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Science and Intellectual Liberty

A LITTLE more than a year ago, a number of scientific workers and scholars formed themselves into an Academic Assistance Council with the intention of helping university teachers and investigators "who on grounds of religion, political opinion or race were unable to carry on their work in their own country". The Council consists of forty-two members, representative of all sides of British intellectual activity, and its first annual report, which has just been issued, is a document worthy of careful study*. Upon the Council's records are the names of 1,202 scholars and scientific workers who have been displaced. Of these, rather more than a quarter, 389, have been permanently or temporarily—in the majority of instances only temporarily—enabled to continue their work, 178 in the British Isles, 211 abroad. There remain 813 so far unsuccoured.

Although the Council does not confine its aid to those of German origin, nearly all these distressed intellectuals have come from, or still suffer in, Germany. It might seem, then, that the Germany of to-day is not a very kindly soil for the cultivation of science and scholarship. Prof. J. Stark, president of the Physikalisch-Technische Reichsanstalt, Berlin, has, however, been at some pains to demonstrate both in our correspondence columns and also in a pamphlet entitled "National-sozialismus und Wissenschaft"†, that, far from seeking to diminish scientific freedom, it is the mission of the National-Socialist Government to free German science from the influences which were strangling it.

It is necessary first of all to realise the distinction in the German political mind at the present time between *Germanen* and *Juden*. To *Germanen* has been vouchsafed the gift of seeing things as they really are, with the result that practically all *Naturwissenschaft* is regarded as the creation of the Nordic-German branch of the Aryan peoples. The *Juden*, on the other hand, are entirely centred on themselves, cannot, or rather will not, see things as they really are, and only respect facts which can be made subservient to their own ends. They are consequently quite incapable of making any great discoveries in *Naturwissenschaft*. It is true that Heinrich Hertz made an important discovery, but then Hertz had a Germanic mother.

* The Academic Assistance Council. Annual Report, 1st May, 1934. (London: c/o Royal Society, Burlington House, London, W.1.)
† Zentralverlag der N.S.D.A.P. München, 1934.

We might also mention names, such as those of Jakob Henle and Paul Ehrlich ; whether anatomy and immunology are not *Naturwissenschaften* at all, or the pedigrees of Henle and Ehrlich have been insufficiently scrutinised, we do not know. The result of the moral and intellectual limitations of the *Juden* has been, not only that they have devoted themselves to unreal theorising, but also that little Jewish coteries have succeeded in strangling genuine German science. One of these *jüdische Wissenschafter-Konzerne* founded by Klein and Hilbert no doubt discouraged that stern objectivity which should characterise Nordic-German mathematics ; another, controlled by Einstein and Sommerfeld, tampered with physics ; a third, the Haber-*Konzern*, has strangled physical chemistry. What *Konzern* has suppressed Germanic biology is not disclosed. Anyhow, we are apparently led to the conclusion that, instead of discovering anything important, Germany has been simply putting on the market dogmatic theories, such as Einstein's theory of relativity.

It may be difficult for the English reader, recalling the often painful elaboration of genuine Germanic humour, not to suppose that "Nationalsozialismus und Wissenschaft" is a facetious essay, but the consequences of its acceptance in Germany are too plainly evident. No one can suppose, however, that this kind of 'reasoning' will be taken seriously long. Even the Committee of Public Safety was not wholly composed of Barères : more temperate counsels will prevail in Germany in good time. Meanwhile, however, a good deal of 'sand' is being thrown into the intellectual machinery of the world.

One function of the Academic Assistance Council has been to enable serious workers to escape from an atmosphere of noise and truculence and to continue their researches. The reports of what has already been done by grantees show the success of the policy. One (a mathematician) "has finished an exceptional piece of work which will make a considerable sensation when it appears and add greatly to his status". Another (a physiologist) has done work which, the referee thinks, "may well be revolutionary". Another (an art historian) "has been doing quite invaluable work" ; and so the story goes on.

These are the products of a single year's work and of comparatively trifling expenditure. Were we only concerned for the credit of Great Britain and the enrichment of its intellectual life, we might almost pray that the present vogue in Germany would be long. It would be difficult indeed to invest capital at a more usurous rate of interest—we are securing some of the best intellects in Europe, perhaps permanently. However, we all hope that the restraint of German intellectual activity will not continue ; but common prudence must warn us that, for some years to come, much of the burden of maintaining the intellectual life of Europe will have to be borne by us. The Academic Assistance Council estimates that £25,000 a year for the next two years will be necessary to enable it to continue and consolidate its work. In 1931–32, according to the return of the University Grants Committee, the expenditure in Great Britain on salaries (including payments for superannuation) of teaching staff in university institutions of Great Britain was £2,856,216. The annual sum required by the Academic Assistance Council is less than one per cent of this. While it would be preposterous to suggest that the whole of the burden can be, or should be, borne by the academic staffs of British universities, and reasonable to expect that enlightened men of wealth will contribute to this deserving object, it does at least appear that the Council is not asking for a sum beyond the means of those who value science and scholarship to supply.

We doubt whether an appeal more worthy of support than this has ever been made to the educated public. We have the ordinary appeal to decent human sympathy which the story of oppression makes, but beyond that is the appeal to our imagination. The individuals suffering at present will pass away and be forgotten : the revocation of academic freedom in Germany will no more be forgotten than the revocation of the Edict of Nantes.

A Poet Looks at Religion and Science

The Unknown God. By Alfred Noyes. Pp. 383. (London : Sheed and Ward, 1934.) 7*s.* 6*d.* net.

MR. ALFRED NOYES is one of a not inconsiderable number of literary intellectuals who, having begun thirty or forty years ago as agnostics, have become in their maturity orthodox and practising Catholics. This spectacle of agnostic poets leaving the waste land and returning *ad limina* is a sign of the times. Now that the traditional European culture, which was

predominantly literary, is in danger of being displaced by a new scientific culture with its strange products, human and material, the poet may experience a very natural distaste. He sees, or thinks he sees, the world being rapidly decivilised by the mass barbarian, who is a deplorable by-product of scientific developments. He is appalled by the prevalent vulgarity and insensitiveness to the values he cherishes, and repudiates modernity; and who shall say that he is altogether wrong? Compare the shallow philosophy, or philosophies (since there is a Babel of conflicting tongues) of modernity with the *philosophia perennis* of traditional Catholicism—with its richness, its comprehensiveness, its sweep and power of speculation, its nobility and depth of emotional content, and its rationality.

Yet this is not the sort of argument that Mr. Noyes proffers in his book. Out of disgust for the contemporary world he does not repudiate science which has created that world. On the contrary, he begins from the scientific point of view as found in T. H. Huxley, Herbert Spencer and Haeckel. From studying these writers in his youth, Mr. Noyes gained too clear an insight into scientific culture ever to wish to repudiate it out of disgust at a few of its products. Yet his interests in those early days were evidently philosophic rather than strictly scientific. What fascinated him were the perennial problems of space, of time, of personal identity, and so forth.

Yet the Victorian agnostics contained more than a little of the old culture suspended in their thought. It was not really difficult for Mr. Noyes to discover parallel doctrines, a little differently phrased but not dissimilar in content, in Herbert Spencer and Aquinas. The modern unbeliever is at once more technical (though less verbose) and more tough than the author of the "Synthetic Philosophy". This, indeed, is part of the trouble to-day. Our men of science are all specialists, "each working along his own narrowing line, each developing a language of his own, and each diverging further and further from that central point of view which once enabled us (from the lost height of a great historic religion) to 'see life steadily and see it whole'."

That is bad enough, though one does not see how it can be avoided. What is far worse is that the philosophers are specialists too. We get very little that is helpful in constructing a satisfactory synthesis from modern metaphysicians, whose treatises are arid and technical; and if we turn to the poets and artists, they too let us down. Mr. Noyes is a poet himself and should know, and he tells us that art and literature are suffering from the same disease as science itself, in an aggravated form. "Their exponents, with few exceptions, have no belief in real values. They are giving over to analysis what was meant for synthesis; and, where they should be creative, or interpretative of life in its fulness, they offer us critical dissections and the disintegrated relics of a post-mortem. More than ever before, they mistake those superficial factual reports for truth; and, if the 'facts' are repulsive enough, they are inclined to suggest that truth requires no further evidence. It is not only the 'facts' of religion that are failing us."

Of course an apologist for the new literature would reply that the industrious and disinterested collection of facts must be preliminary to a synthesis; the task may be extremely unpleasant and even unpromising, but one has to proceed on the inductive principle. Perhaps we shall get our synoptic view in due course, but meanwhile modern writers will not look back for their interpretations and their ideals. They have certainly chosen the more difficult task. To resuscitate the past only calls for erudition and the sympathetic understanding of other people's ideas—in a word, for intelligence. But to provide something new (which is what the times call for), needs genuine creative power, and we may admit that not all our modern writers possess it.

If this is true in art and literature, it is more true than ever in the sphere of religion. As Mr. Noyes most justly says, the need of the world to-day is a religious need, but it is extremely doubtful whether this can now be satisfied by the orthodoxies of the past, however attractive they may be in themselves, however intellectually coherent they may be if you grant their premises, and however much by their grandeur they may expose our modern spiritual penury. "The world is groping," says Mr. Noyes, "for a religion in which it can believe without evasions, without dishonest ambiguities, without self-deception, and without superstition." That is just the point. A religion, however satisfying in other directions, is no good to you unless you can believe it with your whole heart. That Mr. Noyes finds traditional Catholic orthodoxy completely satisfying himself is evident from this utterly sincere and large-hearted book. But not all of us are so fortunate.

J. C. HARDWICK.

Advancing Sterility in Plants

Publications of the Hartley Botanical Laboratories. Nos. 1, 2, 4, 6, 7 : *Studies in Advancing Sterility*, Parts I to V. By John McLean Thompson. No. 11 : *The Theory of Scitaminean Flowering*. By John McLean Thompson. No. 3 : *The Life History and Cytology of Sphacelaria Bipinnata*. By Hilda B. Clint. No. 5 : *The Cytology of Callithamnion Brachiatum*. By William T. Matthias. No. 9 : *A Contribution to Knowledge of the Mesogloiaceae*, etc. By Mary Parke. Nos. 8, 10 : *Studies of Flowering in Heterostyled and Allied Species*, Parts I and II. By James Stirling. (Liverpool : University Press of Liverpool, 1924–1933.)

THESE publications of the Hartley Botanical Laboratories of the University of Liverpool are beautifully printed and illustrated on large pages of good paper. In them Prof. McLean Thompson records his observations of floral development in a few selected families, and supports his view that only through such developmental studies is it possible to interpret floral form and structure satisfactorily. In selecting the families for study, Prof. Thompson has shown himself ready to face difficulties. His choice has fallen first on the Leguminosæ, one of the largest families of Dicotyledons, the very variable subfamilies Cæsalpinioideæ and Mimosoideæ having been investigated in considerable detail, but the more uniform Papilionatæ much less extensively. Next he has chosen the Lecythidaceæ and the Scitamineæ, two groups in which the flowers exhibit a wide range of freakish forms with marked variation in the number of functional stamens.

The investigations of the Leguminosæ have been directed towards three main ends : first, to find the directions of evolution within the family ; secondly, to interpret the morphology of the corolla and gynæcium, and thirdly, to reconstruct a prototype. It was unfortunate that the Cæsalpinioideæ should have been studied before the Mimosoideæ, since the latter are certainly the more primitive in many respects, and conclusions derived from the former have had to be revised. The final conclusions are that evolution has been mainly a progressive reduction in the number of stamens, with the ultimate attainment of monandry and apetalous dicliny. The corolla is a secondary intercalation between perianth and androecium, and the legume is the reduction-limit from a terminal system of phylloclades with marginal ovules. The prototype showed numerous members in a continuous spiral sequence, bracteoles and perianth outermost, then stamens, and finally, on the apex of the long conical receptacle, the gynæcium.

For the most part these conclusions seem incontrovertible. The constancy of the serial origin of members even in apparently cyclic types is a point of considerable interest. This has been observed also in Ranunculaceæ, and an essentially similar picture to Prof. Thompson's has been drawn for that family. The corolla has been regarded as arising secondarily, and all members as originally arranged in a continuous spiral sequence. In both groups the members, as their numbers are reduced, settle down usually to pentamerous, but occasionally to trimerous or tetramerous, alternating whorls. The derivation of such cyclic or pseudocyclic arrangements from the spiral offers no great difficulties if it be realised that the average angle of divergence between successive members in spiral types is never far removed from 137·5°, and that an average divergence of 144°, corresponding to the 2/5 phyllotaxy of the old Schimper-Braun theory, is rarely found. Thus members cannot be supposed to have lain along a small Fibonacci number of radii, five, eight or thirteen, and Prof. Thompson had no need to assume and explain secondary displacements of 36° to remove a sixth member from radial juxtaposition to a first.

There is no doubt that the numerous stamens of the prototype have been steadily reduced until, in several species, only one remains. This does excuse the frequent use of such expressions as "doomed", "menaced by sterility", "await extinction". Much more must be known of the general biology of these types, of their pollination mechanisms and their ecology, however, before drawing a conclusion of suicidal orthogenesis.

The evolutionary history of the legume is a much disputed matter. Many might agree that the facts of form and vascularity do not support a multi-carpellary interpretation. It is not difficult to agree that the carpel, growing for the most part by intercalary elongation *after* infolding, is no longer a leaf whatever its form in ancestral types. But to call it, with Prof. Thompson, a phylloclade, does not seem to help appreciably. In the first place there seems no strong reason, on grounds of structure and development, for calling it phylloclade rather than leaf ; and in the second place it is far from evident why the organs figured

in the reconstruction of the prototype should be called phylloclades rather than leaves. There is sore need for a revision of morphological terminology.

His studies of the floral development of the Scitamineæ have led Prof. Thompson to deny the cymose nature of the peculiar partial inflorescences of such genera as *Musa*. He adduces many interesting facts and submits an ingenious interpretation, but it cannot be said that his arguments are entirely convincing. The frequent association in pairs of one left-handed and one right-handed flower is not satisfactorily explained in terms of the direction of movement of nutrient materials, but is to be expected in a reduced cymose inflorescence.

From a study of individual floral development emerges the fact that again in the Scitamineæ the members arise serially. But the most interesting conclusion is that the gynæcium is not composed of carpels, but of ovules arising on the walls of a receptacle-crater which is roofed in by 'stylar-components'. The inference is that the Scitamineæ are 'acarpous' in ancestry. This does not seem a legitimate inference. The inferior ovary is surely a derivative type in which the ancestral carpels have ceased to bear the ovules and are represented only by the 'stylar-components'. All stages between this and the hypogynous condition are known, and the essential change seems to be in the distribution of growth after initiation of the carpels on a concave receptacle. Growth of the carpels as free or concrescent members, independently of the receptacle, gives the superior ovary; but growth predominantly beneath the primordia, increasing the concavity of the receptacle or forming the loculi as pockets beneath the stem-apex, gives the inferior ovary. It is thus true that the ovary is not composed of carpels, but it cannot be maintained that it is ancestrally acarpous.

Observations on the Lecythidaceæ reveal an interesting correlation between cell gigantism and sterility, and progressive sterilisation of the androecium is again recognised as the main evolutionary trend.

The publications constitute a valuable collection of data on floral development, and Prof. Thompson is to be congratulated on having directed attention to many outstanding problems for the solution of which his mode of approach may justly be claimed indispensable. In conclusion it should be said that the drawings of flowers are extremely good, but perspective drawings and longitudinal sections should have supplemented the contoured plans and serial transverse sections in illustrating floral development. Why should none of the floral diagrams be orientated in the conventional manner, and why should the inflorescence-axis be represented by a little maltese cross or a more elaborate figure? The large number of unfortunate printing errors of the earlier volumes has been much reduced in later volumes.

Publications by other members of Prof. Thompson's department deal with the development of heterostyled flowers (Nos. 8 and 10), and with the life-histories of certain algæ (Nos. 3, 4, 5 and 9.) There are also valuable notes by Mr. W. Horton dealing with technical points.

A. R. CLAPHAM.

World Petroleum Congress

World Petroleum Congress organised by the Institution of Petroleum Technologists held at the Imperial College of Science and Technology, South Kensington, London, July 19th–25th, 1933. Proceedings. Edited by Dr. A. E. Dunstan and George Sell. Vol. 1: *Geological and Production Sections.* Pp. xxiv+592. Vol. 2: *Refining, Chemical and Testing Section.* Pp. xxvi+956. (London: World Petroleum Congress, 1934.) Vol. 1. 35*s*. net; to Members of the Congress, 30*s*. net. Vol. 2: 45*s*. net; to Members of the Congress, 37*s*. 6*d*. net.

IT is impossible accurately to assess the value or measure the success of the World Petroleum Congress, held in London on July 19–25 last, for, as with all international meetings of this character, vital problems discussed cannot be solved at the time, but must be referred to various committees of experts. Only time, and with it much detailed work, can show which of the innumerable ideas propounded at this Congress are of scientific import; many as yet must be classed as interesting but unproved theories. Anyone, however, can furnish himself with at least one tangible and lasting memento of this international pooling of current ideas and can extract therefrom such technical information as may be necessary to his particular branch of research or industry. The memento is a complete record of proceedings published at the offices of the Congress in two volumes. Vol. 1 includes all papers submitted in connexion with the Geological and Production Sections. Each section and sub-section is prefaced

by a general reporter's summary giving the trend of present-day thought and research at a glance.

Geologists throughout the world are bringing the resources of science to bear on vexed problems of petroleum source-rocks, their geographical limits and the principles governing distribution of oil-fields. Geophysical science has advanced rapidly during the last ten years, and papers on this subject provide an excellent basis of assessment of capabilities and relative usefulness of the numerous instruments now available. The value of aeroplane reconnaissance and photography appears to be capable of enhancement, and an urgency is obviously felt by its sponsors and operators for its more universal application to cover the vast amount of pioneer work still to be done. Stress is also laid on analysis and interpretation of oil-well data acquired during drilling—now a very exact science—and on the great assistance which such data, though not always appreciated, provide to field operators. Drilling, production, transport and storage of oil form the main themes in the Production Section. In the first instance, opinions are collected and problems discussed chiefly in connexion with pressure drilling, use of mud fluids and oil-well cementation. The second group comprises contributions describing actual production methods as now practised and their relation to reservoir conditions, while the last group is of interest mainly from the point of view of modern pipeline construction and protection.

Vol. 2 contains a great deal more subject matter, and includes papers on cracked gasoline refining and the use of inhibitors for gum prevention, determination of gum in gasoline, knock-rating for motors and aviation, gasoline fuels for high-speed compression-ignition engines, hydrogenation, extraction processes for the refining of oil, lubricating oil, viscosity, bituminous materials and emulsions, kerosene, alternative fuels, oil-coal fuels, petroleum as a chemical raw material, and measurement of oil in bulk. Two important considerations concern nomenclature from the legal aspect and international co-operation in standardisation.

Both volumes conclude with an account of the formal adoption of resolutions, Sir John Cadman's lecture on "Science in the Petroleum Industry" and also Mr. J. B. Aug. Kessler's paper on "Rationalization of the Oil Industry", reports of which duly appeared in NATURE. There are author and subject indexes at the end of each volume, which, in the latter case, might with advantage have been made fuller, in view of the technical value of these volumes as standard works of reference.

The editing of such a large number of papers dealing with so many different subjects and presented in such diverse ways was, however, nothing short of a Herculean task, and the editors are to be congratulated on the efficient manner in which they have discharged it. H. B. MILNER.

Short Reviews

A Short Course in Elementary Meteorology. By W. H. Pick. (M.O. 247.) Fourth edition, completely revised. Pp. 143. (London: H.M. Stationery Office, 1933.) 2*s.* 6*d.* net.

THE material of this book is divided into three parts under the headings general meteorology, synoptic meteorology and the upper air, the first part dealing with wind, temperature, humidity and ordinary weather phenomena, the second with the modern synoptic weather chart and the systems of forecasting based upon it, and the third with the physical structure of the atmosphere from the ground up to the highest levels to which recording instruments have been taken by sounding balloons.

The descriptions are generally clear and contain few of the inaccuracies which are so common in most works of this scope. The author rightly emphasises in the introductory chapter how important it is for the student to remember always that meteorology is a branch of the wider science of physics. It is, however, from the point of view of physics that objection may be made to some of the author's statements: for example, when he discusses (pp. 16–17) the diurnal range of temperature on land and on sea, he attributes part of the greater magnitude of the former to the action of the principle that a good radiator is also a good absorber, but overlooks the fact that it is largely the absorption of radiation of short wave-length (visible radiation) that has to be considered during the daytime, and that even if it be demonstrable that the solid surface of the earth absorbs such radiation better than does water, it does not follow that the land is a better radiator for the much longer wave-lengths emitted at night. A small error deserves notice in section 102 (p. 95), where it is stated that in the northern hemisphere the eye of a tropical cyclone generally moves eastwards. As it is the active stage of a cyclone that is being discussed, the movement would be nearly always westwards whether in the northern or southern hemisphere, for these storms spend a large proportion of their active life within the tropics. E. V. N.

Annual Reports on the Progress of Chemistry for 1933. Vol. 30. Pp. 462. (London : The Chemical Society, 1934.) 10*s.* 6*d.*

THE series of reports for 1933 deals with general and physical, inorganic, organic, and analytical chemistry, biochemistry, radioactivity and sub-atomic phenomena, and crystallography, and forms a substantial contribution to the literature of the science. As in former years, the plan adopted is to discuss progress in a limited number of special subjects rather than to attempt a comprehensive survey, a task which would indeed be impossible within the accepted limits of space and cost. Thus, for example, Mr. R. P. Bell discusses solubility and related phenomena, Mr. J. H. Wolfenden's section on electrochemistry is confined to 'heavy hydrogen', the structure of water, and the mechanism of hydrogen and oxygen electrode processes, and in the biochemistry section space is devoted to a review of progress in the biochemistry of bacteria during the past three or four years. Analytical chemistry is represented by discussions of the polarographic, spectroscopic, and magneto-optic methods, the physical properties of solutions, an extended account of electrometric methods, and a section on gas analysis. Dr. A. S. Russell examines, *inter alia*, advances in artificial disintegration and the positive electron, whilst Dr. G. A. R. Kon discusses in some detail the considerations which have recently led to the establishment of the main structural outlines of the sterols and bile acids.

Among research chemists this series of annual reports is recognised as providing extremely valuable and authoritative surveys ; among teachers of chemistry it is regarded as affording the best means of keeping abreast of modern developments. Workers in related sciences, although not requiring to make a study of every chapter, will nevertheless find in this book a great deal of valuable information and explanation, some of which may prove of prime significance in their own researches. A. A. E.

(1) *Pink Disease* (*Infantile Acrodynia*). By Dr. Ch. Rocaz. Translated by Dr. Ian Jeffreys Wood. Pp. v+153.

(2) *Infantilism.* By Dr. E. Apert. Translated by Dr. R. W. B. Ellis. Pp. v+117+4 plates. (London : Martin Hopkinson, Ltd., 1933.) 7*s.* 6*d.* net each.

THE translation into English of these two French monographs provides interesting and valuable additions to medical literature.

(1) "Pink Disease" is the title given to Dr. I. J. Wood's translation of "L'Acrodynie Infantile", which is a comprehensive survey of an illness the obscure nature of which is indicated by the numerous names it has received. A full historical, clinical and pathological review is given, and the conclusion is reached that the disease is an inflammation of the nervous system closely allied to epidemic encephalitis. It is probably extremely rare in Great Britain, but its apparent tendency to occur in small outbreaks makes it important that physicians should have some knowledge of it. The long bibliography included provides references for those who wish to make a detailed study of the subject.

(2) "Infantilism" describes in detail the many varieties of the well-known state of retarded development, and includes a chapter on the less familiar condition of regression after mature development known as Gandy's retrograde infantilism. As textbooks of neurology and pediatrics make but scanty reference to these disorders, and offer little or no therapeutic indications, it is significant to find a whole chapter of this book devoted to treatment.

Both monographs are particularly well illustrated.

The Method and Theory of Ethnology : an Essay in Criticism. By Paul Radin. Pp. xv+278. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1933.) 15*s.* net.

ETHNOLOGY is defined by Dr. Paul Radin as the description of aboriginal culture, and the object of this essay in ethnological criticism is to show how far the various schools of thought fail to attain the object of the study. The 'evolutionary' school, of which Tylor is regarded as the founder and the chief exponent, as might be expected, is sharply criticised for various reasons, of which the principal is that it regarded the study of primitive peoples as an evolution of culture and also looked upon its material as representing a phase anterior to that of civilised man of to-day. Hence the theory of survivals. Other schools, the 'diffusionists', the 'functionalists', and in America the followers of Prof. Boas, are alike criticised from the point of view of the author that ethnology is a purely historical science, and that as such it must treat each phase and manifestation of culture as individual.

Chemistry and Physics : for Botany and Biology Students. By Dr. E. R. Spratt. Second edition. Pp. vii+284. (London : University Tutorial Press, Ltd., 1933.) 3*s.* 6*d.*

THIS up-to-date little book is designed, in particular, to include the sections on elementary chemistry and physics in the syllabuses of botany and biology of the Oxford and Cambridge School Certificate examinations, and emphasises the applications of physical and chemical phenomena to plant and animal life. The second edition has been revised and extended to deal with magnetism and electricity, light, electrolytic dissociation and hydrogen ion concentration, the structure of the atom and valency.

It can be recommended without reserve to students as indicated in its title, and should, in addition, meet the needs of students in general or of classes requiring a sound and inexpensive course in general science. N. M. B.

Liquefaction of Helium by an Adiabatic Method without Pre-cooling with Liquid Hydrogen

By PROF. P. KAPITZA, F.R.S., Royal Society Mond Laboratory, Cambridge

THE methods for the continuous liquefaction of hydrogen and helium at present in use are essentially the same as those originally used by Dewar and Kamerlingh Onnes when these gases were first liquefied. These methods are based on the use of the Joule-Thomson effect, combined with a regenerating heat exchange after the gas has been cooled below its conversion temperature by liquid air or hydrogen. Since these processes are essentially non-reversible, the efficiency of the method is very low: for example, Meissner[1] calculates that to produce liquid helium, one hundred times more power is required than if the process could be done reversibly. The advantages to be gained by using adiabatic expansion for the cooling of liquefying gases have long been realised, but owing to technical difficulties this method has only been used up to the present to liquefy small amounts of gas by a single expansion. Thus in 1895, Olszewski was the first to obtain a fog of liquid hydrogen drops by a sudden expansion of compressed hydrogen. Recently, Simon[2] has produced appreciable quantities of liquid helium also by a sudden expansion of highly compressed helium.

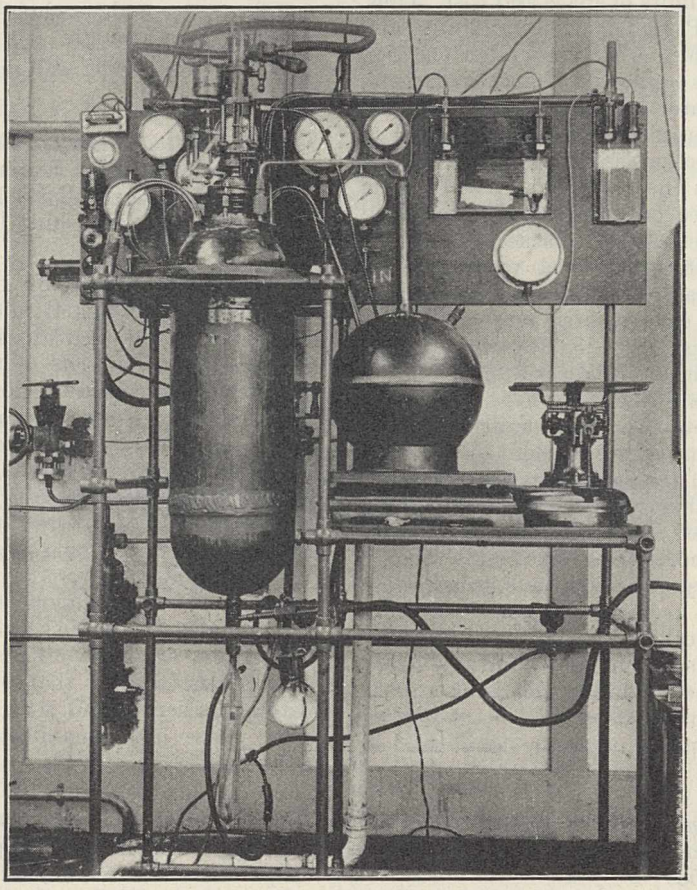

FIG. 1. Helium liquefaction apparatus at the Royal Society Mond Laboratory.

The technical difficulties in constructing an apparatus for continuous liquefaction by adiabatic expansion lie chiefly in the designing of a cooling expansion engine which will work at low temperatures. Two principal types of expansion engine can be considered. The first is a turbine, but this involves a number of technical difficulties which have not yet been overcome. The second type of machine is a reciprocating moving piston expansion engine; this also involves great difficulties, chiefly arising from the difficulty of finding a lubricant which will make the piston tight in the cylinder and retain its lubricating properties at the very low temperatures. Claude, however, managed to make such an expansion engine which would work at the temperature of liquid air by using the liquefied gas as the lubricant. This method, however, does not appear to be practicable for liquefying helium and hydrogen.

During the last year, in our laboratory we have been working on the development of a reciprocating expansion engine working on a different principle which does not require any lubrication of the piston at all, and which will work at any temperature. The main feature of the method is that the piston is loosely fitted in the cylinder with a definite clearance, and when the gas is introduced into the cylinder at high pressure, it is allowed to escape freely through the gap between the cylinder and the piston. The expansion engine is arranged in such a way that the piston moves very rapidly on the expanding stroke, and the expansion takes place in such a small fraction of a second that the amount of gas escaping through the gap is very small and does not appreciably affect the efficiency of the machine.

The principal difficulty in constructing such a machine was concerned with the valves in the expansion engine, which had to let in a considerable amount of gas in a small fraction of a second. Another difficulty was to find metals with the necessary mechanical properties for use at these low temperatures. All these difficulties have now been successfully overcome, and the liquefier is shown in the accompanying photograph (Fig. 1).

The expansion engine is placed in the middle of the evacuated cylindrical copper casing, the dimensions of which are 75 cm. long and 25 cm. diameter. The casing also contains heat-exchanging spirals and a container of liquid air for the preliminary cooling of the helium. Helium is compressed to 25–30 atmospheres and is first cooled to the temperature of liquid air and then cooled by the expansion engine and regenerating spiral to about 8° K.; the final liquefaction is produced by making use of the Joule-Thomson effect. This combination proves to be the most efficient method of liquefaction. The liquid helium is drawn off from the bottom of the liquefier by means of a tap.

Following the preliminary cooling to the temperature of liquid nitrogen, the liquefier starts after 45 minutes to liquefy helium at a rate of 1 litre per hour, consuming about 3 litres of liquid air per litre of liquid helium. This output we hope will shortly be increased, but even now it compares very favourably with the original method of making liquid helium, in which, according to Meissner (*loc. cit.*), the consumption is 6 litres of liquid air plus 5 litres of liquid hydrogen per litre of liquid helium. It is also evidently a considerable advantage to be able to dispense with liquid hydrogen as a preliminary cooling agent. Theoretically it would be possible in our case also to dispense with liquid air, but the size of the liquefier would then be impracticably large. Using liquid hydrogen as a cooling agent, the output of the liquefier could be increased about six times.

The same liquefier has also been used for liquefying hydrogen, which was passed through a special circuit under a pressure of a few atmospheres.

A detailed description of the apparatus will shortly be published elsewhere.

[1] "Handbuch der Physik." Geiger and Scheel, vol. 11, p. 328.
[2] *Z. Phys.*, **81**, 816; 1933.

Science and the Royal Academy

IF the art of the painter were to begin and end in mere representation, the coloured photograph would completely satisfy most people. Indeed, science, by the invention of the stereoscope, has furnished a means of actual representation in three dimensions which far surpasses in this respect even the greatest paintings that exist. It is a commonplace to hear, in any gallery, expressions of approval or otherwise based mainly upon such considerations.

Sir Joshua Reynolds, in his sixth discourse before the Royal Academy, says: "When the arts were in their infancy, the power of merely drawing the likeness of any object was considered one of its greatest efforts. The common people, ignorant of the principles of art, talk the same language even to this day." On the other hand Carlyle, quoting Goethe, points out that "In every object there is inexhaustible meaning; the eye sees in it what the eye brings means of seeing". The colour, arrangement, style or texture, design and rhythm can only fully appeal to those who have given the matter some thought, and who realise that "Art is Nature expressed through a personality".

Yet there must be rules underlying the making of a picture which give to it those fundamental qualities that ensure its survival through the ages. Although science has given the painter a wider range of reliable pigments, and the oils and mediums used by him are more refined and less liable to change, it is interesting to notice that this craft still employs identically the same kind of tools and methods that have been in use for centuries. The development of machinery, the vast accumulation of knowledge in all branches of human activity, the great advances in chemistry and physics, leave the artist undisturbed with his simple appliances. He still works in surroundings very similar to those that could have been found in the studios of Michael Angelo or Titian. The artist is probably unique in this, and acquires therefrom a peculiar position in the scheme of things; often being regarded by the ignorant as a kind of magician, by the intelligentsia as a species of poet, and sometimes by men of science as an overrated member of society, who seems in fact to have contributed nothing to the accumulations of unsorted knowledge.

A possible remedy for this state of affairs lies with the artists themselves. The old masters have left us pictures of the alchemist in his laboratory. Present-day artists have missed a great opportunity in not attempting to represent something of the atmosphere in which modern scientific experiments are frequently conducted. Surely there is wide scope here for artistic adventure. It is not merely a question of depicting some distinguished individual before a background of scientific apparatus. The figures, some in action and others eagerly note-taking, should be subsidiary to the general plan. There is often great beauty of colour and composition to be found—especially in a physics laboratory—where some important work is afoot and being carried through, in dim light stabbed only by beams reflected from the instruments.

The one hundred and sixty-sixth annual exhibition of the Royal Academy, which was opened to the public on May 7, includes the famous bust of Prof. Einstein (1593) by Mr. Jacob Epstein. This has been purchased for the nation under the terms of the Chantrey Bequest. There is also a good portrait of Sir Robert Mond (146), painted by Mr. F. O. Salisbury, and an excellent picture of Prof. John Walton (with a microscope at his elbow) (248) by Mr. W. O. Hutchison. An attempt

to portray a situation of scientific interest may be seen in No. 167, entitled "The Wilson Observer, 1933", by Winifred M. Abram. The portrait of Sir Almroth Wright (26) by Mr. Gerald F. Kelly exhibits a quality which will please all who are satisfied with photographic accuracy. Other portraits likely to interest readers of NATURE are those of Major C. H. Douglas, consulting engineer and economist (3), by Mr. Augustus E. John, R.A.; Prof. H. M. Macdonald, professor of mathematics in the University of Aberdeen (254), by Mr. R. G. Eves; Sir George Buckston Browne (1096), a miniature by Mr. P. Buckman. Since the portraits exhibited at the Academy are often of especial interest, a small additional index to them might with advantage be included in the catalogue.

The work of Mr. Terrick Williams, R.A., entitled "Sun and Mist, Mousehole" (19), is interesting as representing some beautiful changes in appearances due to the dispersion of light through an atmosphere laden with warm vapour.

One outstanding feature of this year's exhibition is the large scale model (1 in. to 4 ft.) of the Metropolitan Cathedral of Liverpool, made by Mr. John B. Thorp, to the designs of Sir Edwin Lutyens, R.A. Finally, we may direct attention to the remarkable metallic sheen upon the herald's coat in the portrait of Sir Gerald Wollaston, Garter Principal King of Arms (237), by Mr. Harold Knight. The brilliant lustre of polished gold is perfectly imitated, merely by the skilful use of suitable pigments.

Dr. Boys on Gas Calorimetry

THE nineteenth Guthrie lecture of the Physical Society was delivered on May 4 by Dr. C. V. Boys, one of the Gas Referees, who took as his subject "My Recent Progress in Gas Calorimetry". Lord Rayleigh presided.

After referring to his very close association with Prof. Guthrie, Dr. Boys remarked that "the making of specious scientific surmises unsupported by experiment, however amusing it may be as a pastime or however loudly it may be advertised, does nothing to advance the certain knowledge of the world; the acid test of experiment is essential. So will you, who in years to come will have the management of this Society in your hands, accept this as a solemn message from the dead. If you would be true to the ideals of Guthrie, you will seek for a Guthrie lecturer from among those who have done things rather than from those who have merely talked."

Proceeding, Dr. Boys stated that he had not been entirely satisfied with the gas calorimeters he had already invented, but now, as the result of work extending over the last nine years, he had designed a calorimeter which gave him complete satisfaction. The essentials of a water-flow calorimeter for measuring the heating value of gas comprise a stream of water to be heated by the combustion of a supply of gas, and means for indicating or recording the resulting rise of temperature of the water stream. As the volume of a given mass of gas depends on its temperature and pressure, it is clear that means must be provided either to correct such volume to standard conditions of temperature and pressure, or alternatively to ensure that water shall flow through the calorimeter at a rate proportional to the uncorrected density of the gas, that is, inversely proportional to the volume at the time of a standard volume of gas.

In his previous recording calorimeter, Dr. Boys utilised the first of these alternatives; in the present instrument (Fig. 1) the latter alternative is adopted. The appropriate hyperbolic relation is realised practically by a device which ensures that the depth of water in the vessel A is proportional to the density of the gas, and that water is picked up from this vessel and delivered to the calorimeter F in this same proportion. The device comprises (1) the closed burette tube, D, containing air or other gas, carried on the radial arm, C, and immersed at its lower open end in a vessel containing mercury, (2) four rotating scoops carried on arms for collecting distilled water from the lower vessel B and delivering it to the upper vessel, A; these pick up rather more than is required for the calorimeter water; (3) a pair of rotating scoops and delivery vessels, of which one is shown at E, for collecting the appropriate volume of water from A and delivering same to the calorimeter proper, F. The excess of water escapes from a siphon carried by the arm C, thus maintaining the required level. The motive power for driving the mechanism is derived via a 'Meccano' chain from the small electric motor shown at H. The water flow system requires the addition of only about 1 gallon of water per annum to replace that lost by evaporation.

The gas-pump, G, for supplying gas to the calorimeter, incorporates a number of novel features. Hitherto, the calorific value of gas supplied for towns' use has been measured with reference to a volume of gas saturated with water vapour, at atmospheric temperature. Within recent years, there has been an increasing tendency on the part of gas companies to supply dried gas, that is, gas from which a very considerable proportion of the water vapour ordinarily present has been removed. In order that the calorific value of such, or any other, gas shall be measured with reference to its actual water vapour content, whether saturated or unsaturated, the gas pump, G, uses mercury as confining liquid. Briefly, the pump comprises an inner cylinder having six longitudinal compartments accurately reamed out, and rotating within an outer casing. Appropriate inlet and outlet ports are provided for each compartment. The same

small electric motor, *H*, driving the water supply device, rotates the inner drum of the gas pump and causes gas to be delivered to the calorimeter proper, *F*, at a constant rate of ½ cub. ft. of gas per hour. The volume of gas is accurately determined from the known dimensions of the pump. Water levelling, which is an essential and troublesome operation with all existing forms of wet meter in order that the gas volume may be accurately known, is no longer necessary.

The calorimeter, *F*, is of very small thermal capacity, so that a reading of outlet water temperature, steady to within about 0·01° C., is attained in about 15 minutes; and this despite the fact that with the calorimeter as at present constructed, the flow of water through the calorimeter is intermittent in character. Later, if found preferable, the water flow will be made continuous. The gas burns at the end of a small tube made of Pyrex glass which is carried by the arrangement including a Watt parallel motion device shown at *J*. The tubes of this parallel motion device can be used for supplying gas and oxygen to the burner, if desired. The constructional materials used in the calorimeter comprise ordinary glass for the combustion chamber, a Pyrex glass burner tube and brass and German silver, the latter being protected by a coating of special bakelite varnish which very effectually prevents corrosion of the base metal by the products of combustion. The water flowing through the calorimeter suffers no deterioration owing to its passage and is re-circulated. The rise of temperature of the water is a measure of the calorific value of the gas supply and can be observed by thermometers inserted respectively in the inlet and outlet water, or can be recorded by thermometers, preferably of the electrical type, connected with an electric recorder.

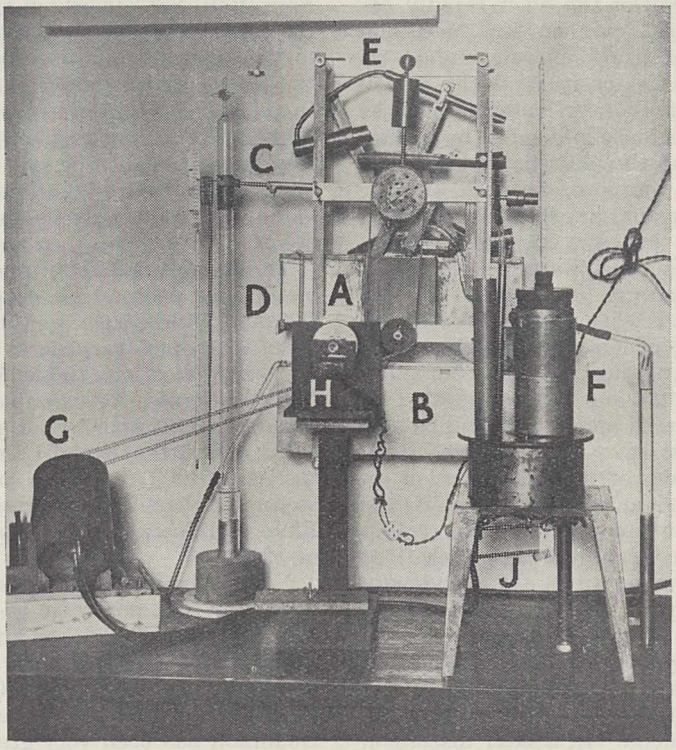

FIG. 1. Dr. Boys's new gas calorimeter.

Concluding his remarks, Dr. Boys stated that he had carried out the whole of the work single-handed and had constructed the whole of the apparatus himself. "For sixty years the Gas Referees have been men of high scientific distinction. My predecessors were Sir Arthur Rücker and Prof. Tyndall and my colleagues and their predecessors were of equal standing. This has always been considered necessary because of the technical difficulties of the questions which they had to decide. The Gas Referees have been in the position of judges, between the gas maker and the gas consumer. Though provision for appeal on their decisions is available, no appeal in all that time has ever been made and heard. Now the Board of Trade is knocking at the door of Parliament to replace the Gas Referees by the cumbersome machinery of the Civil Service."

Dr. Charles Carpenter, president of the South Metropolitan Gas Co., expressed his very high appreciation of the work done for the gas industry by the Gas Referees, and stated that he was unable to understand how the Government is being so misguided as to recommend the abolition of these posts.

J. S. G. T.

Obituary

PROF. A. B. MACALLUM, F.R.S.

PROF. A. B. MACALLUM, who died on April 5 at London, Ontario, in his seventy-sixth year, may be regarded as the pioneer of general physiology in Canada. Educated at the University of Toronto, he received his training in physiology under Newell Martin in the then newly organised Johns Hopkins University. Returning to his *alma mater* in 1887, as lecturer in physiology on the staff of biology under Ramsay Wright, he devoted himself to investigations bearing on the interpretation of microchemical reactions.

Macallum's first paper, on the demonstration of iron in chromatin, was published in 1891 (*Proc. Roy. Soc.*, 50, 277) and it was followed two years later by a second one (*J. Physiol.*, 26, 268; 1893) dealing with the path of absorption of this element from the alimentary canal. Methods were then

tested and elaborated for the micro-chemical demonstration in cells and tissues of other elements, especially phosphorus, potassium, calcium and chlorine. He showed (*Proc. Roy. Soc.*, B, **76**, 217 ; 1905) that the colour reaction which tissues give under the influence of light when impregnated with nitrate of silver is not due, as had been supposed, to protein itself but to halogens, so that this staining method could be used for determining the distribution of chlorides in various cytological elements.

Being a keen student of the then rapidly expanding knowledge of physical chemistry, Macallum saw the possibility of using micro-chemical reactions to investigate the position in the cell of adsorbed ions and of thereby determining the extent to which this might be influenced by surface tension. Realising that the chloride reaction was independable for this purpose, because of slow penetration of the reagent, he devised a method by which potassium can be identified microchemically through its precipitation with hexanitrite of cobalt and sodium (*J. Physiol.*, **32**, 95 ; 1905). He showed that when proper precautions are taken, the reagent penetrates the cell rapidly and that the position of the yellowish compound which it forms with potassium can be revealed by subsequent treatment with ammonium sulphide.

A thorough investigation, extending over several years, was then made of the distribution of potassium in plant and animal cells, and it was found that the element is concentrated in regions of the cell in a manner to suggest that alterations in surface tension are responsible. In a review of these researches published in 1911 in *Ergebnisse der Physiologie*, there is a full discussion of the hypothesis that the properties of division and movement in cells, as well as of secretion and absorption, can be attributed in part, at least, to surface tension phenomena. In a later discussion of his results (1913) (Presidential Address, Soc. of Biol. Chem.), Macallum advanced the view that the chief factor in muscular contraction "is the attraction between the molecules constituting the superficial film of a sarcostyle and forming an interface with the sarcoplasm surrounding the sarcostyle". This attraction, which is the cause of the surface tension, is not equal throughout the doubly refracting discs, as is shown by the fact that potassium salts are localised at the ends of the longitudinal axis, indicating, according to the Gibbs-Thomson principle, that the surface tension is lower here than on the lateral surfaces. During contraction, the discs tend to become spherical because the surface tension of the lateral surfaces becomes less. Speculations follow concerning the relationship of the breakdown of the lactic acid precursor to these changes in surface tension, and the paper is interesting reading in the light of the more recent researches in this field.

Macallum also made numerous observations by chemical methods of the percentage amounts of inorganic ions in the tissues and body fluids of various animals. He showed that when regard is paid to the relative proportions of sodium, potassium and calcium, rather than to the absolute concentrations of these ions, there is a striking resemblance between the composition of the ocean and the inorganic composition of the blood plasma of mammals. His first paper in this field appeared in 1903 (on "The Inorganic Composition of the Medusæ", *J. Physiol.*, **29**) and the conclusions there drawn are sustained in a second one published in 1910 ("The Inorganic Composition of the Blood of Vertebrates and Invertebrates and its Origin", *Proc. Roy. Soc.*) in which there is a discussion of the relationship of the development of the kidneys to the inorganic composition of the blood plasma of various marine invertebrates and vertebrates. In this paper Macallum points out that the establishment of a constant internal medium was the first step in the evolution of vertebrates from an invertebrate form and advances the view that the kidney was essentially the first typically vertebrate organ.

Throughout all his investigations, Macallum maintained a broad philosophical outlook and his thorough knowledge of biology and indeed of natural science in general enabled him to find various applications for the results of his laboratory investigations. As examples may be mentioned papers dealing with the origin of life on the globe (read before the Royal Canadian Institute about the year 1903) and the physical and chemical factors in heredity (address as president of the Biological Section of the Royal Society of Canada in 1910).

No account of Macallum's career would be complete that did not refer to his painstaking work from 1916 until 1921 as the first administrative chairman of the Advisory Council for Scientific and Industrial Research of Canada. His influence on the development of scientific research in the Dominion has been very great, partly through his active participation in the work of the Royal Canadian Institute and the Royal Society of Canada, and partly through his association first with the University of Toronto and latterly with that of McGill in Montreal.

Macallum was a man of imposing presence and forceful character, and it will be long before he is forgotten in Canadian scientific circles.

J. J. R. M.

Dr. E. W. Washburn

Dr. Edward Wight Washburn, who died on February 6 at the age of fifty-two years, was the chief of the Division of Chemistry of the U.S. Bureau of Standards at Washington. He was well-known to a wide circle as a physical chemist of distinction and the author of an "Introduction to the Principles of Physical Chemistry".

Washburn was a graduate of the Massachusetts Institute of Technology, where he was a pioneer in the study of the hydration of the ions in aqueous electrolytes. From 1908 until 1922 he held appointments in physical chemistry and then in ceramic

engineering at the University of Illinois, where he produced a long series of scientific and technical papers. Then, during a period of four years, he undertook the Herculean task of editing the "International Critical Tables", a task which was rendered supremely difficult by the fact that it had to be undertaken *de novo* instead of undergoing a progressive development. The completed tables, which have recently been made much more accessible and easy to use by the addition of a new index volume, will remain as a monument to Washburn's patience and skill, and are likely for many years to serve as a foundation, to which successive volumes of the "Annual Tables" may be added in order to maintain the up-to-date character of the whole edifice.

When appointed to the Bureau of Standards in 1926, Washburn undertook a wide programme of investigation and research, from which two items may be selected for comment. The first was the remarkable achievement of preparing crystals of rubber, by distillation under extreme conditions of low pressure and short distance, in which Washburn was keenly interested when I visited him at the Bureau of Standards in 1930. The second, which will perhaps be appreciated more widely than any other feature of his career, was his discovery in January 1931 of the fractionation of light and heavy water by the process of electrolysis. The separation of isotopes on a practical scale marks the beginning of a new period in chemistry, and, since Washburn's method of separation is already being developed as a manufacturing process, his name will long be remembered as the originator of this new period.

T. M. LOWRY.

DR. L. R. FARNELL

WE regret to record the death of Dr. L. R. Farnell, formerly rector of Exeter College, Oxford, and the well-known authority on the religious cults of ancient Greece, which took place at Parkstone, Dorset, on March 28.

Lewis Richard Farnell attained the age of seventy-eight years on January 19 last, having been born at Salisbury in 1856. The second son of John Wilson Farnell, he was educated at the City of London School, of which Dr. Evelyn Abbott was then headmaster, and at Exeter College, Oxford, where he won an open classical scholarship. Practically the whole of the rest of his life was devoted to the service of his College and University. Two years after taking his degree in 1878, with first-class honours in both Classical Moderations and *Literæ Humaniores*, he was elected to a fellowship of his College. He then studied classical archæology in Germany and travelled in Greece and Asia Minor, returning to Oxford to serve Exeter as tutor, sub-rector, senior tutor and dean, and from 1914 until 1928 as rector, in which office he succeeded the late Dr. W. W. Jackson.

His studies in classical archæology, more especially of the attributes of the gods as represented in art, led Farnell to the comparative study of Greek religious cults. He rapidly attained a high reputation as an interpreter of obscure passages in Greek literature in the light of his research. His greatest achievement, however, was his monumental work "The Cults of the Greek States" in five volumes, which appeared between 1896 and 1909, with a supplemental volume on hero cults, published in 1921. In this work Farnell showed a mastery of detail which was equal to, if it did not surpass that of the best German scholarship of the day, combined with an unusually wide knowledge of comparative material. His contribution to the study of Greek culture is original in conception, fundamental and epoch-making.

Farnell was also the author of a number of smaller works, dealing with the religions of Greece and the ancient East and with comparative religion, in which he showed a great gift of lucid, semi-popular exposition, combined with sound scholarship. He was a frequent and valued contributor to the learned periodicals concerned with his special studies.

In 1901 Farnell was one of the first to receive the newly instituted degree of D.Litt. of his University. He was University lecturer in classical archæology from 1905 until 1914, the first Wilde lecturer in natural and comparative religion, Hibbert lecturer in 1911, and Gifford lecturer in 1919. He served as Vice-Chancellor of the University in 1920–1923. If he required a high standard from his pupils in conduct, industry and scholarship, his whole life and work afforded them an admirable example.

DR. ALBIN STOCKÝ, professor of archæology at Prague, died on April 18 at the age of fifty-eight years. He was the author of numerous publications dealing with Bohemia in the Stone and Bronze Ages. He had served on various archæological commissions and had given valuable assistance to museums in connexion with the identification of objects dating from prehistoric times.

WE regret to announce the following deaths:

Mr. Henry S. Hall, formerly head of the military and engineering side at Clifton College, author of many well-known textbooks of mathematics, on May 3, aged eighty-five years.

Mr. Carl Olaf Lundholm, technical adviser to the Nobel Trust in 1909–14, a pioneer in the manufacture of explosives, on May 8, aged eighty-four years.

Dr. J. P. van der Stok, director of the Section of Oceanography and Maritime Meteorology at the de Bilt Meteorological Institute, near Utrecht, in 1899–1923, formerly director of the Magnetic and Meteorological Observatory, Batavia, on March 29, aged eighty-three years.

News and Views

Royal Society Elections

AT the meeting of the Royal Society held on May 3, the candidates whose names were given in NATURE of March 10, p. 352, as having been selected by the Council for fellowship of the Society, were duly elected. In addition, two foreign members were elected, namely, Prof. H. L. Lebesgue, of Paris, the discoverer of 'Lebesgue integration', and Prof. O. Warburg, of the Kaiser-Wilhelm Institut für Zellphysiologie, Berlin-Dahlem, who is known for his work on cellular metabolism and respiration.

Prof. Henri-Léon Lebesgue, For. Mem. R.S.

HENRI-LÉON LEBESGUE was born in 1875 at Beauvais, and after studying at the École Normale Supérieure, taught from 1899 until 1902 in the Lyceé at Nancy, where he wrote his famous thèse de Doctorat "Intégrale longueur, aire", which was published in the *Annali di Matematica*, in 1902. After holding academic posts at Rennes and Poitiers, he was appointed in 1910 lecturer at the Faculty of Sciences of Paris, in 1921 professor of mathematics at the Collège de France, and in 1922 a member of the Academy of Sciences. Prof. Lebesgue's reputation was first made by his definitions of the functional operations of integration and derivation, which are of such generality that they may be applied to classes of functions vastly more extensive than the restricted classes to which earlier definitions had been applicable. It was Cauchy who first replaced the geometrical idea of an integral, as an area, by a precise arithmetical definition, regarding it as the limit of a sum of elements $f(x)\ \Delta x$ when Δx tends to zero ; and on this basis he proved theorems of existence and uniqueness. Riemann generalised Cauchy's conception by extending it to certain functions which were discontinuous at points forming sets dense everywhere ; but the functions integrable in Riemann's sense are still a limited class.

IN order to obtain a more general definition, Lebesgue first devised a theory of the 'measure' of a set of points, which was a great improvement on the theory of 'content' previously given by Cantor, namely, that the content of the sum of two sets is not in general the sum of their contents, whereas the measure of the sum of two mutually exclusive sets is always the sum of their measures. He then departed from the procedure of Cauchy and Riemann for defining $\int f(x)dx$, by dividing the range of variation of $f(x)$ into intervals (as contrasted with dividing the range of variation of x into intervals), and considering the measures of the sets of points belonging to these intervals, whence a definition of the integral naturally follows. Lebesgue's definitions of integration and derivation have led to developments of far-reaching importance in the theories of Fourier series and other trigonometric series, of singular integrals, integral equations, Dirichlet's problem, the calculus of variations, functional operations, and the properties of analytic functions in the neighbourhood of their singularities.

Prof. O. Warburg, For. Mem. R.S.

PROF. OTTO WARBURG is well known for his very important work on metabolism and respiration in cells. In this work he made extensive use of the manometric technique, which he greatly developed. This method was applied by him and the members of his school to a great variety of biological problems with conspicuous success. By using very thin slices of animal tissues suspended in serum, precise measurements of respiration and other metabolic processes could be made under approximately physiological conditions. By this means he discovered an important difference between the metabolism of normal tissues and that of rapidly proliferating tissues such as tumours, namely, the fact that the latter show a high ærobic glycolysis. By the study of the inhibitory effect of certain specific poisons, such as cyanides and carbon monoxide, on respiration, he showed the important rôle played by catalytic compounds of iron. On studying the effect of light of different wavelengths on cells poisoned by carbon monoxide, a photochemical absorption spectrum was obtained which was found to be very similar to that of a hæmatin compound. In this way he showed the importance of hæmatin compounds in cell respiration. In the analysis of these effects he displayed remarkable technical genius. In addition to this hæmatin system (known as the respiratory enzyme), Prof. Warburg has recently discovered another important intracellular system involving a different type of catalytic pigment, belonging to the class now known as flavines. Prof. Warburg is also well known for his fine work on photosynthesis.

Bicentenary of Stahl (1660-1734)

Two hundred years ago, on May 14, 1734, Georg Ernst Stahl, the celebrated German physician and chemist, died at Berlin at seventy-three years of age. For many years he had been physician to Frederick I, King of Prussia, and he was widely known for his original views and for his numerous writings. He wrote, edited or superintended no fewer than 250 works. Born at Anspach, Bavaria, on October 21, 1660, at a time when Germany was just recovering from the terrible effects of the Thirty Years War, he studied medicine at Jena ; at the age of twenty-seven years became physician to the Duke of Weimar and six years later was appointed professor of medicine, anatomy and chemistry in the newly founded University of Halle. He taught there for twenty-two years (1693–1716), and it was during that time he enunciated the doctrines of vitalism and animism and the theory of phlogiston, the latter a generalisation which did much to make chemistry a science. "The doctrine of phlogiston," says Thorpe, "was embraced by nearly all Stahl's German contemporaries, notably by Marggraf, Neumann, Eller and Pott. It spread into Sweden, and was accepted by Bergmann and Scheele ; into France, where it was taught by Duhamel, Rouelle and Macquer ; and into Great Britain, where its most influential

supporters were Priestley and Cavendish. It continued to be the orthodox faith until the last quarter of the eighteenth century, when, after the discovery of oxygen, it was overturned by Lavoisier."

Refrigeration and its Applications

FOR the first of the series of Research and Development Lectures arranged under the auspices of the British Science Guild and delivered at the Royal Institution, Sir William Bragg, on May 2, took as his subject "Refrigeration". This he pointed out is of great importance to Great Britain, which imports an immense amount of meat, fish, butter and fruit, many hundreds of shiploads of which are received every year. The principles underlying refrigeration are comparatively simple, but their application on a commercial scale has involved much research such as is being carried out at Cambridge, the National Physical Laboratory, East Malling and elsewhere. Historically, the subject of heat and cold goes back to the early days of the Royal Society, and Hooke's views on fluidity are of much interest. In the eighteenth century, the theory of caloric held sway, but it was through the work of Rumford, Davy, Mayer and Joule that it was shown that heat is, in the phrase of Tyndall, a mode of motion, and to-day it can be shown that the molecules of substances are all in motion, the rapidity of which is increased by heat and decreased with cold. All the phenomena of expansion, compression and evaporation, which are utilised in refrigerating machines, are explained by this theory. Throughout the lecture, each step was illustrated by experiments in which billiard balls, bicycle pumps and liquid air played as important a part as thermo-couples and galvanometers. A singularly beautiful demonstration of the formation of vapour and clouds was given by pouring liquid air on to the surface of warm water lying in a large shallow pan. Liquid air was used also to show the alteration in the properties of substances when really cold, rubber becoming brittle and a bell of lead giving a metallic note when cooled in it. Sir William referred to the refrigeration exhibition now being held at the Science Museum, and on behalf of the director of the Museum invited all those in the audience to visit it.

Electrical Phenomena at Very Low Temperatures

PROF. J. C. MCLENNAN gave the twenty-fifth Kelvin Lecture before the Institution of Electrical Engineers on April 26, taking as his subject "Electrical Phenomena at Very Low Temperatures". In 1823 Faraday succeeded in liquefying chlorine and afterwards succeeded in liquefying many other gases, but he failed to liquefy oxygen, nitrogen and hydrogen as he was unable to obtain the requisite low temperature. At the end of the War, a large stock of helium was available in Toronto, and this gas was successfully liquefied in 1923, a century after Faraday's experiment with chlorine. By evaporating liquid helium and thus reaching an absolute temperature of 0·7° K., Keesom of Leyden successfully solidified this element in February 1932. The liquid was subjected to a pressure of 175 atmospheres and surrounded by rapidly evaporating liquid helium. The reason why liquid oxygen, hydrogen and helium are very good insulators is probably because the electrons are closely bound to the nuclei. In 1911, Kamerlingh Onnes found that the resistance of mercury vanishes suddenly at 4·2° K. and that some other metals behave similarly at definite low temperatures. Most metals show no trace of this supraconductivity even when great pains are taken to ensure their purity. Certain alloys have been found to become supraconductive. This supraconductivity can be destroyed by placing them in a magnetic field. The lower the temperature the greater the magnetising force necessary to destroy the supraconductivity. By suddenly destroying the magnetic field surrounding a ring of supraconductive metal, a current can be set up in it if its temperature be below the transition point. This current is quite independent of the nature of the metal and depends only on the intensity of the original induction. It looks as if the results of low temperature research would throw light on the nature of magnetism.

The Restrictive Law of Population

IN his Huxley Memorial Lecture under this title, delivered on May 4, Prof. Johan Hjort, of the University of Oslo, dealt with a subject which exercised a decisive influence upon the thought of Huxley : the question of over-population (London : Macmillan and Co., Ltd. 1*s*. net). Prof. Hjort assumes that human society can be studied as a historical group of diverse individuals living in a restricted complex environment, and shows that biology has disclosed the many and various factors which influence the vital processes of the individuals comprising a population and determine the quantity and quality of the population as a whole. He defines an optimum population as the minimum number of individuals who can utilise to the full the vital possibilities made available by one or other of these factors. Incidentally, he surveys the fishing and whaling industries as examples, and illustrates his point that the conditions in both depend upon the power of regeneration shown by the stock. In the case of the whale, technical developments have produced a grave disharmony between the reproductive rate and the death rate, and the problem before the industry is that of defining the optimum catch. Restriction of the numbers killed is urgently demanded, but this requires both State intervention and international agreement.

ACCORDING to Prof. Hjort, the ideal of all social endeavour is the maintenance of the population in a state of permanent equilibrium under conditions of life which are optimal. For the achievement of this ideal, society must undertake vast and prolonged biological experimentation. Through biology there has come an emancipation from mental chaos and from the belief that human life is governed by irrational chance. Biology has shown that over-population, which inevitably arises in certain given natural conditions, is not due to a superficial turmoil of moods and sentiment, but to the operation of natural laws. To-day society has both the knowledge

and the power to solve, in its own ways, the problem of population. If there be the possibility of enlargement of the means of subsistence, of renewed expansion, then this should be completely explored; but, if such expansion is impossible, then the aim of society must be to ascertain the limits in which an optimum population can enjoy the maximum of liberty. In both tasks the method must be that of the social experiment. Though Prof. Hjort mainly restricts himself to a discussion of the method of research and experiment in its application to social problems, he does not avoid the conclusion that an economically re-united Europe would afford conditions for a new emancipation, for a recovery of the freedom that the War destroyed. For, he holds, this would bring peace, and peace amongst men is not a natural state of things; it does not make itself, but must be made.

Representation of Science on Government Commissions

As announced last week in this column, the Postmaster-General is about to set up a committee to consider the development of television, and to advise on the conditions under which any public television service should be provided. It is understood that the personnel of the committee is to consist of representatives of the Post Office, the British Broadcasting Corporation, and the Department of Scientific and Industrial Research. A committee so constituted, presuming that some of the members have practical knowledge of the problems involved in television, would command that measure of public confidence which is necessary if its deliberations are to find general acceptance; and it would be an advance on many Commissions and committees appointed by the Government in this respect. For reasons which it is difficult to understand, there has been a lamentable tendency on the part of Ministers to pass over scientific men in setting up Royal Commissions, committees, and departmental committees, even when matters in which scientific and technical issues are involved.

IT is to be hoped that the constitution of the television committee is a sign that the Governmental mind is being quickened in this respect. Time and again, we have urged that no body set up to consider any subject with scientific or technical ramifications can be adequate or complete unless it includes scientific workers or technicians in its personnel. The Parliamentary Science Committee—a body representing the British Science Guild, the Association of Scientific Workers, and a number of learned societies—has also taken up the matter, urging the Prime Minister to insist on his colleagues observing this principle. Some fifteen months ago the Postmaster-General appointed a Post Office Advisory Committee. If this body is to be of real service it will, presumably, have to advise on technical matters such as telephony and telegraphy. Yet no one with scientific or technical qualifications was appointed amongst a numerous membership. There is now a vacancy occasioned by the death of the Hon. Mary Pickford, thus affording an opportunity of rectifying this state of affairs.

Scientific Method and Politics

THE first instalment of a tabular analysis of various social and economic systems, in the form of answers to a questionnaire prepared by the Engineers' Study Group on Economics (NATURE, 132, 635, Oct. 21, 1933) is to appear in the forthcoming issue of *Progress*, the organ of the Association of Scientific Workers. The Study Group, apart from research investigations, arranges for discussions on questions of the moment, at which those engaged in any branch of scientific work are welcomed. On May 16 Mr. Harold Macmillan, M.P., will address the Group on "Reconstruction". The meeting will be at 7.45 for 8 p.m. at Denison Hall, 296 Vauxhall Bridge Road, Victoria, and Sir Richard Gregory will take the chair. Tickets may be obtained from the honorary secretary of the Group, Col. P. Johnson, Gunnersbury House, Hounslow, Middlesex.

THE interest which scientific workers are beginning to show in social and economic questions is not restricted to Great Britain. In France there are several active groups. The Centre Polytechnicien d'Etudes Economiques (12 rue de Poitiers, Paris; president, M. Gerard Bardet) consists mainly of former students of the Ecole Polytechnique, one of the best-known engineering colleges in France, and is now in its third year of existence. Another, the Centre d'Etudes Economiques de l'Alimentation (39 boulevard de Sebastopol, Paris; president, M. André Roussel) was formed by the fusion of three pre-existing groups drawn from the Ecole Polytechnique, Ecole des Centraux and the Institut Agronomique. Both organisations publish bulletins regularly, giving the results of their studies on economics and production and distribution of foodstuffs.

Unemployment and Poverty in India

IN a recent article in the *Karachi Daily Gazette*, Capt. Petavel, formerly lecturer on the poverty problem at the University of Calcutta, strongly advocates the formation of co-operative colonies as a solution of the problems of unemployment and poverty in India. He suggests that the colonies should be open not only to those who have merely their labour to offer, but also to those who would contribute capital, land or equipment. All would be co-operators in their way, and would have a share of the products. The workers' remuneration would be mainly in kind, but part might be in money. This would enable the more ambitious to save, and in time to launch out on any small undertaking they might fancy. If they failed, they could return to the colony, which would thus provide opportunity with security. As the colonies developed, they could adopt a system of 'exchange tickets' redeemable in the produce of the colony. Thus it is claimed purchasing-power would always be commensurate with productive power. People could always get work in the colony, because they would get a ticket to take away what they had produced. To reinforce his argument, the author refers to the Swiss Labour Colony at Witzwil and that at Llano in Louisiana.

In the former, even people classed as 'unemployables' have been made self-supporting. In India he suggests a start could most easily be made with an educational co-operative colony in which young persons could work and receive their education. Elderly persons might also be included to act as leaders, or to work in departments of their own. In order to start a fund for experiment on the lines advocated by Capt. Petavel, the Mayor of Karachi has announced that he will give Rs. 5,000 and 50 acres of good land near Karachi.

Re-equipment of Collieries and Steelworks

IN the supplement to the *Daily Telegraph* of March 19, Dr. A. H. Railing says that the need for the reorganisation of certain of the basic industries of Great Britain is urgent. As a result of recent applications of scientific knowledge, great advances have been made in developing new plant for the economic mining of coal and the manufacture of iron and steel products. In recent years the grouping of collieries makes it possible to use large turbo-machines and thus considerably lowers the cost of generating electric power. This solution of the problem of the handling and transport of coal will contribute greatly to the economic success of the undertaking. A colliery equipped with a modern coal-cleaning installation can command higher prices for its output. Loss and waste due to the breakage of coal can now be reduced to a minimum by using anti-breakage devices. By grouping together iron and steel works it would be possible to utilise the by-product gases of the iron and steel industry. An installation of large turbo-generator units in such a station would enable it to have a thermal efficiency as high as that obtained in the largest modern power station. The by-product gases from the industry would in this way acquire the same heat value as the coal used in coal-fired power stations. Many of the rolling mills in Great Britain have been installed for very long periods and their retention in service militates against securing the high quality of product demanded to-day. An electrically driven rolling mill of modern design can be regarded in the light of a precision tool, capable of an output of material possessing the highest degree of accuracy obtainable in rolling practice. The electric furnace also opens out great possibilities. One of the valuable properties of the high-frequency electric furnace is that, when operating, it gives rise to an automatic stirring action which secures a uniform product.

Street Traffic Signals, 1868–1934

IN 1868 the City of Westminster introduced a method of mechanical signalling to help the police to control the traffic. A semaphore, having a red and green gas lamp for night use, was employed, but unfortunately an explosion put an abrupt end to this experiment. Early in this century, road signals similar to railway signals were used for controlling a few tramways and also the traffic on Tower Bridge. So far back as 1918, colour light signals were used to control street traffic in New York. The Siemens and General Electric Railway Signal Co. (S.G.E.) installed the first modern British traffic signal at a busy road junction in Wolverhampton in 1926. The most recent development of the vehicle-actuated signals is the 'Autoflex' system of the S.G.E., a full description of which is given in the Engineering Supplement of the *Siemens Magazine* for April. It was first brought into use in November 1933 and there are now several installations giving very satisfactory service. In this system vehicles approaching a road junction pass over pneumatic detector mats, installed in the paths of the various traffic streams, and so notify their movements to an electrically operated controller. The mats are equivalent to the eyes and ears of a traffic policeman. If vehicles leave the intersection on the wrong side of the road the mats are insensitive. The top of the mat is rounded and projects slightly above the road level presenting a good striking face, so that it is not possible for high-speed vehicles or caterpillar tractors to ride over it without registering. If no suitable gap occurs within a predetermined time, the continuous stream is arbitrarily interrupted and the right of way transferred. There is no necessity for long 'amber' periods since signal changes take place only when the intersection is clear; two or three seconds are generally sufficient. The power required for a controller is only about 30 watts, which is less than that required by an ordinary lamp.

Crystalline Structure and Failure of Metals

THE eighth Edgar Marburg lecture of the American Society for Testing Materials was delivered by Dr. H. J. Gough, his subject being "Crystalline Structure in Relation to Failure of Metals—especially by Fatigue". Dr. Gough dealt almost exclusively with the results of X-ray examination of metals, and the paper contains what is probably the fullest résumé yet given of the subject. Some indication of the ground traversed will be obtained from the fact that the bibliography contains no less than 175 separate references. Starting off with a general discussion of the nature of the atomic bond and of the structure of solids in connexion with the basic problem of failure under stress, the methods of preparation of single crystals of metals, and crystal structure as revealed by X-ray investigation, Dr. Gough then proceeded to consider more specifically the distortion of single metallic crystals under simple static stresses, the influence of the crystal boundary upon strength and distortion and the effects of cold-working upon single crystals and multicrystalline aggregates. Coming to the subject of failure under 'fatigue' conditions, Dr. Gough dealt with metals crystallising in the face-centred cubic, in the close-packed hexagonal (discussing incidentally the twinning of zinc), in the body-centred cubic, and in the face-centred rhombohedral lattices. Finally, he considered the behaviour of single crystals as compared with that of multicrystalline metals. Dr. Gough's conclusions are not yet everywhere accepted, but whatever the individual opinions of readers of the lecture may be, it will be universally welcomed as providing, in a readily accessible form, an almost

ideal summary of work dispersed throughout a multitude of different publications.

Aerial Surveys for Town Planning

THE urgent necessity for modern town plans required under the Town Planning Act has raised the possibility of meeting the demand by aerial survey. In most cases, less than two years remain for the completion of these plans. The Ordnance Survey at its existing strength cannot hope to meet this demand. A scheme outlined in the *Times* of May 5, however, promises to meet the situation, and the Ordnance Survey has promised its co-operation if local authorities make immediate revisions by air survey. The scheme would admit of the 16,000,000 acres of town planning areas in England and Wales being covered within two years. The country would be divided into sixteen units, of which eight would be photographed concurrently. On the reasonable assumption that 30 days in the year would be suitable for vertical photography, the work could be done in the two years available. Local authorities would be supplied with prints on a scale of 1 : 5000 and a set of transparencies on the same scale as the Ordnance sheets. The originators of the method are Messrs. H. Hemming, Ltd., and Economic Air Surveys, Ltd. The fully revised Ordnance sheets would follow later.

Aerial Surveys in the United States

AN extended scheme of aerial mapping in the southern States is planned under the United States Geological Survey in co-operation with the Shore and Geodetic Survey, the Census Bureau and other Federal bodies. The area to be covered, according to a report issued by Science Service, of Washington, D.C., is 40,000 square miles, selected from agencies in the States of Alabama, Arizona, Arkansas, California, Georgia, Louisiana, Mississippi, New Mexico, South Carolina, Texas and the District of Columbia. The maps will be used primarily in connexion with the agricultural census to be made in November next, but will have a permanent use as State records and for other purposes. The need for a more systematic land survey is indicated by the fact that air reconnaissances have already revealed the existence of vacant farms and waste lands not under cultivation hitherto unrecorded and consequently in some instances escaping taxation. There may be an extension of the scheme later to cover 1,000,000 square miles. As at present planned, it will take seventy days to complete at a cost of 650,000 dollars. The aeroplanes will have the co-operation of link-men on the ground under observation, and altogether 500 engineers with 1,500 assistants will be employed. The scheme is part of the programme of the Civil Works Administration for the relief of unemployment.

Records of the Maya

STUDENTS of American archæology will welcome the publication by the Carnegie Institution of Washington of "The Book of Chilam Balam of Chumayel"—the Book of Balam the Prophet, which, giving an account of certain matters pertaining to ritual and belief as recorded by the ancient Maya in their own language, is one of the most important pieces of documentary evidence relating to the early history of Yucatan known to scholars. The book has been edited by Mr. Ralph L. Roys, who for the first time has applied the principles of classical scholarship to the establishment of a standard text. The text is accompanied by a translation and annotations by the editor. There are several versions of the Book of the Prophet Balam, each known by the name of the village to which it belonged originally, such as that of Tizimin, Ixil, or Nah. That of Chumayel, with those of Tizimin and Mani, have the greatest value for the study of Maya civilisation. Chilam Balam, whose prophecies are recorded among the matter in his book, lived at the end of the fifteenth century and the beginning of the sixteenth. The Chumayel version dates only from 1782; but there is little doubt that the greater part of it has a pedigree as an authentic copy going back to the sixteenth century when the Maya wrote down in the European script, but in their own language, prophecies, chronicles, rituals, myths, calendrical matter and medical treatises, much of which would appear to have been transcribed directly from the hieroglyphic manuscripts afterwards destroyed and proscribed by the Spaniards. The original manuscript of the Chumayel version has disappeared, and the present text has been prepared from photographic copies.

Nature Sanctuaries in Zululand

NATAL possesses five sanctuaries for wild life, and all, with the exception of the bird sanctuary at St. Lucia and False Bay, have special interest on account of the rare mammals they contain—the Umfolosi has the only surviving herd of the southern white rhinoceros. The reserves have been threatened to some degree because of the fear that their mammals preserved a reservoir of the trypanosomes of the cattle disease, nagana. But it may be accepted that the destruction of big game is a futile method of controlling the tsetse-borne disease, and that the reserves may well be retained, since they occupy areas unfitted for agriculture on account of endemic nagana, malaria, insufficient rainfall or poverty of soil. Indeed, in a pamphlet on "Natal's Nature Sanctuaries in Zululand" E. K. du Plessis urges that they should be properly established and made statutory, that they should be provided with suitable approaches to encourage tourist traffic, and that they should be surrounded by a three-mile buffer-zone, to prevent shooting parties from slaying animals on the very border of the reserve. It is further suggested that the shooting season should close at the end of September, since the does are in young by October, and that all-year licences for shooting should be discontinued.

Lancashire and Cheshire Fauna Records

THE issue of the nineteenth annual report of the Lancashire and Cheshire Fauna Committee for the

year 1932 adds *Plastoscira Egertoni*, from Rostherne Mere, Cheshire, as a new species to science, while a list of a hundred new species added to the faunistic records for the two counties includes 38 Mallophaga on the birds and mammals, which Mr. H. Britten is investigating, 20 Diptera, 17 sawflies, 10 Coleoptera, 9 Hymenoptera, 3 Anoplura, and one each of Lepidoptera, Arachnida and mites. The avi-fauna records for the year include the nesting of the golden-eye and of the pochard in Cheshire for the first time, and the occurrence of a flock of knots (*Calidris c. canutus*), estimated to number 7,000, on the Lancashire coast in July. White-fronted geese and grey lag geese are increasing in north Lancashire in winter, while tufted ducks, teal, shoveller and little owl are also reported to be increasing in parts. The main colony of Sandwich terns on Walney Island, Lancashire, was wiped out by the herring and lesser black-backed gulls, the colony of which, established five years ago, has assumed alarming proportions. The terns from Walney went to nest at Ravenglass ternery where the Sandwich terns have increased from 12 pairs in 1930 to 70 in 1931, and 370 in 1932. The ruff (*Philomachus pugnax*) is still a regular autumn migrant and records are made of the wood-sandpiper (*Tringa glareola*), green-sandpiper (*T. ochropus*), greenshank (*T. nebularia*) and grey phalarope (*Phalaropus fulicarius*) on passage, while large numbers of black-tailed godwits were seen in the spring on the coast. The Fauna Committee announces that it will dedicate Part 2 of its "Check List of the Fauna of Lancashire and Cheshire" to the late T. A. Coward, for many years one of the recorders of the Committee; Part 1 having been issued in 1930. Mr. A. W. Boyd is president of the Committee and H. E. Britten, Prof. S. J. Hickson and W. Mansbridge vice-presidents.

National Museum of Wales

THE annual report for 1932–33 of the National Museum of Wales shows with what fine spirit the people of Wales are supporting their progressive Museum. The opening of the exhibition galleries in the east wing threatened to be marred by the existence of a considerable debt upon the building; but a public appeal has resulted in the receipt of more than three hundred contributions, so that, as promised moneys come in, the debt will be finally extinguished. The Folk Industries Gallery in the new wing was opened to the public in July 1933. It illustrates a side of museum activity of much interest to the public. Amongst the exhibits are the plant of a woollen yarn factory, and series showing the whole range of the woollen industry in Wales, cider-making, sawing, fishing and pottery-making. An early cast-iron gate, an engine from Neath Abbey Iron Works and an early colliery train illustrate the transition effected by the Industrial Revolution. Special reference should be made to the reconstructions of a rural smithy and a wood-turner's shop.

Cabbages and Related Crops

THE second edition of Bulletin No. 53 of the Ministry of Agriculture ("Cabbages and Related Green Crops"; H.M. Stationery Office, pp. 60. 1*s*. 3*d*. net) was issued in November 1933. It deals with the commercially useful variants of the wild *Brassica oleracea*, namely, cabbages and savoys, Brussels sprouts, cauliflowers, broccoli and kale. Details of cultivation in many districts are combined with extensive notes on the economic uses of various products, and numerous methods of marketing are given. Production and harvesting of seed are also discussed. The volume is designed to help the grower, and should do this effectively. A chapter on the cultivation of *Brassicæ* as farm crops has been added to the material published in the first edition, and the whole text has been improved by the incorporation of much recent knowledge.

Liverpool Observatory

THE report of the Liverpool Observatory and Tidal Institute for 1933 records several interesting matters concerning tidal records. Experiments were made with seismographs with the view of recording the tilting of the earth due to tidal loads as well as to thermal effects. An instability in the records was traced to distortion in the structure supporting the instruments. This was overcome and satisfactory records were obtained. The work is being continued with improvements in the instruments. Another important piece of work concerns a new method of prediction of mixed diurnal and semi-diurnal tides. Work was also done on the tidal bore of the Trent and on the tides of the Bay of Biscay. Tidal predictions have been worked out for various authorities.

Rainfall of the World

MOST maps hitherto constructed to show the mean annual distribution of rainfall are confined to the land areas and have no indication of rainfall over the oceans. Prof. W. Meinardus has published in *Petermanns Mitteilungen* (1934) a new rainfall map on a scale of 1 : 100,000,000 which shows the distribution over the entire surface of the globe. On so small a scale it naturally does not differ materially so far as land areas are concerned from Supan's and other maps, although it shows effectively the low precipitation in north and south polar regions; but over the oceans, and in particular the Indian and Pacific Oceans, there is much of interest. These details have been taken chiefly from G. Schott's oceanic maps. The map is produced in tints of two colours showing six different grades of rainfall.

Study of Cosmic Rays in Armenia

PROF. A. F. JOFFE, of the Physico-Technical Institute of the U.S.S.R., is sending out a scientific expedition to Erivan to establish a laboratory for the study of the cosmic rays. It is proposed to set up the station on Mount Alagöz, in Armenia, at a height of 14,400 ft. above sea-level. The object of this station will be to investigate the distribution of the cosmic rays. The leader of the expedition is Dr. D. V. Skobeltzin. It has also been decided to set up on the shore of Lake Gokcha (6,345 ft. above sea-level) an astrophysical observatory where a 16-in. reflector will be erected.

Announcements

SIR SIDNEY HARMER, formerly director of the Natural History Departments, British Museum, has been awarded the Gold Medal of the Linnean Society. The medal will be presented at the annual general meeting on May 24.

PROF. VICTOR VAN STRAELEN, director of the Royal Belgian Natural History Museum and formerly vice-president of the Parc National Albert in the Belgian Congo, has been appointed president of the Parc National Albert in succession to King Leopold III, who held the office of president until the death of his father, King Albert.

WE are glad to learn that the Belgian Parliament has now made ample provision for the preservation of the unique collection of skeletons of the Wealden Dinosaur Iguanodon in the Royal Museum of Natural History, Brussels, to which we referred on March 3 (p. 320). The late King Albert, who was always deeply interested in scientific research, had the satisfaction of learning, just before his death, that a sum had been voted both for the repair of the fossils and for their enclosure in two large glass cases. The work is proceeding at once.

AN earthquake of moderate intensity was recorded at Kew Observatory on May 4. The first impulse was received at 4 h. 46 m. 22 s. G.M.T. The records indicate that the shock occurred at a distance of 4,500 miles and probably near the coast of British Columbia.

AT the anniversary meeting of the Royal Society of South Africa held at Cape Town on March 21, the following were elected officers for the year 1934: *President*, Dr. A. W. Rogers; *Hon. Treasurer*, Prof. L. Crawford; *Hon. General Secretary*, A. J. H. Goodwin; *Hon. Editor of Transactions*, Prof. R. S. Adamson; *Hon. Librarian*, Prof. E. Newbery.

THE following appointments in the Colonial Agricultural Service have recently been made by the Secretary of State for the Colonies: Mr. C. H. Burgess to be agricultural field officer, Federated Malay States; Mr. J. R. E. Hindson to be inspector of plants and produce, Gold Coast; Mr. R. K. Kerkham to be agricultural officer, Uganda; Mr. R. W. Kettlewell to be district agricultural officer, Nyasaland; Mr. A. E. Moss to be inspector of plants and produce, Gold Coast; Mr. E. Williams to be superintendent of agriculture, Gambia; Mr. F. M. Bain, formerly inspector, plant protection ordinance, Trinidad, to be agricultural officer, Trinidad; Mr. T. McEwan, formerly senior agricultural research officer, Northern Rhodesia, to be agricultural officer, Uganda.

THE Dorothy Temple Cross Research Fellowships in Tuberculosis of the value of at least £350 each for one year for the academic year 1934–35 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1. The object of these fellowships is to give special opportunities for study and research to persons "intending to devote themselves to the advancement by teaching or research of curative or preventive treatment of tuberculosis in all or any of its forms". The fellowships will preferably be awarded to candidates who wish to make their studies or inquiries outside the borders of Great Britain. It may also be possible to award a Senior Fellowship of considerably greater value to a specially well-qualified candidate wishing to undertake an intensive study of some particular problem of tuberculosis at a chosen centre of work in another country. Particulars are obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in geography (woman) at Bingley Training College—The Education Officer, County Hall, Wakefield, Yorks (May 16). A teacher of domestic subjects at the National Society's Training College of Domestic Subjects, Berridge House, Fortune Green Road, London, N.W.6—The Principal (May 21). A clinical biochemist at the Glasgow Royal Infirmary—The Superintendent, Royal Infirmary, Castle Street, Glasgow (May 21). A lecturer in experimental psychology at the University of St. Andrews—The Secretary (May 24). An assistant lecturer in physics at University College, Gower Street, London, W.C.1—The Secretary (May 26). A fuel technologist to the Public Service Board of New South Wales—The Official Representative of the Government of New South Wales, Wellington House, 125, Strand, W.C.2 (May 31). A reader in dyeing and printing, a reader in chemical engineering, a lecturer in experimental dyeing, a lecturer in industrial and tinctorial chemistry, and a lecturer in fuel technology at the University of Bombay—The Registrar (May 31). A lecturer in economics, an assistant lecturer in pharmaceutical chemistry, a demonstrator in mechanical engineering, and a demonstrator in electrical engineering at University College, Nottingham—The Registrar (June 1). An intelligence officer in the Engineering and Metals Section of the Department of Overseas Trade—The Chief Establishment Officer, Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1 (May 31). Two Robert Blair fellows in applied science or technology—The Education Officer (T. 3), The County Hall, S.E.1 (June 1). A junior scientific officer (chemist) in the Department of Scientific and Industrial Research—The Secretary, 16, Old Queen Street, London, S.W.1 (June 2). An assistant lecturer in mechanical engineering at the Manchester Municipal College of Technology—The Registrar (June 4). A lecturer in geography at Truro Training College—The Principal. Assistant keepers in zoology, entomology and botany at the British Museum (Natural History)—The Secretary, British Museum (Natural History), London, S.W.7. A professor of botany at the University of Reading—The Registrar.

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.*]

Mass of the Neutron

THE mass of the neutron has been calculated by Chadwick on the assumption that the neutrons of boron are emitted by the isotope $^{11}_{5}B$, according to the nuclear reaction

$$^{11}_{5}B + ^{4}_{2}He = ^{14}_{7}N + ^{1}_{0}n.$$

Using the exact masses of $^{11}_{5}B$, $^{4}_{2}He$ and $^{14}_{7}N$ and the maximum energy of the neutron excited by the α-rays of polonium, one may calculate for the neutron a mass 1·0068 (taking $^{16}O = 16$).[1]

We have suggested[2] that the emission of the neutron of boron is due to the isotope $^{10}_{5}B$ and not to $^{11}_{5}B$. The nucleus $^{10}_{5}B$ can suffer two kinds of transmutation under the action of the α-particles of polonium, one with the emission of a proton, one with the emission of a neutron and a positive electron, according to the equations :

$$^{10}_{5}B + ^{4}_{2}He = ^{13}_{6}C + ^{1}_{1}H$$

$$^{10}_{5}B + ^{4}_{2}He = ^{13}_{6}C + ^{1}_{0}n + ^{+}_{\varepsilon}.$$

Our latest experiments on the creation of new radio-elements have confirmed our interpretation of the transmutation of boron. Similar reactions are observed with the nucleus $^{27}_{13}Al$ and with $^{24}_{12}Mg$. The reactions can be divided in two steps :

$$^{10}_{5}B + ^{4}_{2}He = ^{13}_{7}N + ^{1}_{0}n \qquad ^{13}_{7}N = ^{13}_{6}C + ^{+}_{\varepsilon}$$

$$^{27}_{12}Mg + ^{4}_{2}He = ^{27}_{14}Si + ^{1}_{0}n \qquad ^{27}_{14}Si = ^{27}_{13}Al + ^{+}_{\varepsilon}$$

$$^{27}_{13}Al + ^{4}_{2}He = ^{30}_{15}P + ^{1}_{0}n \qquad ^{30}_{15}P = ^{30}_{14}Si + ^{+}_{\varepsilon}$$

$^{13}_{7}N$, $^{27}_{14}Si$, $^{30}_{15}P$ being unstable nuclei that disintegrate with the emission of positrons.

The complete reactions, with the masses and energy of all the particles are, for the two modes of transmutation of boron :

$$^{10}_{5}B + ^{4}_{2}He + W_a = ^{13}_{6}C + ^{1}_{1}H + W_H + W_R,$$

$$^{10}_{5}B + ^{4}_{2}He + W_a = ^{13}_{6}C + ^{1}_{0}n + ^{+}_{\varepsilon} + W_n + W_\varepsilon + W'_R,$$

where W_a, W_H, W_n, W_ε, W_R, W'_R are the energies of the α-particle and the corresponding energies of the ejected particles and of the recoil atoms in the reactions. Subtracting the first of these equations from the second gives :

$^{1}_{0}n$ = mass of proton − mass of positron + Q,
where $Q = W_H + W_R - W_n - W'_R - W_\varepsilon$.

One gets exactly the same equation using the transmutations of aluminium and magnesium.

Thus these equations enable us to calculate the mass of neutron without using the exact masses of any nucleus, except the proton.

According to our most recent measurements, the positrons emitted by the new radio-elements form a continuous spectrum of maximum energy $1{\cdot}5 \times 10^6$ e.v. for $^{13}_{7}N$, 3×10^6 e.v. for $^{30}_{15}P$ and approximately $1{\cdot}5 \times 10^6$ e.v. for $^{27}_{14}Si$. The emission of positrons is probably accompanied by the emission of neutrinos, but if the positrons have their maximum energy, the neutrinos will have a very small energy; the most recent hypotheses on the nature of this particle admits of a mass which is zero, or very small. So we need not take this particle into account in the calculations. The energy of the recoil atom in the disintegration with emission of a positron is negligible.

For the irradiation with the α-rays of polonium we have the following numerical values for the energies (expressed in 10^6 e.v.).

	W_H	W_R	W_n	W'_R	W_ε	Q (10^6 e.v.)	Q in units of mass
B	8·05	0·23	3·3	0·59	1·5	+ 2·89	0·0031
Al	7·56	0·11	2	0·33	3·0	+ 2·34	0·0025
Mg	4·82*	0·21	1	0·48	1·5	+ 2·05	0·0022

One gets for the mass of neutron three values : 1·0098, 1·0092, 1·0089. These values agree approximately. Yet the first, deduced from boron, is the most precise. The energies of the neutrons of aluminium and magnesium and the energy of the positrons of magnesium are not well known.

From considerations on the stability of the nucleus $^{9}_{4}Be$, the mass of the neutron should have a minimum value 1·0107. But an error of 0·001 in the determination of the mass of Be seems quite possible.

We may adopt for the mass of the neutron a value 1·010, in which the error probably does not exceed 0·0005.

With the mass 1·010 for the neutron, the maximum energy of the neutron ejected from beryllium by α-particles from polonium should be about 9×10^6 e.v. The emission of slow neutrons when lithium is bombarded with α-particles from polonium, according to the reaction $^{7}_{3}Li + ^{4}_{2}He = ^{10}_{5}B + ^{1}_{0}n$, cannot be explained unless the mass adopted for $^{10}_{5}B$ is too great, namely, by about 0·003.

If atomic nuclei contain only protons and neutrons, then the β-emission might be the consequence of the transformation of a neutron into a proton inside the nucleus, with the ejection of the negative electron and a neutrino, as has been suggested by several authors. The inverse processes would also be possible : transformation of a proton into a neutron with the ejection of a positron and a neutrino.

With the mass 1·010 for the neutron, the energy liberated in the transformation neutron → proton + $^{-}_{\varepsilon}$ is $2{\cdot}1 \times 10^6$ e.v.; the energy absorbed in the transformation proton → neutron + $^{+}_{\varepsilon}$ is $3{\cdot}1 \times 10^6$ e.v.

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* The maximum energy possible for the positrons does not correspond to a group effectively observed, but has been deduced by F. Perrin from the experiments of Bothe and Klarman, by the consideration of the energy balance relative to the groups of protons.

[1] Chadwick, *Proc. Roy. Soc.*, **136**, 692; 1932.
[2] I. Curie and F. Joliot, *C.R.*, **197**, 237; 1933.

Induced Radioactivity of Sodium and Phosphorus

IN view of the discovery of 'induced radioactivity' by F. Joliot[1], I have investigated several other elements with an apparatus specially designed for the study of activities with a very short lifetime. The substance to be investigated was attached to the end of a swinging arm, which made it possible to shift the substance within half a second from the α-ray source, consisting of about 1 millicurie of thorium B + C, to a Geiger-Müller counter with a window of 0·05 mm. copper foil.

I have found that both sodium and phosphorus become active after α-ray bombardment. Three different sodium compounds (NaCl, NaF, $Na_2C_2O_4$) have been investigated; they all showed a fairly strong activity, dying off very quickly. The half value period has been determined by recording the impulses on a rotating drum, the whole decay curve being recorded 21 times. The half value period was found to be 7 ± 1 seconds. Phosphorus (elementary red phosphorus) showed a very much longer lifetime. The half value period was found to be 40 ± 5 minutes.

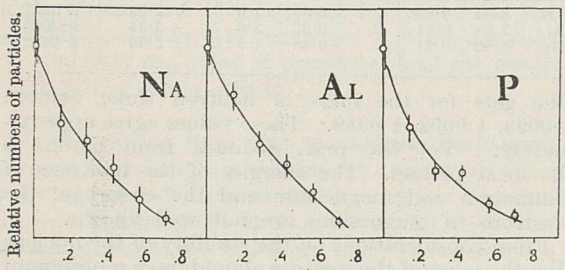

FIG. 1.

The initial activity of phosphorus was about one sixth that of aluminium. The initial activity of pure sodium under the same conditions was estimated, from the composition of the salts, to be about half that of aluminium.

The sign of the particles emitted by the substances was determined by deflection in a magnetic field. Both sodium and phosphorus were found to emit mainly positive electrons. In the case of sodium, no negative particles have been detected; there cannot be more than one fifth of the positives, if any. In the case of phosphorus, the results are not quite so definite; anyhow, the negative particles cannot be more than one third of the positives.

Some information about the energy of the particles was obtained by putting copper foils between the substance and the window of the counter. For a better comparison the same has been done with the particles emitted by aluminium. The three absorption curves are given in Fig. 1, the mean statistical error being indicated by the vertical lines. The range of the particles can be extrapolated to be about 0·8 gm./cm.² of copper, corresponding to an energy of $1{\cdot}8 \times 10^6$ e.v., for all three elements.

The nuclear reactions leading to the creation of these new active elements are very probably analogous to the production of radio-phosphorus by bombarding aluminium. In that case, the reaction is generally assumed to be $_{13}Al^{27} + \alpha = {}_{15}P^{30} +$ neutron, the $_{15}P^{30}$ disintegrating after a time according to the reaction $_{15}P^{30} = {}_{14}Si^{30} +$ positron. So for sodium and phosphorus the reactions would be $_{11}Na^{23} + \alpha = {}_{13}Al^{26} +$ neutron and $_{15}P^{31} + \alpha = {}_{17}Cl^{34} +$ neutron, respectively. In the last case, this view was confirmed by the chemical separation of the active chlorine. The active phosphorus was burned, the products of combustion dissolved in caustic soda. The solution was acidified with nitric acid, a trace of ammonium chloride added and then excess of silver nitrate. The silver chloride, filtered off and washed on a small disc of filter paper, was found to contain more than 50 per cent of the original activity, showing the same time decay.

By extrapolating the series of odd elements $_{15}P^{31}$, $_{13}Al^{27}$, $_{11}Na^{23}$, all of which show induced activity, one would anticipate that $_9F^{19}$ would show it too, especially since fluorine is known to emit neutrons under α-ray bombardment. On the other hand, the extrapolation of the periods: 40 min., 3 min., 7 sec., leads to a very short life for the hypothetical activity produced in fluorine. I have tested calcium fluoride in my apparatus, but have not been able to find definite evidence of an activity.

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May 4.

[1] NATURE, **133**, 201, Feb. 10, 1934.

β-Emission of Positive Electrons

THE artificial production of radioactive isotopes recently discovered[1] has to be brought into connexion with the theoretical treatment of the β-type of radioactive transformation[2]. It is easily seen that the formulæ given for the β-decay of heavy elements apply to the emission of positive electrons by simply changing the sign of the charges involved. We have calculated the continuous energy spectra to be expected from N^{13} both according to the theory developed some time ago by ourselves and according to the assumption that a so-called 'neutrino' is emitted simultaneously with the electron. The curves obtained in this way are very similar and may be represented by Fig. 1, which has been drawn for a special case. It seems to us that it will be scarcely possible to distinguish between these two theories by measuring the shape of the energy spectrum.

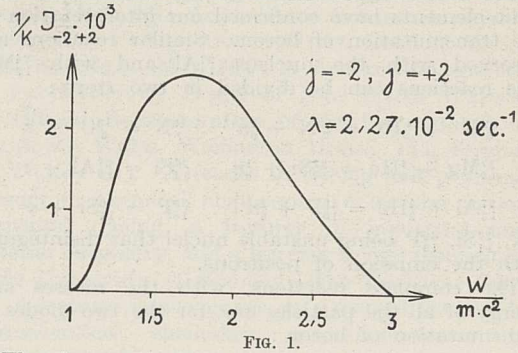

FIG. 1.

The decay constant, however, resulting from the extrapolation of the values known for the heavy radioactive β-bodies, fits very nicely the order of magnitude of the value of several minutes actually observed. (A more exact comparison cannot be made unless the upper energy limit of the continuous energy spectrum has been determined.) This fact seems to confirm the view previously taken by us, that the extremely long life period of the lighter β-bodies (potassium and rubidium) should not be compared with that of the other β-active substances. The extremely high values of the decay constants of these elements have evidently to be explained by a more complicated mechanism, possibly by a double process in which two electrons leave the nucleus simultaneously.

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German University, Prague,
March 15.

[1] I. Curie and F. Joliot, *C.R. Acad. Sci.*, **198**, 254; 1934. J. D. Cockroft, C. W. Gilbert and E. T. S. Walton, NATURE, **133**, 328, March 3, 1934.
[2] G. Beck and K. Sitte, *Z. Phys.*, **86**, 105; 1933. E. Fermi, *La Ricerca Scientifica*, **2**, No. 12.

Slip-bands and Twin-like Structures in Crystals

THE β-constituent of the copper-zinc alloy system containing about 48–50 per cent zinc and having a cubic body-centred crystal lattice, does not readily show slip-bands when the crystals are distorted[1]. On the other hand, structures resembling twins have been described[2]. v. Göler and Sachs[3] found slip-bands on some crystals only and identified them approximately with traces of dodecahedral planes {110}. I have recently confirmed the occurrence of slip-bands agreeing with the traces of {110} planes in a number of crystals (Fig. 1), and in some cases the distortion can be accounted for completely by slip on one of these planes and in a direction parallel to the normal of an octahedral plane [111]. More often, the distortion is more complicated and other dodecahedral planes are involved. In these circumstances, the slip-bands do not represent crystal planes, but relics on the surface of the original traces of planes.

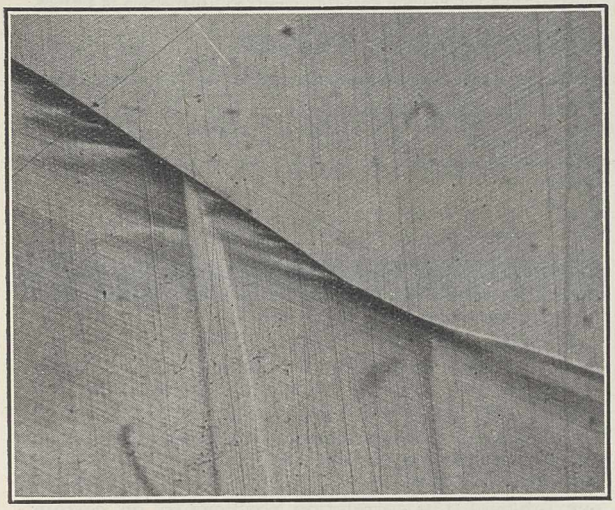

FIG. 1. Two deformed β brass crystals showing slip-bands and twin-like structure near boundary. × 100.

Twin-like structures are produced when slip takes place on two planes equally inclined to the axis (in a tensile test) in different parts of the same crystal. This frequently occurs if the axis lies in a {100} plane, for example, when the uniting plane coincides with this plane at the beginning of the distortion, but soon ceases to do so as deformation proceeds. These structures persist when the crystal is repolished and re-etched and resemble lamellar twinning if there are many of them.

When the crystals are rolled, they fracture with an almost perfect cleavage parallel with one or more {110} plane. The separation occurs with a loud crack.

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March 23.

[1] G. I. Taylor, *Proc. Roy. Soc.*, A, **5**, 118; 1928.
[2] F. Johnson, *J. Inst. Metals*, **5**, 24, 301; 1920.
[3] v. Goler, G. Sachs, *Naturwiss.*, 412; 1928.

Intensity Measurements in the First Positive Bands of Nitrogen

WE have recently measured the intensities of several of the first positive bands of nitrogen, using the method of photographic photometry. As sources, the afterglow of active nitrogen and a high frequency electrodeless discharge in nitrogen at a low pressure have been used. The figures in the second and third columns below are proportional to the energy

Band v'–v''	Intensity		Intensity ratio
	H.F. discharge	Afterglow	H.F. discharge/Afterglow
10-6	294	128	2·30
10-7	245	99	2·48
11-6	68	102	0·67
11-7	300	520	0·58
11-8	159	270	0·59
12-7	74·5	59	1·26
12-8	244	190	1·28
12-9	151	55·5	2·72

radiated per second by the gas due to the various vibrational transitions indicated.

If the probability of a transition occurring between two levels is independent of conditions of excitation, it is evident that the figures in the last column must be constant for bands having a common value of v'. Our results show that this is the case for $v' = 10$ and 11, to within 15 per cent, but does not hold for bands having $v' = 12$. There is, however, close superposition of the 4-0 band on the 12-9 band, which would have the effect of increasing the apparent intensity of the 12-9 band. In the afterglow of active nitrogen, the progression having $v' = 4$ is very weak, but in the high frequency discharge (and in direct current discharge) it is of appreciable strength. These facts would be sufficient to account for the variation noted in the table.

Preliminary measurements with direct current excitation give results in which the intensity ratio H.F. discharge/D.C. discharge is nearly constant within each progression examined.

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Influence of Oxygen, Sulphur Dioxide and Moisture on the Homogeneous Combination of Hydrogen with Sulphur

PREVIOUSLY[1], we have shown that minute traces of oxygen lead to an apparent increase in the rate of formation of hydrogen sulphide from its elements, as judged by the iodine titre of the resulting gaseous products. The increase was ascribed to a catalysis by oxygen, though we pointed out that "the effect of so minute a quantity of oxygen is remarkable and unexpected". The subject has been systematically investigated using hydrogen containing known concentrations of oxygen ranging from 0·06 to 7 per cent by volume, at temperatures between 290° and 343° C. The method adopted, a static one[2], was carried out in 'Pyrex' bulbs containing quantities of

sulphur which, whilst always sufficient to combine with the oxygen present several times over, were yet insufficient to leave any liquid at the temperature of the reaction. The products consisted of a mixture of sulphur dioxide and hydrogen sulphide together with the excess of sulphur and hydrogen. The amount of each compound was ascertained by an iodometric titration followed by a gravimetric estimation.

The results showed that the whole of the oxygen goes to sulphur dioxide in the first few minutes, and that, thereafter, the hydrogen proceeds to react with the remaining sulphur at precisely the anticipated velocity for hydrogen alone. In unpacked bulbs, there is no detectable reaction between the sulphur dioxide and the hydrogen sulphide so formed in one hour. This shows that neither free oxygen nor sulphur dioxide affect the velocity of the hydrogen-sulphur reaction and is contrary to the observations of Norrish and Rideal[3] who, using a dynamic method, found that oxygen had "a strong poisoning effect in the gaseous reaction between hydrogen and sulphur at all temperatures".

In packed bulbs, some of the sulphur dioxide and the hydrogen sulphide reacts thus: $2H_2S + SO_2 = 2H_2O + 3S$ (specific mechanism not implied) but only at the glass surface and hence to an undetectably small extent in unpacked bulbs. The findings of Taylor and Wesley[4], who showed this reaction to be heterogeneous by a dynamic method, are thus confirmed under static conditions.

Since steam is formed in packed bulbs, evidently moisture, as well as sulphur dioxide, is without effect on the hydrogen-sulphur reaction. In confirmation of this, hydrogen containing 2 per cent of moisture by volume has been found to give identical velocities with those already established for hydrogen which had been slowly passed over a length of phosphoric oxide.

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March 28.

[1] NATURE, 132, 101, July 15, 1933.
[2] NATURE, 131, 471, April 1, 1933.
[3] *J. Chem. Soc.*, 123, 1689; 1923.
[4] *J. Phys. Chem.*, 31, 216; 1927.

The Theory of Two Factors versus the Sampling Theory of Mental Ability

THE accompanying diagram (Fig. 1) gives a graphic representation of the extent to which an observed frequency distribution of 22,712 tetrad-differences (of the form $r_{12}r_{34} - r_{13}r_{24}$) derived from 170 correlation coefficients between 19 non-overlapping mental tests[1] approximates, on one hand, to the theoretical distribution to be expected according to the Two Factor Theory of Prof. C. Spearman and, on the other hand, to the theoretical distribution to be expected according to the Sampling Theory of Prof. Godfrey H. Thomson.

According to the Two Factor Theory[2], the abilities measured by the mental tests are divisible into two

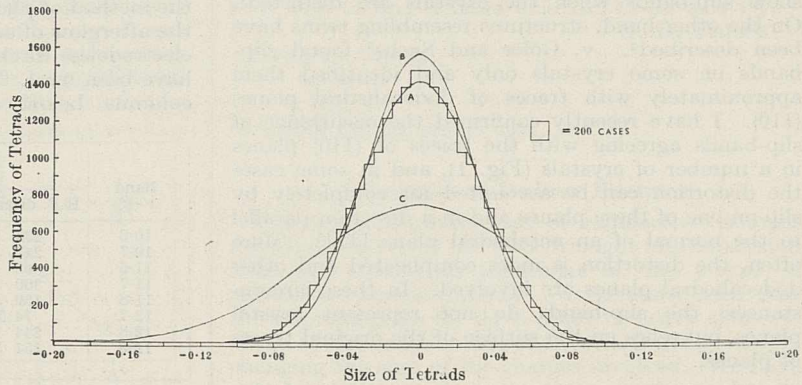

FIG. 1. A: Best-fitting curve (Type II*a* Pearson curve) to observed distribution of tetrads, with equation

$$y = 1412\left(1 - \frac{x^2}{0{\cdot}17234^2}\right)^{13{\cdot}669}; \quad \sigma_t = 0{\cdot}031289.$$

B: 'Theoretical' curve (Type II*a*) to be expected, assuming the truth of the Two Factor Theory (Spearman), with equation

$$y = 1563\left(1 - \frac{x^2}{0{\cdot}1557^2}\right)^{13{\cdot}669}; \quad \bar{\sigma}_t = 0{\cdot}02827 \pm 0{\cdot}0025866.$$

C: 'Theoretical' curve (Type II*a*) to be expected, assuming the truth of the Sampling Theory (Godfrey Thomson), with equation

$$y = 749\left(1 - \frac{x^2}{0{\cdot}3248^2}\right)^{13{\cdot}669}; \quad \sigma_t = 0{\cdot}059 \text{ (allowing also for random sampling).}$$

factors each, one being common to all (the general factor, *g*), while the other is in each case specific and independent (the specific factor, *s*).

According to the Sampling Theory[3], any one mental ability is due to the operation of a certain set of factors, another ability to another set, and so on; and these sets may overlap in any manner. On this theory, if we assume a number of variable elementary factors, N, we can get values for N from the observed values of $\bar{r}$ (0·413) and σ_r (0·087) of our table of 170 correlation coefficients, on certain assumptions as to form of distribution of the factors and of their proportions entering into each ability.

Mr. John Mackie[4] has given the most generalised mathematical expression, up to date, for the Sampling Theory, and accepting certain of his formulæ as those most likely to apply to our investigation, we have

$$\sigma_r = \sqrt{1 - \left(\frac{2}{\pi}\right)^2} \Big/ \sqrt{N} \qquad \text{(p. 32)}$$

$$\text{that is, } 0{\cdot}087 = 0{\cdot}77/\sqrt{N}, \text{ giving } N = 77$$

$$\text{and } \sigma_t = 0{\cdot}463/\sqrt{N} \qquad \text{(p. 31)}$$

$$= 0{\cdot}052.$$

The same value of σ_t follows from $\bar{r} = 0{\cdot}413$, by the formulæ

$$\bar{r} = \frac{2}{\pi}\sqrt{p_1 p_2} = \frac{2}{\pi}\bar{p} \qquad \text{(p. 33)}$$

$$\text{and } \sigma_t = 2\bar{p}\,(1 - \bar{p})/\sqrt{N}. \qquad \text{(p. 34)}$$

But this value of σ_t does not allow for random sampling (of the population). Allowing for this kind of sampling, the correct value is:

$$\sigma_t = \sqrt{0{\cdot}052^2 + 0{\cdot}028^2} \quad (0{\cdot}028 \text{ is the } \bar{\sigma}_t \text{ of the Two Factor Theory})$$

$$= 0{\cdot}059.$$

As a Type II*a* Pearson curve was found to be the best-fitting curve for the observed distribution of tetrads, with $\sigma_t = 0{\cdot}031$ (curve *A*), similar Pearson curves have been drawn corresponding to the Two Factor Theory, with $\bar{\sigma}_t = 0{\cdot}028 \pm 0{\cdot}0026$ (curve *B*), and to the Sampling Theory, with $\sigma_t = 0{\cdot}059$ (curve *C*). It can be seen by inspection which of the two curves, *B* or *C*, approximates more to curve *A*.

Further evidence against the applicability of the Sampling Theory to our data is given if we *assume* the truth of this theory (with Mackie's equations), and set out from the *observed* value of σ_t, that is, 0·031.

$$\text{Since } \sigma_t = 0{\cdot}463/\sqrt{N}$$
$$\therefore \sqrt{N} = 15, \text{ and } N = 225$$
$$\therefore \quad \sigma_r = \sqrt{1 - \left(\frac{2}{\pi}\right)^2} \Big/ \sqrt{N}$$
$$= 0{\cdot}051,$$

whereas the observed value of σ_r is 0·087.

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March 21.

[1] Brown, W., and Stephenson, W., "A Test of the Theory of Two Factors", *Brit. J. Psychol.*, **23**, Part 4, April 1933. Also NATURE, **130**, 588, Oct. 15, 1932.
[2] Spearman, C., "The Abilities of Man", London, 1927, pp. 74, 75.
[3] Thomson, Godfrey H., *Proc. Roy. Soc.*, A, **95**, 400; 1919. Also Brown, W., and Thomson, G. H., "Essentials of Mental Measurement", 3rd edn., 1925, Cambridge University Press, chap. x.
[4] Mackie, John, "Mathematical Consequences of Certain Theories of Mental Ability", *Proc. Roy. Soc. Ed.*, **49**, Pt. 1, No. 2, Feb. 1929.

Water Supplies and Emergency Legislation

WHEN we wish to determine the relation between the rain falling on an area, and the volume of water delivered by the stream draining that area, we are faced with a problem as yet unsolved. The geological, physical and meteorological conditions of river catchment basins are so varied that a search for a mathematical expression connecting 'yield' from rainfall appears to be in vain.

The simplest and most accurate method for such determination is, as suggested in the leading article in NATURE of April 28, by the actual measurement of stream flow for a considerable number of years, so as to ascertain the mean, the maximum, and the minimum flow that may be expected; and also the variation of stream flow during the seasons of the year. Comparing the results so obtained with the rainfall during those years, we may be able to deduce with some reasonable accuracy stream flow in years in which rainfall records are available, and stream flow gaugings are not.

Observation of stream flow in Great Britain have been neglected, and the same remark applies to observation of water levels in our wells. Some years ago the British Association laid down a series of questions in regard to wells which appear to have been lost sight of. It is possible that the limited funds allotted for investigations of this nature curtailed the information collected.

The heavy rains of 1927, the disaster of January 1928, and the following wet years caused the country to be more concerned with floods and arterial drainage, than with drought; leading to the appointment of the Royal Commission of 1927, and the passing of the Drainage Act of 1930, and so to the formation of Catchment Boards, with the result that schemes for widening and deepening our rivers and carrying off the rainfall as quickly as possible are under consideration.

Speculative building on riparian lands subject in former years to flooding at very long intervals, are now more frequently flooded, due to the increased flow from drainage of lands, permeable areas and arterial roads, and this has increased the demand for a more rapid carrying away of flow due to rainfall.

The problem that now faces the country is the preservation of our springs. Most of our rivers derive their dry weather flow from springs, the only source of supply of which is the percolation of our winter rains to the ground water plane of saturation; and instead of widening and deepening our rivers to pass off extraordinary floods quickly, the flood water should be allowed to spill over the river margins so that as the flood slowly subsides, the water is enabled to percolate into the subsoil. One other suggestion I would make, is a return to Mr. Joseph Elkington's 'sink hole drainage'. That is, instead of passing off rain-water from whatever sources it may be received into streams and thus swell our rivers, it is passed into 'soakage pits' or 'absorbing wells' placed at suitable intervals and sunk to permeable areas, and thus to pass the rainfall to ground storage.

The Catchment Boards, I would suggest, should now confine their activities to the measurement of stream flow and its correlation with rainfall; to carry out the requirements of the British Association in regard to riparian lands subject to periodic flooding, so as to reserve them for pasture or agriculture, and to prevent speculative building thereon.

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Factors Controlling Moulting and 'Metamorphosis' in an Insect

IN the blood-sucking bug, *Rhodnius prolixus*, moulting occurs at a definite interval after feeding; only one meal being necessary in each stage. The morphological changes at moulting are relatively slight; save at the fifth moult, when the insect becomes adult[1]. It is therefore convenient (without prejudice to questions of homology) to refer to this final moult as 'metamorphosis'. In this last stage, the interval between feeding and moulting averages twenty-eight days. If its head is removed soon after feeding, the insect will not moult—although some of these headless individuals have remained alive more than eleven months. But there is a 'critical period', about seven days after feeding, after which moulting is no longer prevented by decapitation. If the blood from an insect decapitated *after* this critical period is allowed to circulate in an insect decapitated *before* this period, the latter is caused to moult. Clearly, a 'moulting hormone' is present; and it is probably secreted in the head. Of the organs in the head, the only one which shows distinct changes during this period is the corpus allatum, the cells of which swell up to a maximum at about the seventh day after feeding, and then diminish. Perhaps this is the source of the moulting hormone—though the evidence on this point is still incomplete.

Similar results have been obtained with the earlier nymphs. But if the blood from a 5th or final nymph decapitated *after* the critical period is allowed

to circulate in a 4th nymph decapitated *before* this period, the latter shows a premature 'metamorphosis' and develops adult characters. Two explanations of this result are possible: either (*a*) the moulting hormone of the 5th nymph differs from the moulting hormone of the earlier nymphs; or (*b*) the hormone is always the same, but the earlier nymphs produce in addition an inhibitory hormone which restrains metamorphosis. Of these alternatives the second appears to be correct. For if the 4th, 3rd, 2nd, even the 1st nymphs are merely decapitated around the 'critical period', a certain number of them suffer a precocious 'metamorphosis' and develop into diminutive adults; while others show intermediate characters (prothetely) —due, perhaps, to the varying quantity of the inhibitory factor present in the blood at the time of decapitation.

Two factors, therefore, seem to be concerned in the growth of *Rhodnius*: a factor initiating growth or moulting, and a factor inhibiting 'metamorphosis' —both probably secreted in the head, and perhaps in the corpus allatum. These results, which will shortly be published in full, confirm and extend the well-known conclusions of Kopeć[2].

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April 12.

[1] Wigglesworth, V. B., *Quart. J. Micr. Sci.*, **76**, 270; 1933.
[2] Kopeć, S., *Biol. Bull.*, **42**, 322; 1922. **46**, 1; 1924. *Biol. Generalis*, **3**, 375; 1927.

Spontaneous Crossing-over between *X*- and *Y*-Chromosomes in *Drosophila melanogaster*

Muller and Painter[1] showed that more than one-third of the *X*-chromosome is almost inert genetically and corresponds to a section of the *Y*, and Friesen[2] obtained crossing-over of autosomal genes in males by exposure to X-rays. It therefore seemed worth while investigating whether crossing-over takes place between the *X*- and *Y*-chromosomes in the male during normal meiosis. The gene under investigation, *bobbed* (shorter and finer bristles on the thorax), is the only one so far located both in the inert region and the *Y*-chromosome.

Males containing the mutant gene *bb* (bobbed) in their *Y*-chromosome and its normal allelomorph in their *X*-chromosome were crossed with bar-bobbed females with attached *X*-chromosomes carrying *Bbb* (bar eye) and a *Y*-carrying *bb*. By this method every change taking place in either *bb*-locus in the male can be detected.

The result of the cross was:

	Expected flies.		Exceptional flies.	
Phenotype	*Bbb*♀	normal♂	*B*+*bb*♀	*bb*♂
	422	566	4	5

The exceptional *B*+*bb* females (bar, non-bobbed) and *bb* males (non-bar, bobbed) could have arisen either by crossing-over or by mutation both of normal to *bb* in the *X*-chromosome, and of *bb* to normal in the *Y*-chromosome. The *B*+*bb* females could not have arisen by detachment of one of the attached *X*-chromosomes since they were homozygous for bar eye. The hypothesis of mutation seems to be excluded by the high frequency of the exceptions.

The possibility of spontaneous crossing-over in the males has been suggested by Stern's[3] discovery of translocation of parts of the *Y*- to the *X*-, and Darlington's[4] description of cytological conditions in the spermatogenesis of *Drosophila pseudo-obscura*, which makes the occurrence of crossing-over quite possible.

U. Philip.

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April 28.

[1] *Z. ind. Abst.*, **62**; 1932.
[2] *Science*, **78**; 1933.
[3] *Z. ind. Abst.*, **51**; 1929.
[4] *Genetics*, **19**; 1934.

The Attitude of the German Government towards Science

Prof. Stark's letter in Nature of April 21 may not prove convincing to all its readers. The fact that 'non-Aryans' have been expelled from other posts does not necessarily justify their expulsion from scientific positions unless the premise that 'two blacks make a white' has first been conceded.

It is difficult also to reconcile his assertion that scientific research is perfectly free in Germany with the reported speeches of such officials as the rector of University of Frankfort, who is alleged[1] to have said, "Nowadays the task of the universities is not to cultivate objective science, but soldier-like, militant science, and their foremost task is to form the will and character of their students". This is not an isolated example of the attack on objectivity, on, in plain English, truth, which appears to be taking place in modern Germany. For that reason many British scientists feel that criticism of the present German government may not merely be of value to their expelled colleagues, but also to those 'Aryan' Germans who are still trying, under very difficult conditions, to uphold their country's great tradition of objective science.

J. B. S. Haldane.

16 Park Village East,
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May 1.

[1] *Science*, June 2, 1933.

Psychology of Musical Experience

I have long been impressed by a passage about Lagrange, the prince of mathematicians, in Thomas Young's biographical sketch: "In the midst of the most brilliant societies he was generally absorbed in his own reflections: and especially when there was music, in which he delighted, not so much for any exquisite pleasure that he received from it, as because, after the first three or four bars, it regularly lulled him into a train of abstract thought, and he heard no more of the performance, except as a sort of accompaniment assisting the march of his most difficult investigations, which he thus pursued with comfort and convenience."

I now notice that it correlates rather closely with a remark of Darwin, the prince of naturalists, in the well-known passage in his autobiography where, after describing the atrophy of his tastes for literature and painting and music, he proceeds: "Music generally sets me thinking too energetically on what I have been at work on, instead of giving me pleasure."

Joseph Larmor.

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April 5.

Research Items

Prehistoric East Anglia. Dr. Cyril Fox, in his presidential address to the Prehistoric Society of East Anglia for 1933, which is published in full in the *Proceedings* of the Society, vol. 7, pt. 2, discusses the implications of a series of maps showing cultural distributions from neolithic times to the iron age, that is, from about 2300 B.C. to A.D. 50. He points out initially that in the Lowland area of Great Britain, of which East Anglia is a part, human distribution is determined by the character of the soil. Hence East Anglia is divided into three zones, of which two, a western and an eastern, suitable for the habitation of early man, are separated by an unsuitable area, a plateau, forming the East Anglian watershed, which is extended southward to the Thames valley by the exposure of the London clay. In each successive period, therefore, the distribution maps show that the area of closest settlement was within the inner curve of the clay-covered watershed, with a second area of density in the lower Thames valley and estuary. A shift of the population on the chalk belt in the course of ages was accompanied by a like southward movement on the coastal belt, as the estuarine trade sought the shortest route to its markets in the centres of denser population through the valleys which penetrated the plateau in the direction of the settlement area on its western side. Changes in distribution of population on the chalk belt in the later periods indicate the opening up of fertile, but less easily worked, lands by the Iron Age Celtic tribes, to whom the Belgæ found themselves opposed and against whom they erected their great system of earthworks, when they had occupied the hitherto unexploited land around St. Albans, which they had reached from the Thames valley and not from the east coast. Differences in type of distribution bring out clearly the distinction between the products of a locally developed culture, of objects imported by trade, and of those introduced by invasion. The series of maps strikingly confirms the reliability of the available data as an index—though an incomplete reflection—of the life of the dwellers in the region, showing where it was vigorous, where it was sluggish, and where almost entirely absent.

Mass Physiology in Animals. W. C. Allee (*Biol. Rev.*, 9, Pt. 1, 1934), in reviewing recent work on mass physiology, remarks that analysis of the reactions leading to the formation of aggregations in Nature, or in the laboratory, has scarcely proceeded beyond the recognition that much of such behaviour is innate, although recent evidence indicates that a part of the schooling behaviour of the fish *Ameiurus* is acquired rather than inherited. It is easy to demonstrate that overcrowding lessens the rate of growth of organisms ; evidence is presented that undercrowding (for example, in mealworms, fishes, mice) frequently has the same effect. The results from aggregation upon the rate of oxygen consumption vary with different animals ; thus, for example, goldfishes in small groups use less oxygen than when isolated, but with the more closely schooling *Ameiurus* opposite results are reported. Groups of animals are able to afford protection to their members if exposed to toxic conditions due to the absence of accustomed salts (as the marine flat-worm *Procerodes* does when placed in fresh water) or to the presence of toxic substances such as colloidal silver. The amount of protection has been measured for some examples and the protective mechanisms are discussed. The transition from parthenogenetic to sexual reproduction in certain Crustacea (Cladocera) has been shown to result from overcrowding. The effect of numbers present upon the rate of learning differs with different animals and even in the same animals with different problems ; thus, fishes learn to run a simple maze more rapidly if in groups than if isolated, but they learn less readily to jump for a bit of worm held just above the water level. Cockroaches learn to run a simple maze more slowly if more than one is present in the maze at the same time. Groups of birds show a fairly definite flock organisation which may or may not be related to active leadership of the flock. "The whole range of mass physiology has been presented with the thought that it forms a large part of the background for social life".

New Snails from Hawaii. Mr. C. Montague Cooke, jun. in his paper "New Species of Amastridæ" (*Bernice P. Bishop Museum, Occasional Papers*, 10, No. 6 ; 1933) describes many new members of this interesting genus, which is peculiar to the islands of the Hawaii group, usually living on or under trees or under wood and stones. These snails are viviparous and bear embryos of a fair size, the embryonic whorls having distinct sculpture. One specimen of *Amastra* (*Metamastra*) *gulickiana dichroma*, new sub-species, although not quite fully grown, contained an embryo of about two and a half whorls. Many of the shells, however, were found dead and in one locality, East Maui, Kula, near the division between the lands of Keokea and Kamaole, where there are the last remnants of a native forest of a few decades ago, there were numbers of dead shells of several species and genera scattered among the loose surface stones. Under a single stone about two or three quarts of the richest fossiliferous earth was uncovered. From this mass of earth about 1,300 whole or nearly whole shells were picked out with representatives of about 70 species belonging to 23 genera including a new species, *Amastra inopinata*. Undoubtedly this region was inhabited by a rich land snail fauna some time within the last hundred years. A number of these species must be entirely extinct, as no native forest area is located within several miles. The shape of the various forms varies enormously, some of the shells flat and almost like a *Planorbis*, others *Achatina*-shaped, some sinistral.

Japanese Decapods. A valuable monograph on the distribution of decapod crustaceans inhabiting the continental shelf around Japan, chiefly based upon materials collected by the S.S. *Sôyô-Maru*, during the years 1923–30, by Yu Yokoya (*J. Coll. Agric., Tokyo Imperial University*, 12, No. 1 ; 1933) gives a very good idea of what is common and what is rare in this area ; all the records are given with sex and egg (if any) included, so that the breeding seasons are also shown. The extensive material from 658 stations was collected during the biological survey of the continental shelf of Japan, surrounding Honsyû, Sikoku and Kyûsyû, by the surveying ship of the Imperial Fishery Experimental Station of Tokyo. 292 species of decapods are recorded, 52

being new to science, and there are 33 new records for Japanese waters, whilst 3 new genera are proposed. Most of the stations were of 100–400 metres depth, therefore few shallow-water forms are included. Some species have a northerly distribution extending from central Japan as far as the Bering Sea, Alaska and the west of America, others a southerly distribution to the Malay Archipelago, Indian Ocean and Australia. The northern species were collected mainly from the west side of Japan, the southern species mainly from the east, but there are some notable exceptions and the subject is a complicated one which is discussed together with the position of the currents. Two main currents are well known, the warm current, the "Kuro-siwo", sweeping the south-east coast from the East Indian region and turning eastward, and the cold current, the "Oya-Siwo", entering the North Pacific by the Bering Strait, principally deflected along the western side.

Hydroids as Enemies of Fishes. E. W. Gudger (*Ann. Mag. Nat. Hist.*, 13, No. 74, Feb. 1934) remarks that the lower invertebrates are commonly thought of as food for fishes rather than as enemies—and so they are broadly speaking—but he brings together the recorded observations on *Hydra* and sessile colonial hydroids as fish-eaters, beginning with those of Trembley (1744) who saw young roaches, about one-third of an inch long, caught by the tentacles of *Hydra*, carried to the mouth and swallowed. Beardsley (1904) found the mortality among trout fry in the troughs of a hatchery at Leadville, Colorado, to be due to the presence of great numbers of *Hydra pallida* (130 per square inch in one trough) and a heavy mortality in the ponds of a trout hatchery in Germany was due to the presence of *Hydra fusca*. The author summarises the accounts of the attacks of *Polypodium* on the ovarian and free ova of the sturgeon of the Volga, of the colonial hydroid *Hydrichthys mirus* which has been found on sea fish off Rhode Island and was believed by Fewkes (1887) to be parasitic, of *H. boycei* described by Warren as parasitic on *Mugil* and other fish in South Africa, and lastly of a species of *Clytia* which fed on young angler fish (*Lophius*) in jars in the Plymouth Laboratory.

Parasites of the Hessian Fly. Miscellaneous Publication No. 174 of the U.S. Department of Agriculture (Dec. 1933) consists of a paper by Mr. A. B. Gahan on the serphoid and chalcidoid parasites of the Hessian fly in America. Some 41 species are clearly described and figured with very full synonomy and biological data. Since many of the species dealt with also occur in Europe, this work is one which is of importance to British and other extra-American students of the parasitic Hymenoptera. Particular interest is attached to the species *Eupelmella* (*Eupelmus*) *vesicularis*, Retz., which appears to be one of the most polyphagic species of all the Chalcids, since its recorded hosts embrace no fewer than 68 species, belonging to six of the major orders of insects. This feature is all the more remarkable from the fact that the insect has greatly abbreviated wings and is incapable of flight. Five generations have been reared in a single season and males are unknown. Geographically it extends from the British Isles to Russia eastwards, and to Italy in the south: in North America it is likewise very widely distributed. Owing to its polyphagic habits, it appears to be of little economic value as a primary parasite. The most efficient parasite in the biological control of the Hessian fly seems to be *Platygaster hiemalis*, Forbes, and, in North America, it is practically the only species which attacks the autumn generation of that host.

Plant Tumours and Polyploidy. Dontcho Kostoff and James Kendall give some details (*Archiv. Mikrobiologie*, 4, 487; 1933) of the cytology of tumourous growths produced in plants by various means—in some cases occurring generally over an interspecific hybrid, in others induced by injection of various chemical substances into the tissues or by injection with *Bacillus tumefaciens*. They regard these tumours as in all cases similar in construction, and in certain cases have been able to show that some of the cells in their neighbourhood have become either binucleate or multinucleate or polyploid. Such nuclear changes they attribute to an increased viscosity of the protoplasm, which makes the separation of the chromosomes more difficult after they have divided. From the neighbourhood of these tumours in some cases roots arise in which all the cells are polyploid or which have a chimæral structure as regards polyploid and normal nuclear apparatus. In other cases it was possible by cutting back shoots in the neighbourhood of tumours to obtain polyploid shoots and thus polyploid individuals could be separated and propagated. The authors are thus led to suggest that some of the various polyploid types that have been found growing naturally may have arisen as the result of cell disturbances produced by bacterial or other infection.

Earthquake Seawaves in North-East Japan. The Pacific coast of north-eastern Japan, perhaps more than any other region in the world, is subject to the inrush of destructive *tunamis* or earthquake seawaves, the most recent examples being those of 1896 and 1933. Earlier *tunamis* along the same coast are described by Prof. A. Imamura (*Japan. J. Astr. Geoph.*, 11, 79–93; 1934), who gives two reasons for their occurrence and destructiveness. Off this coast lies the deep Tuscaroora trench, in which changes of level occur one after another in its bed, while the coast contains numerous V- or U-shaped bays opening towards the trench. Excluding *tunamis* less than 10 ft. in height, Prof. Imamura enumerates 15 from 869 until 1933, of which those of 869 and 1611 were the greatest. In the latter year, about 4,783 lives were lost, the height of the waves being 66 ft., as compared with 48 ft. in 1896 and 20 ft. in 1933. From 1611 until 1689, there were five *tunamis* along this coast. Then came a pause of one and a half centuries, followed by another epoch of activity culminating in the disaster of 1896. A few hours before the arrival of the *tunamis* in 1894, 1896 and 1933, large secondary undulations were observed in the water of the V-shaped inlets, suggesting that minor crustal deformations had occurred before the great movements that gave rise to the main *tunamis*.

Long Period Temperature Changes. In the *Monthly Weather Review* of September 1933 there is an interesting study of long period temperature trends by J. B. Kincer, that is carried back in certain cases to the latter part of the seventeenth century. A number of temperature records are analysed in a manner that has been found specially suitable for

showing gradual changes. The sum of the annual mean temperatures for the first twenty years of a record is obtained and is plotted as the first point on a curve, additional points being obtained by subtracting the figure for the first year and adding that for the twenty-first, and so on. In this method an occasional exceptional year or two has only a slight effect on the general run of the curve. The analysis was applied to records in middle latitudes both in North America and Europe and to a few other parts of the world, with rather striking results. It appears that in middle latitudes there has been an upward trend since about the second quarter of the nineteenth century, in spring, autumn and winter, the change being generally about 3°—a substantial figure when dealing with means for periods so long as twenty years. The longest records are generally made in or very near to large towns and the possibility that the effect may be due to the growth of such towns and the consequent increase of the influence of artificial heating was considered. A number of overlapping records at town and country stations in the same State in America showed such striking similarity that it was concluded that the effect is general and corresponds with a world-wide change of climate.

Absorption of 1 cm. Waves. Cleeton and Williams have successfully produced waves down to 1·1 cm. in length by a vacuum tube oscillator, and have made absorption measurements of these waves in ammonia gas (*Phys. Rev.*, Feb. 15). In accordance with a theory of Dennison, the gas shows a strong absorption band in this region with a maximum absorption at λ 1·25 cm. The oscillator used employs a special type of thermionic tube with a split anode. The tube is placed in a strong magnetic field, and the frequency of oscillation depends primarily on the time of transit of the electrons between cathode and anode. The frequency may be varied over a small range by changing the magnetic field and the circuit voltages. There is a small Lecher wire system inside the vacuum tube. The spectrometer has an echelette grating of 18 elements and concave mirrors for focusing the waves, which are detected by an untuned crystal detecter at the focus of one of the mirrors.

Electrical Measurement of Small Vibrations. In the report of the Aeronautical Research Institute, Tokyo Imperial University (No. 103, Feb. 1934) there is an interesting paper by J. Obata, S. Morita and Y. Yoshida describing an electrical method of measuring small vibrations and its application to the measurement of the vibrations of airscrew blades. The electrical arrangement used comprises an electrical circuit containing a triode. An oscillation with a frequency of about 600,000 cycles per second can be started in the circuit. The displacement or vibration to be measured is made to produce a corresponding change in the anode current of the vacuum tube and this change is recorded by an oscillograph. The novelty of the method is its extremely high sensitivity and the fact that there is no need to bring anything into contact with the moving body. It is known that the vibration of the screw blades is one of the factors affecting the sound emitted. The positions of the loops and nodes were determined for model airscrews and also for an actual airscrew. Oscillograms are shown of the vibrations of the blades for given striking and measuring points. Fairly good agreement between the observed and the calculated values is obtained. The most conspicuous feature observed in the records of the vibrations of blades is a remarkable beat which is especially prominent in the case of metallic airscrew models. It was found that a slight change in the manner of clamping the airscrew model gave rise to marked changes in the number of beats produced per second. The beat is undoubtedly produced by the coupled vibration of the two blades. The degree of coupling is altered by changes in clamping. It is interesting to note that when a four-bladed airscrew model is vibrating, then at the instant of the downward stroke of one of the blades, the ends of the three remaining blades spring upwards.

Multiplet Intensities in Stars. Mr. A. D. Thackeray has described an investigation of multiplet intensities in thirty stars in the late types *K*5 and *M* (*Mon. Not. Roy. Ast. Soc.*, Dec. 1933). His work, which was carried out with the full spectrophotometric method, confirms the results reported by workers at Yerkes Observatory, who had announced that visual estimates of line intensities demonstrated the existence of anomalies in certain multiplets. The relative intensities of the lines in a multiplet, as they appear in a stellar spectrum, do not agree with the theoretical values, which have been confirmed by laboratory experiments. The effect in solar multiplets was first reported by Minnaert and independently by Woolley. A great deal of argument has been directed towards examining the cause of the anomaly, so far without arriving at any conclusive result. Thackeray discusses some of these arguments in the paper under review. The Solar Physics Observatory, Cambridge, at which Thackeray carried out the work, is to be congratulated on being amongst the first observatories to produce finished results of stellar spectrophotometry on narrow absorption lines with a slit spectrograph.

Plate Efficiency in Fractionating Columns. A paper was read by Mr. A. J. V. Underwood before a joint meeting of the Institutions of Chemical Engineers and Petroleum Technologists on March 21 dealing with the determination of plate efficiency in fractionating columns with complex mixtures. The essence of the paper was an evaluation of individual plate efficiency, which is generally taken as the ratio of change in composition of the vapour effected by a plate in the column to the change in composition which would result if the vapour, after passing through the plate, were in equilibrium with the liquid on it. It was claimed that this efficiency could be calculated for each component of the mixture knowing the composition of the vapour below and above the plate, the composition of the liquid on the plate and the composition of the vapour that would be in equilibrium with that liquid. From the above, it would seem that to obtain these data for any given fractionating column would involve numerous analyses of liquids and vapours in contact with every plate, but the author showed that it is only necessary to determine liquid compositions, leaving vapour compositions to be calculated by the use of material and thermal balances. The assumption that an efficiency of the order of sixty to seventy-five per cent is to be expected in practice was not supported by much available experimental data; probably this efficiency is seldom attained, and if it is on the low side, then there is considerable scope for progress in modification of plate design.

The Explanation of Supraconductivity

IT is customary to describe the supraconductive state of a metal by setting its specific electric conductivity σ equal to infinity. I wish to direct attention to another possibility, namely, that the supraconductive state can be described much more adequately by setting equal to infinity the *dielectric constant* ε of the substance, its conductivity σ remaining finite or even becoming equal to zero.

The actual meaning of the new definition can be seen from a comparison of the mechanism of ordinary electric conduction (σ finite) and ordinary polarisation (ε finite). In the former case the electrons called 'free' move *independently*, the conduction current being constituted by a drift motion due to the action of an external electric field and superposed on the unperturbed random motion of the individual electrons. In the second case the electrons called 'bound' are displaced by the electric field simultaneously in the same direction, the polarisation current being due to an orderly collective motion of all the electrons. Under normal conditions the displacement of the electrons with regard to the respective atoms remains small compared with the interatomic distances; this corresponds to a finite value of the dielectric constant. The assumption that the latter becomes infinite means that under the action of an infinitesimal field the electrons are displaced simultaneously over finite distances, each of them passing successively from an atom to the next one, like a chain gliding over a toothed track.

Such a collective motion of the 'bound' electrons will constitute an electric current just as much as the individual motion of the free electrons, but a *polarisation* current rather than a *conduction* one. The electrostatic mutual action of the electrons moving collectively in a chain-like way will stabilise them against the perturbing action of the heat motion of the crystal lattice, which will result in the permanence of the polarisation current after the disappearance of the electric field by which it was started[1]. This permanence, which has been erroneously interpreted as corresponding to an infinite value of the specific conductivity, must be interpreted in reality as corresponding to an *infinite value of the dielectric constant*. Now, how is it possible to explain the occurrence of such an infinite value? This turns out to be a very simple matter, the appropriate mechanism having been considered already by Hertzfeld, who, however, failed to give it the correct interpretation. Consider a chain of equally spaced atoms with a polarisation coefficient α. This means that an isolated atom assumes under the action of an external field E an electric moment $p = \alpha E$. If the field E is acting in the direction of the chain, then in computing the polarisation of a certain atom we must add to it the field E' produced by all the other atoms in virtue of their induced electric moments. All these moments being the same, we get

$$E' = \frac{2p}{a^3}\, 2 \sum_{n=1}^{\infty} \frac{1}{n^3} = 4{\cdot}52\, \frac{p}{a^3};$$

and consequently

$$p = \alpha \left(E + 4{\cdot}52\, \frac{p}{a^3} \right),$$

whence

$$p = \frac{\alpha E}{1 - 4{\cdot}52\, \alpha / a^3} = \alpha' E. \qquad (1)$$

We thus see that with a finite value of α for an isolated atom, an infinite value of the effective polarisation coefficient α' for the atom-chain is obtained if

$$4{\cdot}52\, \alpha \geqq a^3. \qquad (2)$$

The sign $>$ corresponding to a negative value of α' need not be distinguished from the sign $=$; in both cases the atom chain is characterised by the instability of the electron chain connected with it. This instability, which has been noticed previously by Hertzfeld, was interpreted by him as an indication of the fact that the electrons no longer remain bound, but become free 'conduction' electrons. Thus the inequality (2) was considered as characteristic of the metallic state in general. I believe that it is characteristic not of the metallic state but of the supraconductive state, a supraconductor being rather a dielectric with freely movable electron chains (that is, with $\varepsilon = \infty$) than a metal.

According to a theory of the metallic state developed in a rather qualitative way by Slater[2] and recently greatly improved and generalised by Schubin[3], the normal conductivity of a metal is due to a *partial ionisation* of the atoms, a certain fraction s of all the atoms becoming positive ions, and an equal portion (to which the corresponding electrons are attached) negative ions. If these electrons are bound very weakly, they may be considered as 'free' in the usual sense of the word. The conductivity of a metal is equal to the sum of the conductivities due to these free electrons or negative ions on one hand and the positive ions or 'holes' on the other. The mechanism of electrical conduction consists in the *individual* jumping of an electron from a negative ion to one of the neutral atoms surrounding it (which is thus converted into a negative ion), or from a neutral atom to a positive ion, which thus becomes a neutral atom, its rôle being switched over to the 'donor'. We meet with the same type of electric conduction in electronic semi-conductors[4]. The chief distinction between a metal and a semi-conductor consists in the fact that in the former case $s > 0$ at the absolute zero of temperature (T) whereas in the latter case $s = 0$ at $T = 0$, increasing according to the Boltzmann equation ($s = ce^{-W/kT}$ where W is the ionisation energy) with the temperature.

The elements which are likely to become supraconductors form an intermediary group in the sense that at ordinary temperatures they are relatively poor conductors, like the ordinary semi-conductors; the dependence of their conductivity on the temperature is, however, of the same character as that of typical metals (negative temperature coefficient). This means that in the case of these intermediary elements or 'half-metals', we have to do with substances which are characterised by a practically constant value of the ionisation fraction s. Their small conductivity can be explained either by a small value of s or by a small mobility of the individual electrons (which seems the more probable alternative in view of the correlation between supraconductivity and the Hall effect discovered by Kikoin and Lasareff). The fact that, in ordinary circumstances, that is, above the 'transition temperature' T_c, these substances are not supraconductive, can be explained by the finite value of their dielectric constant as determined by the polarisability

of ions stripped of the conduction electrons. The nature of the transition which takes place when the temperature T is decreased below T_c can thus be very simply interpreted by assuming that, at this temperature, s suddenly falls from a certain rather high value to *zero*, and that the polarisation coefficient α of the resulting *normal* atoms with their full complement of bound electrons satisfies the inequality (2)*. The very fact that the substance loses its conductivity (σ falling to zero along with s) thus transforms it from a metal into a dielectric with $\varepsilon = \infty$, that is, it becomes a supraconductor.

Both the necessity and the sharpness of the transition $s \to 0$ (that is, $\sigma \to 0$ and $\varepsilon \to \infty$) can be easily understood if we assume that the state $s = 0$ has a smaller energy than the state $s > 0$. It results from Slater's and especially from Schubin's calculations that the *lowest* energy level for polar (ionic) states *may* correspond to a *finite* value of s, whether this lowest level lies below or above the energy level corresponding to $s = 0$. It can further easily be seen that the distance between the successive levels in a band of levels corresponding to a given value of s is very small compared with kT, even for extremely low temperatures (of the order of a few degrees K.). If, further, the *total* width of the band was also small compared with kT, the entropy of the state $s > 0$ could be calculated as $k \lg g$, where g is the statistical weight of the whole band, that is, the number of ways in which the state s is realised. Taking all possible distributions of the ns electrons (negative ions) and ns positive holes (positive ions) between the n atoms, we get

$$g = \left[\frac{n!}{(ns)!\ (n - ns)!}\right]^2.$$

The transition $0 \to s$ is thus connected with an *increase* of entropy

$$\triangle\eta = 2k[n \lg n - ns \lg ns - (n - ns)\lg(n - ns)]. \quad (3)$$

In reality, the width of a band is of the order of 1 volt and therefore at least a thousand times larger than kT at the transition point. This will result in a much smaller entropy increase $\triangle\eta$.

So long, however, as $\triangle\eta > 0$ it follows that the state $s = 0$ must be stable at low temperatures and the state $s > 0$ at higher ones.

The transition temperature T_c as determined by the equality of the free energies of the two states is given by

$$T_c = \frac{\triangle\varepsilon}{\triangle\eta} \quad (\triangle\varepsilon = \varepsilon_s - \varepsilon_0). \quad (4)$$

Taking $s = \frac{1}{2}$ (which is probably an exaggeration) and calculating $\triangle\eta$ with the help of (3), we get $\triangle\eta = 1{\cdot}7k_n$. If $T = 4°$ (say) the transition energy $\triangle\varepsilon$ should be of the order of 14 small calories per gram atom. This value is greatly reduced if the width of the energy band under consideration is large compared with nT, its effective weight being accordingly small compared with g.

We thus see that the second condition for supraconductivity is expressed by the inequality $\varepsilon_s > \varepsilon_0$ at $T = 0$. But this is not all. Equation (1) is a good approximation so long as the chain-like displacement of the electrons x is small compared with the interatomic distance a. When x approaches $\frac{1}{2}a$, the electrons are pushed back by a force which varies more rapidly than the first power of x and can be overcome through the quantum mechanism of the tunnel effect. If a large number of electrons N are moving together in a chain-like way, they behave like a particle with an N-fold mass, the transition probability being correspondingly reduced. Now in his second theory of supraconductivity, Kronig[5] has shown that a chain or, as he puts it, a 'linear lattice', of electrons, bound to each other in a quasi-elastic way, can be displaced through a periodic field of force (with a period a equal to the average spacing between the electrons) under the condition

$$h/b\sqrt{m} > a^2, \quad (5)$$

where h is Planck's constant, m the mass of an electron and b is the rigidity coefficient of the 'electron lattice'. Putting $b = \tau e/a^{3/2}$ where τ is a numerical coefficient of the order 1, Kronig finds that the condition (5) is fulfilled if a is of the order of less than a few Ångström units. This seems to show that a 'linear lattice', that is, chain of electrons, is practically *always movable* with respect to the corresponding chain of atoms, provided the condition (2), which is much more restrictive, is fulfilled also. In fact, the latter condition seems to be the mathematical formulation of the possibility of treating the (bound) electrons as a kind of lattice. I do not believe in the reality of the three-dimensional lattices postulated by Kronig in his first paper. He has himself shown that such lattices, even if they exist, could not be moved through the ionic lattice. As a matter of fact, one-dimensional lattices or rather movable *chains* of bound electrons fully suffice for the explanation of supraconductivity. Such chains need not be movable in all directions. It is sufficient to assume that they should be movable in one particular crystallographic direction corresponding to the smallest spacing between the atoms, the dielectric constant being infinite for this direction and preserving a finite value for all the others.

In spite of its shortcomings, Kronig's theory is certainly the nearest approach to the correct explanation of supraconductivity published hitherto, the present theory differing from it more in form than in essence. The theory I advanced before, which was based on the supposed stabilisation of the free electrons (against heat motion) by their *electromagnetic* action, was wholly erroneous in this particular respect. It was correct, however, in describing the motion of the electrons in the supraconductive state as an organised 'collective' motion. This led to the result that a metal must possess when in this state an enormous diamagnetic susceptibility. This corollary subsists in the new theory and is corroborated by the fact recently discovered by Meissner that the magnetic permeability μ of a metal in the supraconducting state drops to zero. A supraconductor can thus be described as a body with $\mu = 0$ and $\varepsilon = \infty$, its electrical conductivity σ in the exact sense of the word being either finite or even zero.

A more complete account of the present theory will be published elsewhere. J. FRENKEL.

* This inequality is probably satisfied for all metals, although not all of them are supraconductors, because for true metals s remains finite (and practically constant) down to the absolute zero of temperature, while for supraconductors it jumps to a finite value slightly above it.

[1] The effects of heat motion of the crystal lattice on the individual electrons are mutually cancelled. Cf. R. Kronig, *Z. Phys.*, **80**, 203; 1933.
[2] *Phys. Rev.*, **35**, 509; 1930.
[3] In the press.
[4] Cf. J. Frenkel, NATURE, **132**, 312, Aug. 26, 1933.
[5] *Z. Phys.*, **80**, 203; 1933.

Flora of Tibet

THE plant collection made by Capt. F. Kingdon-Ward in Tibet last year for the British Museum (Natural History) comprises about 750 items, and more than 5,000 specimens. Some 500 species are included. The bulk of the collection was made north of Rima (lat. 28° 25′ N., long. 97° 0′ E.), in Zayul, south of the great snow range, and in Nagong, north of the snow range. The Nagong plants come from around Shugden Gompa (lat. 29° 25′ N., long. 97° 0′ E.).

The great range of snow mountains comparable to the Himalaya, and running approximately north-west to south-east, divides this part of Tibet into two. South of this range, in Zayul, the mountains are well wooded with deciduous and evergreen forest. Oaks, maples, birch, hornbeam, magnolias, *Ilex* and *Rhododendron* species abound. Higher up there is conifer forest. North of the range, in Nagong, there is no forest and almost the only tree, found in a few favoured localities, is *Picea lichiangensis*. There is a number of shrubs, especially species of *Lonicera*, *Berberis*, *Spiræa*, *Rosa*, *Clematis* and *Cotoneaster*; but chiefly the mountains are covered with a great variety of herbaceous plants. Thus the snow range acts as a rain screen. Amongst the most prominent alpine genera are *Gentiana*, *Primula*, *Dracocephalum*, *Cremanthodium*, *Anemone* and *Androsace*.

One of the principal results of the expedition was the definite recognition and delimitation of three floral zones in Tibet: (1) the desert zone, with very few species of flowering plants; (2) the outer plateau, with a considerable alpine and a small woody flora; and (3) the river gorge country, divided into (*a*) upper gorge country with a large alpine flora and a few shrubs and trees, (*b*) lower gorge country with a wealth of forest. The discovery that the snow range is an eastern extension of the Himalayan range is also important from a phyto-geographical point of view; as is also the observation that the glaciers on this range formerly extended a long way south. Kingdon-Ward has now been able to trace the southern limit of the ice during the last glacial epoch, from the eastern Himalaya right across to China; this advance of the ice had a profound influence on the flora.

In Nagong, where the snow line stands at about 19,000 ft., flowering plants in some variety were found above 18,000 ft.; mostly, however, collections were made at 14,000–16,000 ft. In Nayul, the snow line is lower: most of the plants found in the Rima district were collected between 5,000 ft. and 10,000 ft., a few alpines at 10,000–15,000 ft. These last include several species of *Nomocharis*.

One other type of flora requires mention—that of the deep Salween gorge, which was reached in August. The heat was great, the lack of water was conspicuous. A peculiar flora of dwarf spiny or prickly shrubs occurs here (altitude 9,000–11,000 ft.).

The southern country traversed is composed almost entirely of igneous rocks: the northern country almost entirely of sedimentary rocks, including limestones, red sandstone and slate.

On the return journey, the Mishmi Hills were crossed by a new route. This country, being technically a part of Assam, falls within the Indian Empire, and few plants were collected there.

In all, a number of new and little-known plants were found, and the distribution of others, especially as between the Himalaya and Chinese mountains, extended; though the most important results were the recognition of the several floral areas in Tibet, and the proof of the Himalayan extension, with all that it implies in the distribution of plants in south-east Asia. Seed of about 180 species was secured, also a number of photographs of plants in their natural surroundings.

The regions which lie to the west of Shugden Gompa, between the Salween and the Tsangpo, still remain to be explored, before we can get an adequate idea of the flora of the river gorge country.

Locust Control*

THE outbreak of locusts which began in the Sudan, Algeria and western Asia in 1926 and reached Kenya two years later, increased in intensity so greatly that it exceeded the powers of local checks and expanded rapidly into an enormous, widespread plague, ranging from Bechuanaland into Persia, India and Turkestan. It is estimated that the damage this caused between 1927 and 1931 exceeds £6,000,000.

The Government realised the significance and at once formed an organisation, which now appears in the form of the Locust Control Committee of the Economic Advisory Council, with headquarters at the Imperial Institute of Entomology, under the direction of Mr. B. P. Uvarov.

The work quickly became international. Italy suggested a congress in Rome, where war was declared upon the locust by an alliance of British, Italian and French Governments, which have since been joined by the Belgian, Portuguese and Egyptian. A striking illustration of the world-wide interest in this war is seen in the list of works published during the period in question, which covers no less than 35 pages of the reports and includes papers in such unexpected languages as Chinese, Yiddish and Uzbeg, while there are 166 papers in Russian.

The three species concerned are the desert locust, *Schistocerca gregaria*, Frosk., no doubt the same that plagued Pharaoh, the tropical form of the migratory locust, *Locusta migratoria*, L., subsp., *migratorioides*, R. and F., and finally the red locust, *Nomidacris septemfasciata*, Serv. The first is confined to the arid belt, and the great forests appear to offer a barrier even to flying swarms. The migratory locust frequents the three types of savannah country, but is stopped by the deserts. Its movements are due to reflexes dependent in temperate regions upon temperature, in hot countries upon humidity. The life-history of the migratory locust in the tropics is different from its cycle in the temperate zone, as the egg stage there is short but the adult long, so it is with the latter that the battle must be joined. Spraying with poison dust from aeroplanes, particularly of the auto-giro type, will probably be the solution, coupled with intelligence work in the home breeding areas, which are being investigated by four British, three French and several Indian entomologists.

With the expansion of agriculture in Africa, the potential damage by locusts becomes vast indeed, but much valuable work has been done, and now that the organisation is in full swing, the outlook is encouraging. M. B.

* The Locust Outbreak in Africa and Western Asia, 1925–31, and the same for 1932. Surveys prepared by B. P. Uvarov for the Committee on Locust Control of the Economic Advisory Council. (London: H.M. Stationery Office, 1933.) 5*s*. and 3*s*. net respectively.

University and Educational Intelligence

CAMBRIDGE.—It is proposed that the degree of Sc.D. *honoris causa* be conferred on Prof. A. Fowler, Yarrow research professor of the Royal Society.

At Clare College, Mr. R. E. Priestley has been appointed to a professorial fellowship.

OXFORD.—Dr. R. W. T. Gunther, Magdalen College, has been appointed University reader in the history of science. The appointment, to which no stipend is attached, is for six years from August 1, 1934. No one in Oxford is better qualified than Dr. Gunther to give instruction in the history of science, especially in its relation with the University. His long series of volumes on "Early Science in Oxford", as well as his smaller treatises on the Daubeny Laboratory and the Botanic Garden, together with his work as curator of the Lewis Evans collection of scientific instruments, are evidence of his power of making available his intimate knowledge of the subject.

The *New Commonwealth*, the monthly organ of a society for the promotion of international law and order, appeals, in a special educational supplement to its December number, to all engaged in education, to co-operate towards the realisation of its aims. The society stands for the establishment of an international tribunal of wider jurisdiction than the court at The Hague, and for an international police force, and this special supplement has articles by well-known writers on "Teaching Peace", "War and History", etc. Simultaneously there appears in *School and Society* of December 9 a protest against premature agitations for organising the surrender to an international body of parts of the sovereignty of the modern State. In an address to the Association of Urban Universities by the president of the College of the City of New York on the place of the State in the modern world, it is contended that it will be centuries before humanity is ready for a world commonwealth, and that the best agencies for conserving such communities of interest as exist among nations are the sovereignties joined in treaties and trade agreements.

Science News a Century Ago

Royal Geographical Society

"At the Anniversary Meeting, held on May 12, 1834, Mr. W. R. Hamilton, V.P., in the chair, General the Right Hon. Sir George Murray was re-elected President, and Mr. R. I. Murchison was elected a Vice-President. A report related that the Society had published, during the last year, the third volume of its *Journal*, in two parts, and a Map of America by Col. Monteith ; that the late African and Palestine Associations had dissolved themselves and transferred their funds to the Society ; that the Royal Premiums for 1832 and 1833 were assigned to Capt. John Biscoe and Capt. Ross, and that the Council had subscribed 50l. to a projected expedition into the interior of Africa from Delagoa Bay ; and to another into the interior of South America—50l. towards outfit, and 50l. a year for three years. It also noticed the formation of a branch society at Bombay. Lieut. Allen, the companion of the late Richard Lander, was present and exhibited a variety of his African sketches. A portrait of Lander, painted by Mr. Brockedon, shortly before his departure, was presented by that gentleman to the Society. The Society have published the first part of Vol. IV of their *Journal*." (*Gentleman's Magazine*, June 1834.)

The first to receive the Royal Premium of fifty guineas (1832) was Richard Lander, for exploring the course of the Niger to the sea ; next (1833), John Biscoe, for his circumnavigation of the antarctic continent and the discovery of Enderby Land and Graham Land. Biscoe's voyage was chronicled only in the Society's *Journal*.

The Padorama

The *Times* of May 12, 1834, describes an exhibition then on view at the Bazaar, Baker Street, London. "It consists of a continuous view of the railway and the adjacent country through which the line of road passes between Manchester and Liverpool. . . . The whole picture covers a surface of 10,000 sq. ft. of canvas and it is made to move on drums by mechanical power. . . . There is also a foreground detached from the principal painting which foreground is also moveable. . . . Along the railroad a great variety of waggons, carts, etc., attached to steam engines, are at intervals made to pass along. This part of the exhibition was well contrived ; the mechanism of the steam engines is accurately represented, and the pigmy passengers by whom the carriages are crowded might easily, so well is the deception of the whole effort preserved, be mistaken for living people of the full size of life."

Coins and Coining

On May 13, 1834, Mr. William Wyon (1795–1857), the chief engraver at the Mint, delivered a lecture before the Society of Arts on "Coins and Medals" in which he gave a sketch of ancient and modern coins, the progress of the art of coining and of modern medals. After referring to the coins of the Greeks and Romans, and to the introduction of the various British coins, he said that one of the most important events in the history of the Mint in London was the introduction of the mill and screw. Previous to the reign of Charles II, money was made by hammering slips of gold and silver to the proper thickness, then cutting the slips into squares, which were afterwards rounded and adjusted to the weight required. After this, the blanks were placed between dies and struck with a hammer. The mill and screw, or coining press, was invented in France, it is supposed by Antoine Brucher in 1553, and was first used in Great Britain during the Commonwealth. At the Mint in 1834, there were eight presses, each press producing sixty pieces a minute. In 1817 the daily production of coins was 343,000, while from January 4, 1817 until December 31, 1833 the sum coined in sovereigns and half-sovereigns was £52,187,265 sterling. One of the problems at the Mint was the selection of the best steel. Fine steel as used by engravers was unfit for the purpose and coarse steel acquired fissures under the die-press. Even the best steel could be spoilt for want of skill on the part of the smith. Casualties to dies were frequent but sometimes a pair of dies would strike three or four hundred thousand pieces. The lecture was reported in full in the *Athenæum* of May 1834.

Sir Charles Bell on the Brain

On May 15, 1834, Sir Charles Bell read a paper before the Royal Society on the functions of some parts of the brain and on the connexion between the

nerves of motion and sensibility. In the course of his paper, he suggested that the best mode of inquiry into the functions of the brain and nervous system would be to trace the filaments of the nerves through the filamentary and striated substance of the brain, and stated that the result of such an examination would show that two columns of motal and sensory nerves descend from each hemisphere of the brain and meet and decussate in the medulla oblongata. He also entered upon a minute account of the medulla, and of the various septa of nerves with which it is connected, tracing the filaments upwards into the brain and downwards into the spinal column. In concluding, he remarked that the use of the cerebellum had not yet been determined with any tolerable degree of accuracy. Bell at the time was surgeon to the Middlesex Hospital. He had been admitted F.R.S. in 1826, and in 1829 awarded a Royal medal for his discoveries relating to the nervous system.

Death of H. W. Brandes

Prof. H. W. Brandes, who died at Leipzig on May 17, 1834, was the first meteorologist to construct a series of daily pressure charts. In his "Beiträge zur Witterungskunde", published at Leipzig in 1820, he discussed the weather over Europe of each day of 1783. He drew charts of equal deviation of pressure from 'normal' and of wind direction; these charts were not published and have been lost, but a specimen chart was reconstructed by Hildebrandsson from Brandes' material. Brandes believed that the winds converged towards regions of rarefied air or low pressure. In a later publication he discussed two 'cyclonic storms' and demonstrated that they advanced from west to east across the earth's surface.

In the year 1834 there was published the "Narrative of a Voyage in the Southern Atlantic Ocean . . . in H.M. Sloop 'Chanticleer' . . .", in which W. H. B. Webster gave what was probably the first printed account of the differences of average annual pressure between different parts of the world, and attributed to these hitherto unrecognised differences the perpetual interchange and motions of the atmosphere.

Belgrave Literary and Scientific Institution

Following the establishment of this institution at 30 Sloane Street, the *Athenæum* reported in its issue of May 17, 1834, the delivery of an opening lecture by Prof. Robert E. Grant, whose subject was, "On the Nature, Growth, and History of Corals". We read that there was a crowded and "highly respectable" audience, and that the lecture was illustrated by a variety of beautiful specimens and diagrams; also, that the results of personal researches and ingenious experiments were detailed.

Prof. Grant, who is referred to above, was born in Edinburgh, and was a graduate of the University there. In his student days he was the frequent companion of Charles Darwin in excursions and walks. Darwin (then) thought that he was "dry and formal" ("Life"). Grant contributed many papers to the *Edinburgh Philosophical Journal*, and the *Memoirs of the Wernerian Society*. In 1828 he took up duties in London as professor of comparative anatomy and zoology at University College, and during forty-six academic years never omitted a single lecture. Appointed in 1837, he was for three years Fullerian professor of physiology at the Royal Institution. By will, Grant bequeathed his property, collections and library to University College. (*Roy. Soc. Proc.*, 23.)

Societies and Academies

London

Royal Society, May 3. W. D. Wright: The measurement and analysis of colour adaptation phenomena. There is a main process of adaptation that operates through the regeneration of a photosensitive substance at a constant rate. The instantaneous response aroused by a stimulus is directly proportional to the magnitude of the latter, but owing to the process of adaptation, the response is rapidly reduced to an approximately constant level. This is the true interpretation of the constancy of the Fechner fraction, as opposed to the suggestion that the response is proportional to the logarithm of the stimulus. By locating the three hypothetical stimuli in the colour triangle corresponding to those sensations that can be modified in intensity, but not in colour, no matter what the colour of the adaptation may be, it has been possible to determine the fundamental response or excitation curves. R. J. Ludford: Factors influencing the growth of normal and malignant cells in fluid culture media. Significant differences have been found in the behaviour of different strains of tumours in mouse and rat serum. Some tumours have not been grown as sheets of malignant cells in either mouse or rat serum; other tumours have given good sheet growths in mouse serum but not in rat serum; while still others have grown in both sera. It is suggested that whether or not cells form sheets from explants in a fluid medium depends upon the adhesion of the cells to glass in that particular medium, rather than upon growth-promoting or growth-inhibiting properties of the medium. The presence of large numbers of active cells of the macrophage type interferes with sheet formation by malignant cells in fluid media. This is regarded as due partly to crowding out of the malignant cell on the surface of the cover glass, and partly to the phagocytic activities of the polyblasts. It may be the activity of cells of this type accumulated around a tumour graft in an 'immune' animal which prevents its growth.

Dublin

Royal Dublin Society, February 27. J. J. Nolan: Observations of atmospheric electricity at Glencree. The results for diurnal variation of ion content and rate of ion production in the lower atmosphere at Washington (Wait and Torreson), Canberra (Hogg) and Boston (Yaglou) were compared with those found at Glencree. It is shown that there is considerable support for the view that the maximum in the rate of ion production occurs approximately simultaneously at these stations.

Paris

Academy of Sciences, March 12 (*C.R.*, 198, 997–1088). Jean Rey: The working of a thermocompressor carrying successively two compressible fluids of different densities: law of yield by weight: law of invariance of the final pressure. C. Camichel, L. Escande and G. Sabathe: The similiture of *ouvrages courts* with free surface. Dmitri Mordoukhay-Boltowskoy: Abelian integrals with reducible systems of periods. J. O. Strutt: Hill's differential equation in the complex domain. A. Rauch: Remarks on holomorph functions in an angle and meromorph algebroids in the plane. K. Nikolsky: The relativist quantic interaction. René Reulos:

A new method of integration of the equation of electromagnetic waves and its application to the physics of the electron. ARCADIUS PIEKARA and BRUNO PIEKARA : The dipole moment of acetic anhydride and some anomalies presented by the acids of the fatty series. G. DÉCHÊNE : Variations with time of the intensity of the current in a semi-conducting substance submitted to a low electromotive force. J. SOLOMON : The relativist theory of atoms with a large number of electrons. JEAN J. TRILLAT : Electronic diffraction by cellulose films. By the use of monokinetic electrons the structure of various cellulose derivatives has been studied : X-rays give no results with these films. A freshly prepared film is amorphous ; after some hours very small microcrystals disposed at hazard appear. After some days, or weeks, the entire film is crystallised and is formed of unique crystals. G. LIANDRAT : Attempts at applying the laws of photoelectric emission to photo-elements with an arresting layer. R. DE MALLEMANN and P. GABIANO : The magnetic rotatory power of hydrogen selenide. From the figure obtained, the value 36×10^{-5} is found for the atomic rotation of selenium, which is thus higher than that of sulphur, 23·5. L. DÉCOMBE : The influence of temperature on the yield of alternators and of transformers. The use of a refrigerating machine for cooling is not worth while, as the improvement in yield is so small. JEAN AMIEL : The action of chlorates on sulphur, selenium and tellurium. A study of the conditions producing spontaneous inflammation of mixtures of chlorates of the alkaline earths with sulphur. MARCEL CHAUSSAIN and HENRI FOURNIER : The passivity of magnesium in solutions of chromic anhydride and its chemical scouring after corrosion. The marked effect of the presence of impurities in the chromic acid, especially small amounts of sulphuric acid, is shown by experiment. MALAPRADE : The acidimetric method of determining formol and sulphites. TIFFENEAU, E. DITZ and MLLE. B. TCHOUBAR : Molecular transpositions in the dimethylcyclohexane series, with or without reduction of the ring, by the removal of halogen from the chlorhydrins and by isomerisation of the epoxides. CH. PRÉVOST, P. DONZELOT and E. BALLA : The Raman effect, molecular refraction and constitution. The supposed α-benzylcyclohexene. A repetition of the work of Auwers and Treppmann on the dehydration of phenylcyclohexylcarbinol, from which the conclusion is drawn that the product is not α-benzylcyclohexene but benzylidenecyclohexane. P. VIÈLES : The dilactylic acids and their anhydride. MLLE. M. TH. FRANÇOIS : The setting of the *Aleurites* oils (China wood oil) by the halogen compounds of antimony. H. BRASSEUR, A. DE RASSENFOSSE and J. PIÉRARD : The crystallographic study of barium nickelocyanide. Hydrated barium nickelocyanide and barium platinocyanide are completely isomorphous. D. SCHNEEGANS : The geological constitution of the Chabrières massif (Hautes-Alpes). MICHEL PERTESSIS : The radioactivity of the mineral springs of Greece. HENRY HUBERT : The general circulation of atmospheric air above Indo-China. R. BUREAU : The direction of the summer sources of atmospherics. L. EBLÉ and G. GIBAULT : The values of the magnetic elements at the Val-Joyeux (Seine-et-Oise) Station on January 1, 1934. D. BARBIER : Theoretical remarks on the distribution of ozone in the atmosphere. PAUL CORSIN : The characters of *Grammatopteris Rigolloti*. ANDRÉ DAUPHINÉ : The different modes of thickening of the membrane in vascular plants. LUIGI MANZONI and AGOSTINO PUPPO : The transpiration of wheat as a function of climatic factors. A. MAUBLANC and L. ROGER : A new rust of the coffee plant of the Cameroons. This plant disease is clearly distinct from *Hemileia vastatrix* and is given the provisional name of *Uredo coffeicola*. PH. JOYET-LAVERGNE : Cytoplasmic sexualisation in yeasts with heterogamic conjugation. ET. RABAUD and MLLE. L. VERRIER : The air bladder of the loach, *Cobitis barbatula*. Y. LE GRAND : Dazzle in yellow light. MAURICE FONTAINE : Absorption and fluorescence spectrography of fabreine. MME. ANDRÉE DRILHON-COURTOIS : The regulation of the mineral concentration of the internal medium in some Crustacea and their adaptation to changes in salinity. PIERRE GIRARD and MLLE. MARGUERITE LOURAU : First indications on the nature and physical properties of an antibody : electrophoresis of hæmolytic sera. R. GUILLEMET, C. SCHELL and P. LE FUR : Fermentable glucides, alcoholic fermentation and gas-production in bread-making. A. W. SELLARDS and J. LAIGRET : The duration of the immunity resulting from vaccination against yellow fever. Experiments are described proving the immunity conferred by vaccination is of at least two years' duration.

SYDNEY

Linnean Society of New South Wales, November 29. F. A. CRAFT : The coastal tablelands and streams of New South Wales. Some of the highland features form surfaces of greater or lesser relief which are not surrounded by higher country, while others consist of plains almost enclosed by higher land, with a sharp break of slope in the passage from lower to higher surfaces ; in addition, the plateau edges are distinguished from the gentle regional slopes of the summit planes, and the growth of the plateau is traced by reference to relic scenery preserved by basalt flows. The streams of the region are classified according to their approximation to profiles of equilibrium, and the extent of canyons along their courses. LILIAN FRASER : The Mycetozoa of New South Wales. Eighty-eight species and varieties of Mycetozoa are listed, most of them from the environs of Sydney and the adjacent highlands. Very few records are known for the western parts of the State, probably due to the relatively hot and dry climate being unsuitable for their development. PEARL R. MESSMER : A new species of *Pterostylis*. A new species of *Pterostylis* is described from Fitzroy Falls, N.S.W. It suggests affinities with *P. grandiflora*, *P. ophioglossa* and *P. reflexa*, and may have originated as a hybrid between the first two of those species. G. A. WATERHOUSE : Australian Hesperiidæ. (4) Notes and descriptions of new forms. Nine new races are described. As the result of an examination of type specimens in the British Museum by Brigadier W. H. Evans, it is shown that *Taractrocera anisomorpha*, Lower, and *T. ina*, Waterhouse, are full species and not races of species found in Timor and New Guinea. Further notes are given on *flavovittata*, Latreille, and this species and its allies are now placed in *Ocybadistes*, Heron, instead of *Padraona*, Moore. The remarkable life cycle of two years of *Hesperilla chaostola*, Meyrick, is described.

VIENNA

Academy of Sciences, January 11. ELISABETH KARA-MICHAILOVA : Nuclear γ-radiation excited artificially. A large number of elements were subjected to intense

radiation with α-particles of polonium to ascertain to what extent they emitted a hard nuclear γ-radiation under such treatment. Positive results were shown by B, N, Al, Na, Mg and especially Be. HERBERT HABERLANDT, BERTA KARLIK and KARL PRZIBRAM: Synthesis of the green, low-temperature fluorescence of fluorite. Ytterbium is found to be the source of this fluorescence. HERMANN WENDELIN: Abel's groups. ALEXANDER KÖHLER and WILHELM FREH: Geological-petrographic studies on the igneous rocks of the Lower Austrian forest region and its neighbourhood (3). Results are given of analyses of granite from Schrem, quartz-mica-diorite from Gebhart, and kersantite from the Loja valley above Steinbruch. F. GRÜTER, A. STÄHELI and E. STEINACH: Removal of sterility from animals (oxen, cows, pigs) by the female sexual hormone. A single administration of this hormone suffices to render sterile animals capable of breeding. ALFRED MÜLLER: Baire's theorem. RUDOLF WAGNER: Prefloration polymorphism and polygamia in *Reineckea carnea* (Ardr.) Kth.

Jan. 18. HERBERT HABERLANDT: Fluorescence analysis of minerals. The presence of rare earths in certain scheelites and zircons, and that of uranium in certain scapolites is detectable by means of the fluorescence spectrum. ROBERT SCHWINNER: Geology of Eastern Styria (i); structure of the mountains about Vorau. HANS PRZIBRAM: (1) Skeletal transitions in regenerating *Sphodromantis*-antennæ. (2) Skeletal transitions in regenerating cricket-antennæ. HEINZ TRAMPUSCH: Influence of endocrine glands on the regenerate in vertebrates.

Jan. 25. FRIEDRICH KÜMEL: Crystalline facies in the Rosalien mountains: eclogite and amphibolite. KARL PRZIBRAM: Plasticity and hardness of alkali halide crystals (2). The author's results are compared with those obtained by other methods by Reis and Zimmermann, and by Goldschmidt. ELISABETH KARA-MICHAILOVA: Luminous intensity of the air caused by α-particles of various ranges. The variation of intensity with the range of the α-particles follows a course similar to that of the ionisation curve. OTTO WETTSTEIN: Results of the Austrian biological expedition to Costa Rica in 1930: Amphibia and reptiles. GUSTAV GÖTZINGER and HELMUT BECKER: New geological-stratigraphic investigations in the Wienerwald.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, May 14

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—W. Rickmer Rickmers: "Ajaristan and Lazistan".

Tuesday, May 15

INSTITUTE OF PHYSICS, at 4.15.—(at the Royal Institution, Albemarle Street, W.1).—Annual General Meeting. Sir Henry Lyons: "Physics and Science Museums". (Presidential Address.)

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. Werner Brock: "Introduction into Contemporary German Philosophy" (succeeding lectures on May 16 and 18)*.

GRESHAM LECTURES IN ASTRONOMY, at 6.—(at Gresham College, Basinghall Street, E.C.2). Arthur R. Hinks: "Times, Dates and Calendars" (succeeding lectures on May 16, 17 and 18).*

Wednesday, May 16

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. G. C. Simpson: "World Climate during the Quaternary Period".

FARADAY SOCIETY, at 5.30.—(at the Royal Institution, Albemarle Street, W.1).—Sir William Bragg: "Molecule Planning" (Spiers' Memorial Lecture).

ROYAL SOCIETY OF ARTS, at 8.30.—Dr. C. E. Kenneth Mees: "Some Photographic Aspects of Sound Recording" (Sir Henry Trueman Wood Lecture).

Thursday, May 17

LONDON MATHEMATICAL SOCIETY, at 5.—(in the rooms of the Royal Astronomical Society, Burlington House, W.1).—Prof. E. A. Milne: "World-Gravitation by Kinematic Methods".

Friday, May 18

BEDSON CLUB, ARMSTRONG COLLEGE, NEWCASTLE-UPON-TYNE, at 6.30.—Prof. G. G. Henderson: "Gutta Percha, Balata and Caoutchouc" (Twenty-sixth Bedson Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, May 15–20.—Annual Congress to be held at Norwich. Alderman H. N. Holmes, president.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS, May 19–22.—Twenty-fifth conference to be held at Middlesborough.

Official Publications Received

GREAT BRITAIN AND IRELAND

Imperial Bureau of Animal Genetics. A Bibliography of the Works of James Cossar Ewart. Compiled by Dr. J. H. Ashworth and Dr. F. Fraser Darling. (Supplement to "Animal Breeding Extracts", Vol. 1.) Pp. xi. (Edinburgh and London: Oliver and Boyd.) 6*d*. net.

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and on the Work of the Hydrographic Department for the Year 1933. Pp. vi. (London: Admiralty.)

Memoirs of the Cotton Research Station, Trinidad. Series A, Genetics, No. 6: (a) Further Experiments on the Inheritance of the Crinkled Dwarf Mutant of *G. barbadense*, by S. C. Harland; (b) Two Interspecific Hybrids between Asiatic and New World Cottons, by A. Skovsted. Pp. 30. 2*s*. 6*d*. Series A, Genetics, No. 7: The Inheritance of Leaf Shape in Asiatic *Gossypiums*. By J. B. Hutchinson. Pp. 78. 2*s*. 6*d*. (London: Empire Cotton Growing Corporation.)

OTHER COUNTRIES

The Journal Hyderabad Geological Survey. Vol. 2, Part 2, Water-Supply Paper No. 1: Geology of the Underground Water Resources of the Hyderabad State, and Notes on Well Sinking. By Capt. Leonard Munn. Pp. vii+204+16 plates. (Lingsugar: Hyderabad Geological Survey.) 5 rupees.

Proceedings of the Sugar Cane Investigation Committee. Vol. 4, Part 4: Progress Reports for July to December 1933. Pp. 201–254. (Trinidad: Imperial College of Tropical Agriculture.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 77: Studies on the Phosphorus Requirements of Sheep, 1: The Effect on Young Merino Sheep of a Diet deficient in Phosphorus, but containing Digestible Proteins and Vitamins. By Sir Charles J. Martin and A. W. Peirce. Pp. 44+2 plates. Bulletin No. 78: Methods for the Identification of the Light-coloured Woods of the Genus Eucalyptus. By H. E. Dadswell, Maisie Burnell and Audrey M. Eckersley. (Division of Forest Products, Technical Paper No. 12.) Pp. 60+41 plates. (Melbourne: Government Printer.)

The Wistar Institute Style Brief: a Guide for Authors in preparing Manuscripts and Drawings for the most Effective and Economical Method of publishing Biological Research. Pp. 169 (37 plates). (Philadelphia: Wistar Institute.) 2 dollars.

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahs 1933. Pp. 21+4 plates. Zweites Bergedorfer Sternverzeichnir 1930·0 enthaltend die mittleren Örter von 4599 Sternen (Eros-Anhaltsternen 2. Ordnung für die Opposition 1930–31) nach photographischen Aufnahmen mit dem AG-Astrographen in den Jahren 1930 und 1931. Herausgegeben von Dr. Richard Storr. Pp. vi+78+1 plate. Sammlung von Hilfstafeln der Hamburger Sternwarte in Bergedorf. Z: Formeln zur geographischen Ortsbestimmung (zum Gebrauch beim Astronomischen Praktikum an der Hamburgischen Universität). Pp. ii+14. H: Formeln und Hilfstafeln zur Reduktion Photographischer Himmelsaufnahmen, Teil 2. Pp. iii+64. (Bergedorf: Hamburger Sternwarte.)

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