of South Africa. Vol. 30, January to December 1927. Pp. iv+144+7 plates. 42s. Proceedings of the Geological Society of South Africa: containing the Minutes of Meetings and the Discussions on Papers read during 1927. To accompany Vol. 30 of the Transactions, January-December 1927. Pp. iii+xlviii. (Johannesburg.)

British Research Association for the Woollen and Worsted Industries. Annual Report, 1927-28. Pp. 40. (Leeds.)

Annals of the Natal Museum. Edited by Dr. Ernest Warren. Vol. 6, Part 1, March. Pp. 169+11 plates. (London: Adlard and Son, Ltd.) 17s. net.

FOREIGN.

Observations and Investigations made at the Blue Hill Meteorological Observatory in the Year 1927 under the direction of Prof. Alexander McAdie. Pp. 36+21 plates. (Cambridge, Mass.)

Transactions of the Astronomical Observatory of Yale University. Vol. 6, Parts 1 and 2: Tables for Weights and Probable Errors, by Frank Schlesinger; The Parallaxes of Fifty-eight Stars, by Frank Schlesinger, Frances Allen, and others. Pp. 32. Vol. 6, Part 3: The Stellar Case of the Problem of Three Bodies. By Paul Slavenas. Pp. 33-43. (New Haven, Conn.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i der Arktiske Have (The State of the Ice in the Arctic Seas) 1927. Pp. 15+5 maps. (København: G. E. C. Gad.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1928. 94e année. Pp. 92+68+3 planches. (Bruxelles: Maurice Lamertin.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des Réunions. Vol. 46: Contribution aux appareils et aux méthodes destinés aux recherches océanographiques pratiquées à bord d'un navire en marche. Par J. Habert. Pp. 50+1 planche. (Copenhague: Andr. Fred. Høst et fils.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a: Ergebnisse aerologischer Beobachtungen. 14, 1925. Pp. iv+41. 2.50 fl. No. 108: Seismische Registrierungen in De Bilt. 12, 1924. Pp. ix+54. 1.00 fl. No. 110: Oceanographische en Meteorologische Waarnemingen in der Atlantischen Oceaan, Juni, Juli, Augustus, (1870-1922). Kaarten. Pp. 16+24 kaarten. 7.50 fl. (Utrecht: Kemink en Zoon.)

CATALOGUES.

Bibliographie des livres français de médecine et de sciences, 1919-1928. Pp. xlviii+166. (Paris: Masson et Cie.)

Early English Books from the Huth, the Hoe, the Britwell and other famous Libraries. (Catalogue No. 19). Pp. 208. (Newcastle-on-Tyne: William H. Robinson.)

Diary of Societies.

FRIDAY, MARCH 30.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Lt.-Col. V. C. Richmond: Some Modern Developments in Rigid Airship Construction.—G. S. Baker and J. L. Kent: Experiments on the Propulsion of a Single-Screw Ship Model.—At 3.—W. G. A. Perring: The Vortex Theory of Propellers and its Application to the Wake Conditions existing behind a Ship.—J. Tutin: Cavitation.—J. L. Taylor: Statistical Analysis of Voyage Abstracts.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall, Westminster), at 3.—D. Brownlie: Liquid Fuel from Coal.

INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at College of Technology, Manchester), at 7.—W. G. Smith: Some Features of the Mechanical and Electrical Equipment of the Port of Manchester.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. L. Hodgson and others: Discussion on The Problem of Utilising the Earth's Internal Heat.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Lighting Service Bureau, Newcastle-upon-Tyne), at 7.15.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. F. Adams: Locomotive Maintenance.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. G. Davis: The Geology of the Clapham-Morden Railway Extension.—Miss Helen M. Muir-Wood: A New Brachiopod, *Discinisca ferroviæ*, from the Woolwich Beds.—E. M. Venables: The London Clay of Bognor.

INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—Dr. W. H. Hatfield: Non-Ferrous Metals in relation to Ferrous Metallurgy.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 7.30.—W. Steele: Bronze Welding.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Radioactive Atoms and their Structure.

SATURDAY, MARCH 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (IV.).

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—B. E. Houle: The Installation of a Booster Fan.

MONDAY, APRIL 2.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—A. H. Forbes: Science in the Book of Ecclesiastes.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—R. W. A. Brewer: Air Cooled Radial Engines.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—J. N. Tait: Mixture Distribution in Multi-Cylinder Engines.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. H. Muthesius: Modern German Architecture.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—C. D. Adams: The English Beet Sugar Industry.

SURVEYORS' INSTITUTION (at Institution of Civil Engineers), at 8.—C. Dampier-Whetham: Agricultural Depression: its Causes and Possible Cures.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. C. Hardy: The Work of the R.R.S. *Discovery* in the Falkland Islands Dependencies.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Leeds).—Annual General Meeting.

TUESDAY, APRIL 3.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. A. Wade: The Oil Well and Later Developments at Hardstoft, Derbyshire.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Miss E. M. Brown: Exhibition of a Fluke (*Microcotyle alcedinis*) from the Gills of the Sea-Bream *Pagellus centrodontus*.—C. R. S. Pitman: (1) Notes on a Young Pangolin captured in January 1928; (2) Nkosi Island and its Sitatunga.—Dr. R. Gurney: Some Copepoda from Tanganyika collected by Mr. S. R. B. Pask.—Cambridge Suez Canal Expedition Reports:—(*a*) Prof. A. Palombi: Report of Turbellaria.—(*b*) Dr. A. Schellenberg: Report on the Amphipoda.—(*c*) F. A. Potts: Report on the Sedentary Polychæts.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Annual General Meeting.—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Substations.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—F. H. Evans: Westminster Abbey.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—E. A. Watson: The Electrical Characteristics of Spark Gap and Sparking Plug.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—Dr. C. Scudder: The Treatment of Recent Fractures by Operation.

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Branch).—G. A. V. Russell: Reversing Blooming Mill Practice.

WEDNESDAY, APRIL 4.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. G. W. Tyrrell: The Analcite-Syenites and Associated Rocks of Ayrshire.—Dr. J. Parkinson: The Pleistocene History of Western Buchivacoa (Venezuela).—A. Tindall Hopwood: *Gyrinodon quassus*, a New Genus and Species of Toxodont from Western Buchivacoa (Venezuela).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Gas Light and Coke Company, Watson House, Nine Elms, S.W.8), at 5.30.—J. G. Clark: Demonstrations of Method of Assessing the Radiant Efficiency of Gas Fires.—Methods of Examining Materials of all Kinds used in Gas Supply.—Testing of Gas Fittings for Soundness, Weight, and Quality.—The Testing of Wrought Iron Fittings for Soundness and Quality.—Methods of Ventilating Gas Appliances and of dealing with Adverse Winds.—Methods used for Instructing the Various Sections of the Staff of the Gas Sales Department.—The Use of Special Flues for Use with Gas Fires, etc.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Prof. E. V. Appleton: The Study of Signal Fading (The Work of the Radio Research Station at Peterborough).

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—D. S. Munro: Modern Electric Wiring, particularly as applied to Small Houses.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. Evans and T. E. Wallis: Coffee Parchment as an Adulterant of Bran and Sharps.—W. B. Adam: Determination of the Colour-producing Constituents of the Cacao Bean.—Dr. A. T. Etheridge: Determination of Vanadium in Steel.—S. G. Clarke: Colorimetric Determination of Antimony and its Separation from Tin.—Dr. A. Riad: Determination of Carbon Dioxide in Soils.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

PUBLIC LECTURES.

MONDAY, APRIL 2.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Summary and Some Outstanding Problems.

WEDNESDAY, APRIL 4.

MEDICAL SCHOOL, LEEDS, at 3.30.—Prof. G. E. Gask: Radium in the Treatment of Malignant Disease.