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Scientific Research and Industry

THE twenty years' work on which the Department of Scientific and Industrial Research can now look back represent a contribution to the national welfare and resources which is not easily over-estimated. The firm establishment of the research associations, to which the expansion and improvement of their financial resources in the last two years bear witness, indicates how successfully the Advisory Council has encouraged the habit and practice of co-operative research in Great Britain. Evidence is to be found everywhere in industry that the importance of applying at every stage of processes the help that science can afford is widely realised.

During two decades, the work with which the Department has been indirectly or directly concerned has provided industry with an immense amount of data, both scientific and technical, the utilisation of which is proceeding at an ever increasing rate. An outline of the achievements of the year 1934–35 appears elsewhere in this issue (p. 300). If the necessity for acquiring such data is now more widely recognised and if many more firms are now, through their own research departments or research associations, taking steps to obtain the knowledge upon which development and progress depend, it would be unwise to conclude that the utilisation of even existing knowledge is everywhere as effective in industry as is desirable.

An important part of the recent report of the Advisory Council of the Department of Scientific and Industrial Research should indeed discourage any undue optimism on this point. From research by itself, it is pointed out, practical benefits can seldom be expected; however promising in themselves processes may be, they need development and method in their application if they are to be useful under factory conditions. Prosperity will only be restored when industry is prepared to carry the knowledge gained by research to a further stage and apply it to meet daily needs.

This kind of 'research-mindedness' is urgently needed in industry to-day. Many of our industries are still paying a price for the remarkable era of prosperity which followed the industrial revolution in Great Britain and lasted until the Great War. As example, the Advisory Council refers to the extent to which manufacturers of machinery have allowed their foreign competitors to establish commanding positions in the world market for new types of machines by the systematic application of scientific investigation and invention. Reference is also made to a report presented last year to the Commissioner of the Special Areas describing the condition of some of the secondary industries of the north-east coast of England and its conclusion that general prosperity in the district is impossible without an intensive application of scientific methods to those industries which the local raw materials, and the skill of the local workers in industry, make possible.

There is, of course, plenty of evidence of industrial leadership here as elsewhere, and the wholehearted efforts of enlightened leaders in some of our great industries have not been without fruit. The number of progressive firms which engage in investigation and research, whether in their own or in co-operative laboratories, and which by applying scientific method in their day-to-day processes are able to use advances in knowledge as they are made available by research, continues to increase. From the national point of view, it is vitally important to enlarge the circle of scientifically

minded firms. Much remains to be done, and while real progress in this respect should continue by its own momentum, there is no time to lose.

There are, however, two closely related aspects of this question to which the Advisory Council directs special attention. Reference is made to evidence which was received in a report on an inquiry carried out at the Council's request by one of the research boards of the Department. The board had been asked to review the conditions in the industries with which it was concerned, and to say whether sufficient research was being undertaken in the country for their benefit; if not, in what directions further investigation was called for, and what further steps were needed to impress on those industries the need for better application of existing knowledge and for further research work.

The conclusion clearly emerged that, compared with some of their industrial rivals overseas, the scientific outlook of these industries under review still leaves much to be desired. Neither in the directorates nor among the technical and executive staffs is sufficient weight yet given to scientific attainment and experience; and until a radical change in this respect has taken place, the industries as a whole will remain unable to obtain the full benefits of the results of scientific investigation.

This question of the utilisation of scientific attainment and experience in the direction of industry thus once more emphasised has a further aspect to which also the Advisory Council refers. Men of first-class scientific ability will be more ready to enter industry if they see a real hope of attaining to positions of responsibility and power. Apart from this question of raising the standard of industrial management and leadership, the work of the Department tends to assume more and more the character of a 'general staff' of industry or even of the nation as a whole which, if its functions are advisory rather than executive, guides the expenditure of the national research effort in ways that afford the maximum advantage to the nation.

The linking up of industrial and social problems, as of research in different branches of science, the growing need for co-operative research whether in the borderline sciences or in fields common to many industries, enhance the importance of this aspect of the Department's work. The absence of a scientific outlook and the lack of appreciation of the value of the application of scientific knowledge in one section of an industry may seriously embarrass progress elsewhere, whether by lack of support for co-operative work or by the contracted market for the products of our industries which an inefficient and depressed branch of industry provides, and is one of the most important causes of the uneven front of what may be termed the national map of research.

The continued progress of the Department is thus closely linked up with those questions of scientific management of industry and effective utilisation of existing knowledge and resources which were considered by the International Congress for Scientific Management in London last year. The full assistance which science can render to industry will only be realised when firms are ready to give the man of science his chance, not only by offering employment in the control and improvement of technical processes, but above all by ensuring opportunity to the man of science in the 'high places' as well as on the technical or subordinate staff.

Research accordingly can no longer be considered as a thing apart, whether in industry or elsewhere, and this tendency illustrates how the success of research in the physical sciences and in industry is enlarging the field over which scientific effort is required. Industrial progress itself calls for the development of the social sciences. In its industrial aspect, research is one of the essential tools of management, and like any other tool demands craftsmanship and knowledge if it is to be used to the best advantage. That skill can only be acquired as the management itself is imbued with the scientific spirit and is competent to evaluate the contribution which research can bring to its assistance, and the significance for its own special purposes of new knowledge which science has made available.

The Department's own effort to enlarge the circle of scientifically minded firms will doubtless continue to be, as in the past, both by precept and example. A conference organised by the Iron and Steel Institute to consider the problem of welding to which the report refers is a striking example of the change in the attitude of industry during fifteen years. The development of the research association movement steadily enlarges the circle, and the example and success of the more progressive firms should prove of ever-growing educational value. The annual report of the Department moreover provides repeated examples which scientific workers themselves might well utilise in furthering the task of education over every field of industrial and national activity.

It would, however, be rash to assume that we can rely entirely upon such educational work, invaluable though it may be. The element of time is too important, and a short-sighted attitude to the use of scientific knowledge and methods even in a small field can hinder the wise planning of the nation's economic and industrial resources much too seriously to be disregarded. More than ever, the wide field over which the activities of the Department of Scientific and Industrial Research range indicates the necessity not merely for the fostering of the scientific outlook and the general encouragement of research, but also for the corporate planning of the attack on some of the great unsolved problems of our national and industrial economy, and of the development of appropriate measures to deal with those whose neglect of scientific skill is responsible either for waste of our resources or for holding up action required for the solution of these problems.

History and Development of Uganda

Uganda

By H. B. Thomas and Robert Scott. With an Introduction by Sir B. Bourdillon, and a Foreword by Lord Lugard. (Published by authority of the Government of the Uganda Protectorate.) Pp. xx+559+56 plates. (London : Oxford University Press, 1935.) 15*s*. net.

UGANDA is a British Protectorate in the heart of Africa, bordering on the great equatorial lakes that form the sources of the White Nile. It is essentially a native Protectorate, climatically a black man's rather than a white man's country. In its 80,000 square miles of land area, it contains an African population of more than 3½ millions ; almost exactly 2,000 Europeans, of whom no less than three-quarters are either Government officials or missionaries and their dependants ; and some 15,000 Asiatics (Indians, Arabs and Goans). Uganda is accordingly a very different country from its much larger neighbour Kenya, with its highlands suitable for European settlement and an actually smaller African native population.

Uganda is to-day one of the happiest, most prosperous and progressive of British dependencies in tropical Africa. From very small beginnings it has advanced in economic development with great rapidity. In the year 1899–1900, the Protectorate revenue was only £47,629. In 1923 the revenue was £999,750. In 1934 it was more than £1½ millions and there was a comfortable surplus balance of £1,400,000. To the Protectorate revenue should be added the revenues of the native local Governments, which are being strongly developed under a system of 'indirect rule'. These additional native revenues amounted in 1934 to approximately £330,000.

The basis of economic expansion and financial progress has been cotton, which occupies in Uganda the place of cocoa in the Gold Coast. Cotton accounts in value for about four-fifths of Uganda's total domestic exports. The first production of cotton (54 bales) was in the year 1904–5. In 1923 this had risen to 88,000 bales and in 1934 to just under 300,000 bales, making Uganda the premier cotton producer of the British Colonial Empire.

Another important feature in the progress of Uganda is its admirable road system, the best and most extensive in tropical Africa. For about 2,000 miles of main road the European Public Works Department is responsible, and an additional 5,500 miles are maintained by native local authorities. Side by side with this material development, and thanks very largely to missionary initiative, native education and public health have progressed. Uganda is rightly proud of its schools, its hospitals and its maternity services, which are among the best in Africa. There can be few better examples of the educability of the African, as evidenced by the work of but one generation, than that furnished by Uganda. The 'Muganda' native, who belongs to the 'Baganda' tribe or nation, living in 'Buganda' and speaking 'Luganda', is no doubt a very capable and well-endowed African native, who has evolved in a changing world with great rapidity. He is mainly of Bantu stock, crossed in the higher social scale with a Hamitic element.

Of the total native population, about two-thirds are classed ethnographically as Bantu, one-fifth as Nilotes and the remainder as Hamites or half-Hamites. The number of pure Hamites now left must be very small.

This admirable handbook to the Protectorate, a model of what such books should be, has been compiled from official sources, but is written in a personal and readable form. It deals not only with the history and administration, but also with the physical and economic background. It contains

an excellent chapter for "The Visitor to Uganda", and is well illustrated with photographs of the scenery, fauna and flora. The sections on geology, forests and botany are excellent. More perhaps might have been made of zoology, but the section on game and hunting is most useful.

The series of coloured maps is more complete and instructive than that in any similar handbook, the principal being: (1) geological, (2) physical, (3) rainfall, (4) political, (5) population density, (6) communications. The population density map is specially worthy of praise. The statistical tables, bibliography and index are exceptionally full and complete.

I have only one criticism, and that I do not wish to stress, namely, I do not think the description of the working of the native Parliaments, or Lukikos as they are called, is adequate. The form and powers of the native local Governments in the Bantu areas of Uganda, and especially in the kingdom of Buganda, are unique and most interesting. They are only dealt with in outline, and the important part played by the Baganda ministers and chiefs, who graduate in a kind of native Civil Service, is not sufficiently brought out. The social and political organisation of the Baganda and their land system differ so widely from that of Bantu tribes in other Protectorates, that it is important that they should be made fully clear.

This book has a real value not only for those who are seeking authoritative information regarding Uganda itself, but also for that wider public in and outside Africa who are interested in the comparative study of colonial administration under different flags. W. ORMSBY-GORE.

Pollen Grains

Pollen Grains:
their Structure, Identification and Significance in Science and Medicine. By Dr. R. P. Wodehouse. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xv+574+14 plates. (New York and London: McGraw-Hill Book Co., Inc., 1935.) 36*s*. net.

IT may safely be asserted that the study of pollen grains, as such, in Great Britain is confined practically to those who are interested in post-glacial vegetational changes as revealed by the pollen-content of the peat mosses, and kindred problems. This line of research was perfected in Sweden by L. von Post some twenty years ago, and now attracts many workers in other lands. A pioneer survey of British mosses was completed a few years ago by Erdtman, a pupil of von Post. Since then, more detailed work of much value has been carried out—particularly by Raistrick and Blackburn in the north of England, and in the fenland by the Godwins.

Still more recently, Raistrick has applied this method *mutatis mutandis* to the study of the microspore-content of the Carboniferous coal seams, and is opening up a most promising field of investigation. In recent months, too, it has been possible to isolate the pollen preserved in British Tertiary coals, and, doubtless, their examination will yield interesting information about the ancient flowering plants.

Studies involving pollen research have been hampered, so far, by a lack of comprehensive works in any language dealing with pollen forms, and for the task of identifying strange grains workers must have recourse to a herbarium and procure comparative material at first hand. The publication of the work under notice, then, is opportune, and all interested should regard the volume as a welcome addition to botanical literature, for they will find within its covers a great deal of valuable information regarding pollen and the uses to which a knowledge of pollen forms may be put. The reader is not provided with a description of the pollen of all known genera or even families of plants. The work is not complete in this respect. In selecting his material the author has kept in mind those readers "who wish to be able to identify pollen found in the air—and possibly causing hayfever—also those who study pollen fossilized in peat and other sediments".

Pollen is dealt with from so many angles that in a review it is difficult to do more than catalogue the contents of the volume. The work is in two parts. The first chapter—a lengthy one—is a historical review of pollen studies, commencing with the work of Grew (1671) and ending with that of Fischer (1890). The next two chapters deal with such aspects as methods of collecting pollen in large amounts, and preparation of pollen for microscopic examination. Chapter iv is contributed by Dr. G. Erdtman of Stockholm. In it he describes the technique of peat sampling and the

application of 'pollen statistics' to the study of past vegetation as revealed by the pollen preserved in peat and other sediments.

A chapter is also devoted to the incidence of hayfever in the United States and the principal pollen causative agents. It is therefore not of such universal interest. Part 1 of the volume closes with a discussion upon the development of pollen-grain characters. Here, and elsewhere, the author introduces new terms to aid in the description of certain pollen features, but all of these are clearly explained in a glossary.

Part 2 commences with a master key in which are set out the characters necessary for the identification of the family and genus of such pollen types as are afterwards described in more detail, and also of some forms to which no further reference is made. This key even includes a description of certain Palæozoic and Mesozoic fossil pollen forms. In the following pages more detailed keys for genera and species are introduced as required.

In the gymnosperm section, the pollen forms in five genera of cycads and thirty-one genera of conifers are described—a very full, if not quite complete, tale.

The section dealing with monocotyledons is the shortest and least satisfying—only six families are touched upon, and most space is devoted to grass pollen, as is perhaps perfectly natural on account of its importance in hayfever.

More than 200 pages are devoted to dicotyledons, and readers will here find an immense amount of information. Twenty-five families, 150 genera, and several hundred species are covered in the descriptions, preference being accorded to known or suspected agents of hayfever.

The pollen forms are most excellently illustrated in 14 plates and numerous text figures. A pleasing feature is that the size of the illustrated grains is stated in the letterpress accompanying each plate. The forms are clearly drawn, and the reviewer can testify to their accuracy in numerous instances, by comparison at first hand with original material.

This book cannot fail to stimulate all interested in pollen. It is, moreover, no mere catalogue of pollen shapes and sizes, but contains, as well, much matter of genuine phylogenetic and taxonomic interest and importance.

Non-American readers may wish that some of the space devoted to hayfever had been allotted instead to the pollen of other families and genera not mentioned. Perhaps, however, Dr. Wodehouse will fill this gap in another volume.

Faraday's Diary

Faraday's Diary:
being the various Philosophical Notes of Experimental Investigation made by Michael Faraday, D.C.L., F.R.S., during the years 1820–1862 and bequeathed by him to the Royal Institution of Great Britain; now, by order of the Managers, printed and published for the first time, under the editorial supervision of Thomas Martin. Vol. 7: Nov. 24, 1855–Mar. 12, 1862. Pp. xvii+465+2 plates. Index. Pp. 64. (London: G. Bell and Sons, Ltd., 1936.) 7 vols. and Index, £12 12*s*. 0*d*. net.

MR. MARTIN has brought to a brilliantly successful conclusion his editorial work on the laboratory notes which we have all learned to call "Faraday's Diary", and it is possible now to look over the whole massive achievement, from the innocent opening entry of September 1820—"ARTIFICIAL CAMPHOR. Rather heavier than water when fused—requires a higher heat than 212° for its volatilisation—readily fuses and is not so volatile as the new substance—burns with bright flame", to the prophetic last sentences of March 12, 1862.

"Apparatus as on last day (28 Jany.) but only 10 pr. of Voltaic battery for the Electromagnet.

The colourless Gas flame ascended between the poles of the Magnet and the salts of Sodium, Lithium, etc. were used to give colour. A Nicol's polarizer was placed just before the intense magnetic field and an analizer at the other extreme of the apparatus. Then the E. Magnet was made and unmade, but not the slightest trace of effect on or change of the lines in the spectrum were observed in any position of the Polarizer or analyzer.

Two other pierced poles were adjusted at the magnet—the coloured flame established between them, and only that ray taken up by the optic apparatus which came to it along the axis of the poles, i.e. in the magnetic axis or line of magnetic force. Then the Electro magnet was excited and rendered neutral; but not the slightest effect on the polarized or unpolarized ray was observed."

In these later years Faraday's powers were fast failing; there are few more pathetic words in the

story of science than those concluding phrases to the lecture on platinum delivered on a Friday evening in 1861 where he speaks of his gradual loss of memory and other faculties and his desire to retire "as I think every man ought to do before his faculties become impaired; but I must confess that the affection I have for this place, and for those who frequent this place, is such, that I hardly know when the proper time has arrived".

Such frank and feeling words, coming, as they did, at the end of a discourse which showed much of Faraday's old resourcefulness and power of illustrating his remarks by simple and striking experiments, go far to explain to us, of a later generation, the affection and esteem in which he was held. All the more pleasant, then, is it to find that the Diary ends on a high note, showing Faraday in active search for that effect, the discovery of which fell to the lot of Zeeman in 1897, and might have been discovered by Schuster had he not been discouraged by finding that a broadening of the spectrum lines which he had observed was a spurious effect due to the action of the magnet on the steel jaws of the slit.

Indeed, this concluding volume shows Faraday very bold in speculation and optimistic in experiment. One of Lord Kelvin's most interesting notes—specially interesting as giving Kelvin's interpretation of Newtonian and Cartesian mechanics*—is devoted to a brief historical account of ether and of action-at-a-distance theories; and he remarks that on the last occasion on which he saw Faraday, he was at work in an underground cellar in the Royal Institution arranging experiments

"to test the time of propagation of magnetic force from an electromagnet through a distance of many yards of air to a fine steel needle polished to reflect light; but no result came from those experiments".

The rough notes pertaining to these experiments are to be found in this seventh volume of the Diary. Here, too, will be found an account of Faraday's experiments made at the Shot Tower, and developed from his note—

"Suppose a relation to exist between gravitation and electricity, and that as gravitation diminishes or increases by variation of distance, electricity either position [*sic*] or negative were to appear—is not likely, nevertheless try, for less likely things apparently have happened in nature".

These experiments, carried out in 1859, were presumably the basis of the paper on electricity and gravitation submitted to the Royal Society in 1860, and withdrawn on the advice of Stokes.

It is possible now to look over the Diary and to frame an answer to the question—Has it been worth while? Indeed it has; and the scientific world is heavily indebted to the managers of the Royal Institution and specially to Mr. Martin who has shown a skill amounting to genius in the exercise (and, indeed, in the *non*-exercise) of his editorial powers. It has been said that the first lesson to be learnt by a young demonstrator is to restrain his capacity for demonstrating; and Mr. Martin, as a mature and skilled editor, knows just where restraint is desirable and necessary. He has endeavoured, and we feel sure that his endeavours have been successful, to present us with a meticulously accurate text; and it becomes possible, in a manner that is scarcely possible in any other instance, to follow the workings and gropings of Faraday's mind; to see something of the manner of birth and of development of those outstanding discoveries that are associated with his name, to fall under the charm of his quaintness of spelling, of speech and of illustration.

But the enterprise is incomplete, and this noble edition will be but a torso if it is not completed in such a manner as to exhibit to the world an edition of the life and works of Faraday which shall be worthy of Faraday's greatness. We want to see, alongside the Diary, those finished works, the materials for which are scattered through its pages, and we would know something, and the more the better, of the Faraday who could not pass an electroscope without giving it a flick with his handkerchief; who resolved, if at a loss for a word, "not to ch-ch-ch, or eh-eh-eh, but to stop and wait for it"; who was found in a thunderstorm, rubbing his hands in glee for he had been lucky enough to see the lightning strike the church steeple; who "became as wild as a boy, and, jumping up, shouted: 'Hurrah for the Yankee experiment'" when Hughes demonstrated an effect of self-induction; who went "to Astley's to see the horses" by way of celebrating the discovery of a magnetic rotation; and who had sufficient of the failings of humanity in his disposition to ignore Sturgeon and to underrate Dalton.

Mr. Martin can do it, an' he will; and why should not this country possess an edition of the works of Faraday such as may fitly be compared with those which have been raised to the memory of great men of science of other nations? If Faraday lead the way, who knows . . .? Newton's countrymen may perhaps look forward to the appearance of a worthy edition of Newton.

A. F.

* Preface to Hertz's "Electric Waves". English translation. (Macmillan, 1893.)

Clinical and Pathological Applications of Spectrum Analysis;

with Notes on Spectrography in Chemistry and Mineralogy, and Tables for Qualitative Analysis. Being the authorised translation of Part 2 of "Die chemische Emissionsspektralanalyse". By Dr. Walther Gerlach and Dr. Werner Gerlach. Translated by Joyce Hilger Twyman. Pp. 143. (London : Adam Hilger, Ltd., 1934.)

THIS book is a valuable addition to the literature of a field of inquiry of growing importance and significance, and is especially welcome at a time when physical methods are being increasingly applied to fundamental biological and clinical problems.

It consists very largely of experimental details and results of work by the authors on the emission spectra of living tissues. Various methods of exciting such emission spectra of animal and vegetable structures are described and criticised, the spark method being strongly advocated. The fundamental aim of the experiments is a knowledge of the chemical topography of the tissues. The method of exciting luminosity by the use of a high-frequency discharge from a metal electrode to the tissue placed on a glass plate and suitably moistened makes practicable, it is claimed, the examination of substances of nearly any nature. By such methods important medical problems such as the normal or pathological metabolism of certain elements may be investigated, or the ultimate fate of heavy metals used therapeutically may be established. The 'chemical' analysis of such tissues as skin appears, moreover, to be of forensic importance in cases of gunshot wounds, when the distribution of lead, copper or nickel may give clues to the direction and distance from which the shot was fired. These dramatic uses, however, are probably of far less real importance than the study of the routine distribution of metals such as copper or iron, or the analysis of urine.

The quantitative aspects are discussed and it is concluded that such measurements can be made, but evidently here many experimental difficulties arise.

The translation is admirable, apart from some verbal infelicities or traces of German spelling still adhering to the text. W. V. M.

The Problem of Noise

By Prof. F. C. Bartlett. (The Cambridge Miscellany, Vol. 15.) Pp. x+87. (Cambridge : At the University Press, 1934.) 3*s*. 6*d*. net.

THIS little volume is based on two lectures delivered by Prof. Bartlett before a London audience. The experimental work on noise carried out by psychologists, including the author, is summarised in a very interesting manner, and a list of references is given. The effect of noise on the output of a healthy worker is shown to be small and temporary ; but because of the association of noise with the fear reaction, its psychological influence may be considerable. The case for serious attempts to reduce noise is clearly stated, and several directions in which these attempts might be made are indicated.

An Economic Survey of the Colonial Empire (1933)

Issued by the Colonial Office. Pp. vi+573. (London : H.M. Stationery Office, 1935.) 25*s*. net.

THIS is a revised and enlarged edition of the first issue, which appeared last year. A further edition is promised at the end of 1936. For every one of the Crown Colonies, Protectorates and Mandated Territories a full account is given of position, area, the chief facts of climate, population, races, occupation of inhabitants, public finance, trade, natural resources and communications. No other publication gives such a mass of orderly information about the colonies, and the volume has the further advantages of being authoritative and of conforming to a uniform arrangement throughout.

The second part of the volume is occupied with an account of the conditions of growth and marketing of the principal economic products of the Colonial Empire. The net is cast so wide that many unusual and little-known products are included. Finally, there are numerous statistical tables of the export of various commodities. The whole book may be regarded as a complete economic geography of the Colonies and Protectorates, and is certainly the only volume of its kind available. The Colonial Office has produced a volume of outstanding interest.

An Introduction to Projective Geometry

By Prof. L. N. G. Filon. Fourth edition. Pp. xviii+407. (London : Edward Arnold and Co., 1935.) 16*s*. net.

THE new edition of this valuable work differs so widely from the older ones, with many changes and additions, and more than twice the original number of examples, that it is almost a new book. Noteworthy features are the treatment of inversion, the circle of curvature, three-point and four-point contact, the harmonic envelope and locus of two conics, the plane cubic and quartic, and the focus-directrix property of the sphero-conic. The three-dimensional portions include homographic spaces, inpolar and outpolar quadrics, analogues of the complete quadrilateral and quadrangle, and the curvature of quadrics and twisted curves.

Modern Pure Solid Geometry

By Prof. Nathan Altshiller-Court. Pp. xi+311. (New York : The Macmillan Co., 1935.) 3.90 dollars.

THE scope of this book is more limited than its title indicates. The nine chapters deal respectively with preliminary ideas, trihedral angles, skew quadrilaterals, tetrahedra, transversals, oblique cones, spheres, inversion, and recent geometry of the tetrahedron. The treatment is synthetic ; but excluding anharmonic ratios, involution, conics, and even the complete quadrilateral. On the other hand, the author uses the concept of the imaginary sphere. The book may be criticised for its limited scope, but it is a useful collection of theorems on elementary topics. In particular, the chapters on tetrahedra bring together information not readily accessible elsewhere.

Does Conservation of Energy Hold in Atomic Processes?

By Prof. P. A. M. Dirac, F.R.S.

THE strict validity of the law of conservation of energy in atomic processes was not seriously questioned until 1924, when Bohr, Kramers and Slater, in order to make progress with the serious conflict then existing between the wave and corpuscular aspects of light, put forward a theory denying it[1]. This theory (which we shall refer to as the B.K.S. theory) postulates that a field of radiation is continually emitted by an atomic system in an excited state, instead of being emitted only when the system makes a transition to a state of lower energy. This field of radiation falling on a second atom gives it a probability of making a transition to a state of higher energy, provided the frequency of the radiation is suitable. The theory makes no coincidences between the occurrence of transitions of the second atom to states of higher energy and the occurrence of transitions of the first atom to states of lower energy, but apart from this question of coincidences, it gives results in agreement with those of other theories of radiation. Thus the new theory gives no conservation of energy for individual atomic processes, though it gives statistical conservation when large numbers of atomic processes take place.

Soon after the new theory was put forward, its predictions with regard to scattering of radiation by electrons were put to experimental test by Bothe and Geiger[2] and by Compton and Simon[3]. The results in both cases were unfavourable to the new theory, and supported conservation of energy. Shortly after that, the new quantum mechanics was discovered by Heisenberg and by Schrödinger, and was developed to provide an escape from the difficulties of the conflict between waves and particles without departing from conservation of energy. Thus the B.K.S. theory was found to be in disagreement with experiment and was no longer required by theoretical considerations, and it was therefore abandoned.

The situation has now been changed by some recent experimental work of R. Shankland[4]. Shankland's experiments have been carried out with the greater accuracy which ten years of development of technique have made possible, and his results do not confirm those of the earlier experimenters. On the contrary, they are in disagreement with conservation of energy and require for their explanation something on the lines of the B.K.S. theory. Thus physics is now faced with the prospect of having to make a drastic change in its fundamentals, a change involving the giving up of some of its principles which have been most strongly relied on (conservation of energy and momentum), and the establishment in their place of the B.K.S. theory or something similar. We shall see, however, on closer consideration, that a large part of the present theoretical structure, in fact all the best part of it, may reasonably be retained, and thus the theoretical physicist need not be at all perturbed by Shankland's results.

Further evidence about the conservation laws is provided by the modern work in nuclear physics. It is found that those nuclear processes in which only heavy particles (protons, neutrons, etc.) are concerned, and in which, consequently, all the velocities are small compared with the velocity of light, can be accounted for fairly well on the basis of conservation of energy and momentum. On the other hand, processes involving an electron or positron, which is shot out with a large velocity, of the order of the velocity of light, seem to be in disagreement with conservation of energy, and a new unobservable particle, the neutrino, has been specially postulated by some investigators, in an attempt formally to preserve conservation of energy by assuming the unobservable particle to carry off the balance.

The above experimental results suggest that we take as the starting-point in our reformulation of atomic theory the assumption that energy and momentum are conserved in atomic processes in which the velocities concerned are all small compared with the velocity of light, but are not in general conserved in processes involving large velocities, including radiative processes. This assumption is all the more plausible on account of the fact that the present quantum mechanics, with its conservation of energy and momentum, forms a satisfactory theory only when applied non-relativistically, to problems involving small velocities, and loses most of its generality and beauty when one attempts to make it relativistic. In this way, we see that we can retain the whole of the present non-relativistic quantum mechanics, and we see the need for a profound alteration in current theoretical ideas, involving a departure from the conservation laws, before we can hope to get a satisfactory relativistic quantum mechanics.

Radiative processes are included among the large-velocity processes because of the large

velocities of the light-quanta. According to the above assumption, the conservation laws should not apply for them, and the present comprehensive theory of them, the so-called quantum electrodynamics, must be given up. There exists, however, a primitive theory of radiation in quantum mechanics, namely, the theory which treats the electro-magnetic field classically as an external perturbing force, and this theory may be retained. This theory gives information about the probability of atoms and electrons making specified quantum jumps under the influence of radiation, but gives no information at all about the reaction of the atoms and electrons on the radiation, and is thus equally consistent with the conservation laws and with the B.K.S. assumptions. This primitive theory of radiation gives no spontaneous emission, but by supplementing it with Einstein's laws of radiation and the B.K.S. assumptions, we can get a fairly complete account of all the elementary radiation phenomena, an account which is in satisfactory agreement with experiment and which is unsatisfactory only because of the lack of unity of its basic assumptions.

In retaining the non-relativistic quantum mechanics and the primitive theory of radiation with unquantised fields, we retain almost all the valuable part of present-day quantum theory. We may include in what we retain the theory of the spinning electron moving in a given electromagnetic field, and the Klein-Nishina formula. The only important part that we give up is quantum electrodynamics. Since, however, the only purpose of quantum electrodynamics, apart from providing a unification of the assumptions of radiation theory, is to account for just such coincidences as are now disproved by Shankland's experiments, we may give it up without regrets—in fact, on account of its extreme complexity, most physicists will be very glad to see the end of it.

[1] *Phil. Mag.*, **47**, 785 (1924), or *Z. Phys.*, **24**, 69 (1924).
[2] *Z. Phys.*, **32**, 639 (1925).
[3] *Phys. Rev.*, **26**, 289 (1925).
[4] *Phys. Rev.*, **49**, 8 (1936). See NATURE, **137**, 241 (1936).

Stephen Gray: The First Copley Medallist

ON either February 15 or February 25, 1736, two hundred years ago, Stephen Gray, one of the earliest British electricians, died at the age of eighty-three years in Charterhouse, London, of which he had been an inmate for seventeen years. He had been nominated as a Brother in 1718 by George, Prince of Wales, but the entry in the records relating to his admission runs: "Stephen Gray for ye Prince, John Gwynn for ye Archbishop, John Cox for Earl Cowper and John Allen for ye Duke of Buckingham sworn at ye hospital before a Committee 24 June 1719."

Gray was then about sixty-six years of age, and though it is known that for a long time he had been devoted to physical science and astronomy, it is for the experiments he made in his room and in the courts of Charterhouse when he was over seventy that he will always be remembered. There is a short notice of him by James Burnley in the "Dictionary of National Biography" and the *Philosophical Transactions* contain a number of his papers, but the best account of his activities was given in a lecture delivered in the Great Hall, Charterhouse, by Dr. (afterwards Sir) Benjamin Ward Richardson (1828–96) on January 22, 1874, a report of which appeared in NATURE a week later.

Dr. Richardson had evidently studied Gray's papers in the *Philosophical Transactions*, and during the lecture he repeated many of Gray's experiments. Gray apparently belonged to Kent and, said Dr. Richardson, he is first discovered at Canterbury in 1692 making observations of a mock sun on February 6. Four years later he was making a water microscope, and in 1698 a microscope with a micrometer for measuring accurately the height of the mercury in a barometer. He studied the fossils of Reculver Cliff in Kent, made observations of sunspots and watched the solar eclipse of 1706, having at Canterbury a well-equipped observatory.

After 1706 Gray is lost sight of until he is recommended as a pensioner for Charterhouse. His first electrical paper in the *Philosophical Transactions*, entitled "An Account of Some New Electrical Experiments", appeared in 1720, and for the next ten or twelve years he devoted himself entirely to electricity. His apparatus consisted of such things as feathers, hair, silk, wool, soap bubbles, resin slabs, beeswax and cubes of oak; and he made observations on the electricity of the human body. Perhaps his greatest achievement was transmitting electricity through long lengths of pack-threads. In the grounds of the mansion of his friend Granville Wheler, Otterden House, Faversham, on July 14, 1729, he transmitted electricity through a pack-thread line 650 ft. long suspended by silk from poles, thus anticipating

by nearly a century the experiments of Sir Francis Ronalds at Hammersmith.

Gray's experiments had considerable influence on his contemporaries and on none more than on the French experimentalist Charles François du Fay (1698–1739).

Three events of interest marked the closing years of Gray's life. On November 23, 1731, when the Prince of Wales and the Duke of Lorraine visited the Royal Society, then housed in Crane Court and presided over by Sir Hans Sloane, among the experiments shown the distinguished visitors were those of "Mr. Gray, which succeeded, notwithstanding the largeness of the company", and about the same time Gray became the first beneficiary under the bequest of Sir Godfrey Copley, who when he died in 1709 left £100 to the Royal Society "to be laid out in experiments or otherwise for the benefit thereof as they shall direct and appoint". The fund was not used for a medal until 1736, but Weld in his list of "Awards of the Copley Medal" places Gray's name at the head. The third event was the admission of Gray in 1732 as a fellow of the Royal Society. That he had not been admitted before may perhaps have been due to pecuniary circumstances and his position as a pensioner of Charterhouse; but, however this may be, it does not lessen our debt to him as a pioneer in electrical science, and one who predicted that what he was doing *in minimus* would, some day, be so extended that electrical phenomena would be made to resemble those of thunder and lightning.

Science in the Service of the State

THE growing number of separate departmental reports issued by the research boards and stations of the Department of Scientific and Industrial Research, among which were included last year for the first time those of the Road Research Board and the Chemical Research Laboratory, enhances, rather than diminishes, the importance of the Annual Report of the Department. No other document gives such a comprehensive picture of the way in which science has been mobilised in the service of every aspect of our national needs, whether of the great departments of State, industry, municipal services or of the everyday wants of the home. The twentieth Annual Report of the Department* issued on December 30 covers the period October 1, 1934–September 30, 1935, and contains the brief report of the Privy Council Committee, signed by the Right Hon. J. Ramsay MacDonald, Lord President of the Council, the longer report of the Advisory Council over Lord Rutherford's signature and summaries of the work of the National Physical Laboratory, the Chemical Research Laboratory, the various research associations and research boards or committees.

The gross expenditure of the Department in 1934–35 was £719,276 or £549,781 net, as against £476,897 net in 1933–34. In this, the National Physical Laboratory, with £219,039 gross or £122,847 net, is as usual the largest single item of expenditure; but the gross figure includes the cost of work at the Laboratory for the Food Investigation Board, the Radio Research Board, the Road Research Board and other research boards of the Department. Expenditure on the Chemical Research Laboratory was £21,722 net, on food investigation £33,539, forest products research £39,408, and on fuel research £83,984, all net. Against gross expenditure of £69,723 on building and road research and £11,769 on water pollution research, receipts amounted to £35,906 and £6,638 respectively, while a further sum of £10,847 was received against expenditure on food investigation. The net expenditure on the Geological Survey and Museum was £65,137 and the centenary of the Geological Survey, the senior organisation of the Department, coincided with the opening in July of the new buildings in South Kensington for the headquarters of the Survey and the Museum of Practical Geology.

The work of the Geological Survey is fundamental for all important schemes of civil engineering, mining and water supply, and is of direct interest to agriculture. It is the senior geological survey of the world, and no British scientific institution has more frequently served as a model for similar establishments both in the Empire and in foreign countries. In addition to re-surveying coalfields of Yorkshire, Lancashire, Cumberland, Northumberland, Forest of Dean, Forest of Wyre, Fifeshire, Dumfriesshire, Stirlingshire, Ayrshire and Lanarkshire, an exceptional number of inquiries on water-supply and inspections of borings for water have been dealt with as

* Department of Scientific and Industrial Research. Twentieth Annual Report for the Year 1934–35. Pp. iv+185. (London: H.M. Stationery Office, 1935.) 3*s*. net.

a result of the drought. The application of geology to the study of soils has also continued jointly with the soil experts of the Development Commission.

Grants to the research associations amount to £85,384 net as against £58,992 net in 1933–34, and developments in connexion with this movement are the most encouraging feature in the present report. Since the Advisory Council made its offer, negotiations have been completed with thirteen research associations, and offers of grants on a new basis have been made to and accepted by all of them. The associations in question as a whole are already assured of a thirty per cent increase in their resources as compared with those they commanded eighteen months ago, and, with one exception, each of these associations now enjoys an income of at least £10,000, the minimum figure which, even in a small industry, can be accepted as securing an assured future for an association. The total income of the Iron and Steel Industrial Research Council is now estimated at £31,000 as against £16,000 two years ago, while in the same period that of the Electrical and Allied Industries Research Association has increased from £44,000 to £64,000. The resources of the Cotton Industry Research Association have increased in one year from £58,000 to £75,000, those of the Paint Research Association from £9,000 to £14,000 and of the Flour Millers Research Association from £7,600 to £13,000.

These increases are due more to industrial support than to Government grants, and in aggregate, if the thirteen associations earned the maximum grant offered, their income would be double the aggregate of eighteen months ago, and three-fifths of this would come from industrial contributions. The work of these research associations themselves, however, touches almost every aspect of our national, and not merely of our industrial, life. For examples, we may refer to its bearing on foodstuffs of all kinds. Thus the Cocoa, Chocolate, Confectionery and Jam Trades Research Association is devising scientific means for ensuring that chocolate creams are evenly coated with chocolate, for preventing the fading of confectionery through exposure in the shop window, and is also studying the jellying properties of different types of oranges and the complicated processes of marmalade manufacture to ensure that the best possible marmalade reaches our breakfast table. The Food Manufacturers' Research Association has studied the resistance of bacteria to salt and saltpetre, and suggested a method of preventing certain defects in bacon and hams. The same Research Association has also found the true explanation of sausages losing their fresh appearance and becoming paler under certain conditions of storage.

Important work carried out by the Flour Millers Research Association has led to better knowledge of our most important foodstuff—bread. Apparatus has been developed for measuring the viscosity (or 'stickiness') of doughs and its elasticity (or 'springiness'), and attempts are being made to correlate the results of such measurements with the behaviour of dough in the bakehouse. Large-scale trials have proved that the hot aeration process developed by the Association improves very markedly the baking quality both of wheat flour and wheatmeal, sterilises the flour against mites, and partly sterilises it against bacteria, as well as improving the handling and character of the flour.

Other work of the research associations has an important bearing on clothing. Such, for example, is that of the Wool Industries Research Association on the development of a process for the production of unshrinkable wool, or on the scouring of wool, or again, the work of the Cotton Industry Research Association not only on cotton but also on silk and rayon and the mixed fabrics which are rapidly growing in popularity. The work of the Linen Industry Research Association, too, not merely bears on clothing but in the extension of the Sandringham experiment touches on agriculture also. A novel type of linen yarn is being developed, and other work is concerned with the protective treatment of linen materials exposed to the weather, and the fundamental investigation of the properties of sisal fibre.

The work of the Launderers' Research Association on detergent efficiency touches the housewife quite as closely, while that of the Boot, Shoe and Allied Trades' Research Association on the effect of perspiration on the wear of shoes has afforded unexpected indication of the state of a person's health in the condition of his footwear, tendencies towards rheumatism, or gout or diabetes having been detected in this way. Other materials besides leather which go to the making of shoes have been investigated by the same Association, while investigations of the Leather Manufacturers' Research Association have covered the preservation of leather from attack by micro-organisms, the evaluation of sole leather, use of leather for sound-absorption and also its use in conjunction with 'anti-ice' equipment for aeroplane wings.

The British Electrical and Allied Industries Research Association is carrying out work on underground cables which should permit the maximum loading within the limits of safety. Overhead line conductors are also receiving attention, as well as the prevention of failure in telephone and pilot cables in the ground around sub-stations, the reduction of the resistance of earth electrodes, surge phenomena, transformer noise and the

interference caused to broadcast listening by the normal operation of electrical apparatus, such as vacuum cleaners, electric lifts, trolley buses, etc.

These investigations touch on both the amenities and the necessities of everyday life, and similarly the work of the Paint Research Association affects not merely industrial interests but also ordinary domestic life, where paints or varnishes or inks are required for many purposes. The Rubber Research Association is contributing to the requirements of the automobile industry as well as to those of the food industry for tubing, tank linings, sealing rings, etc., and has developed, for example, a greatly improved cider hose. Rubber joints for gas mains which will withstand the vibration due to modern traffic conditions are also being developed in collaboration with the gas industry. The Scientific Instrument Research Association has designed a remarkable new lens for use as a spectrographic object glass which should be more than twice as rapid as any lens previously used for astronomical spectrographical work. The supply of a lens of this design to the Mount Wilson Observatory should much increase the range within which remote nebulæ can be investigated, and is a notable triumph for the Association, which has also evolved a detailed technique for the production of very stable mirrors. Reference was made to this lens in Dr. G. E. Hale's article on the 200-inch telescope in NATURE of February 8, and we hope to print a fuller account of it shortly.

If such research associations as those for the non-ferrous metals or refractories have made contributions of less direct interest to the man in the street, their indirect influence through industry has been no less important. The work of the research associations is, however, only one of the ways in which the Department is serving the needs of the community. Equally important contributions are being made by its own special research stations and boards. At the National Physical Laboratory an attempt is being made to devise a formula from which the best lighting for any industrial occupation can be deduced. Investigations are also being made to discover the best colour for the light from luminous discharge lamps used for street-lighting, and the best types of artificial daylight lamp for colour-matching purposes.

Other work at the National Physical Laboratory has been concerned with the measurement and reduction of noise, while in its Aerodynamics Department and the William Froude Laboratory problems bearing on the design of aeroplanes and ships are being investigated. Atmospheric pollution is watched over by a special committee which is endeavouring to complete our knowledge of the nature and extent of pollution in industrial areas, while the Water Pollution Research Board has initiated many important investigations and surveys regarding sewage purification, the disposal of industrial effluent and the pollution of rivers and estuaries. In particular, conditions have been worked out for the purification of effluents from dairies and milk product factories which are now being tested on a large scale. Important dental investigations have also been carried on by the Department, including promising attempts to find a synthetic resin substitute for dental vulcanite.

The Department is also responsible for work which has an important bearing on safety on the roads, as, for example, the study of glare in street lighting, the evaluation of glare from motor-car headlights, or the use of coloured headlight beams for driving in fog. Other illumination research bears on industrial health and efficiency, or on problems of mine lighting. Investigations are also carried out to obtain more accurate data, especially for radiation and convection, as a basis for the scientific design of furnaces.

The Chemical Research Laboratory, like the National Physical Laboratory, has made contributions over a very wide field, from synthetic resin and new drugs, to corrosion of metals, the investigation of rubber, tar and high-pressure reactions. Merely to enumerate many of the other research boards should indicate how wide is the Department's contribution to the national welfare through the work of its own special stations. Space does not permit reference to the work of the Fuel Research Board, of the Steel Structures Research Committee, of the Radio Research Board, the Building Research Station, the Road Research Station and the Forest Products Research Board; but brief reference must be made to the work of the Food Investigation Board, which supplements that of the various research associations concerned with food. In its own stations the Board has made important contributions in the curing of bacon, the storage of fish, preservation of fruit in wrappers and the kippering process and the canning of fruit and vegetables, and the Report shows how well the Department is planning the national effort in this important field to prevent duplication of labour or waste of natural resources.

The Report is thus impressive not only for the picture it gives of the way in which science affects every department of our life, but also for the object lesson it affords of the need of some central organisation which can plan and co-ordinate, if not direct, the research effort of the nation, so as to secure the most efficient service of our myriad needs and the handling of our major problems from a national, and not a sectional, point of view.

Heidelberg, Spinoza and Academic Freedom

From a Correspondent

IN connexion with the forthcoming celebration of the 550th anniversary of the University of Heidelberg, it is of interest to note that the date for this, namely June 27–30, has been significantly chosen. June 30 is the anniversary of that series of events in 1933, now known familiarly as the 'clean up', which established the full rigour of the new regime in Germany. Any visitor to Heidelberg at that date will therefore be able to celebrate both events.

An event of a different kind may be remembered on February 16, which is the anniversary of an important historic gesture by the University of Heidelberg. On February 16, 1673, a letter was sent from Heidelberg to the philosopher Spinoza inviting him to occupy a chair as 'Ordinarius' in that university. This appears to have been the first occasion on which a university called to a professorship one who was known not to profess its prevailing religion. The opinions of Spinoza were at that date widely known. The relevant parts of the letter of invitation may be translated as follows :

"*To the Very Acute and Renowned Philosopher, Benedict de Spinoza*

Most renowned Sir,

His Serene Highness the Elector Palatine, my most Gracious Master, has commanded me to write to you, who are yet unknown to me, but most highly commended to His Serene Highness the Prince, and to ask you whether you are willing to accept an Ordinary Professorship of Philosophy in his Illustrious University. . . . You will not find anywhere a Prince more favourable to distinguished geniuses, among whom he reckons you. You will have the utmost freedom of philosophizing, which he believes you will not misuse to disturb the publicly established Religion."

There follow a few compliments and directions and the letter ends :

"I will add only this, that if you come here, you will live pleasantly a life worthy of a Philosopher. So Farewell and Hail to you, most honoured Sir,

From your most devoted,

J. LOUIS FABRITIUS,

Professor in the University of Heidelberg,
Heidelberg, 16 February 1673."

It is just ten years since the definitive edition of the works of Spinoza was published by the University of Heidelberg. Had Spinoza himself been living to-day, it would be quite impossible for him to occupy a position at Heidelberg. That university has dismissed or forced into retirement more than forty-five of its staff on the ground either of their opinions or of their Jewish descent. Spinoza would have come under the ban on both these counts. Nevertheless, Heidelberg is deeply indebted to men who have had a similar history to Spinoza. Emil Lask, a thinker of Jewish origin, was perhaps the most important philosopher that Heidelberg has produced for half a century. He was, moreover, the only member of the Philosophical Faculty of Heidelberg who fell in the War. Yet it was in the very building where Lask had held his seminars that there appeared in 1933 the well known notice of the Deutsche Studentenschaft : *Wenn der Jude Deutsch schreibt, lügt er.* ("When a Jew writes the German language, he is lying.") No member of the Faculty protested.

On the façade of one of the great university edifices at Heidelberg—built largely by the help of benefactors of Jewish origin—there stands the inscription DEM LEBENDIGEN GEIST (To the Living Spirit). The new regime does not approve this formula and the discussion still rages as to whether it should not be changed to DEM DEUTSCHEN GEIST !

It is an indication of the atmosphere in which teaching is now carried on in Germany that the distinguished physicist, Philipp Lenard of Heidelberg, has just issued the first of the four volumes of his great treatise on physics with the title "Deutsche Physik". It bears a dedication to Dr. Frick, Minister of the Interior, "dem Förderer grosser Forschung im Dritten Reich" ! and the opening sentences of the preface may be translated thus :

" 'German Physics ?', one asks. I might rather have said Aryan Physics or the Physics of the Nordic Species of Man (der nordisch gearteten Menschen), the Physics of those who have fathomed the depths of Reality, seekers after Truth, the Physics of the very founders of Science. But I shall be answered 'Science is and remains international'. It is false. Science, like every other human product, is racial and conditioned by blood."

In connexion with these changes in the atmosphere of the German universities, it may be recalled that one of the founders of modern science, the first to adumbrate the doctrine of the

conservation of matter, a philosophical predecessor of Spinoza, the great liberal Cardinal Nicolaus Cusanus, was a student at Heidelberg and wrote the famous "De pace fidei". It is sometimes said that Germany has returned to the Middle Ages. Would that she had returned to the Middle Ages as represented by the Cardinal who is perhaps the greatest of the children of the University of Heidelberg. The Heidelberg Academy is or was in the course of publishing the works of Cusanus. This has not prevented the authorities at Heidelberg from acting in a spirit utterly opposed to that of Cusanus, and unseemly incidents, prompted by *dem deutschen Geist*, are occurring even in connexion with the issue of the works of Heidelberg's illustrious son.

Obituary

Prof. J. H. Ashworth, F.R.S.

JAMES HARTLEY ASHWORTH was born in Accrington, brought up in Bolton, Lancashire, and educated at Owen's College, Manchester. It was his intention to specialise in chemistry, but he transferred to zoology. He was trained under A. Milnes Marshall and C. H. Hurst and later under S. J. Hickson, all outstanding zoologists and excellent teachers. His marked ability soon became apparent, for he obtained the Dalton prize in natural history, graduated B.Sc. of London at the age of twenty-one years, and four years later obtained the D.Sc. of the same University. From 1896 until 1900 he held the post of junior lecturer and demonstrator in zoology at Manchester. He then spent some time at the Biological Station at Naples, and the large amount of material he collected there is evidence of his zeal and enthusiasm. The visit impressed him deeply, and he retained an affection for the Station and the zoologists he met there. Until his death he was chairman and secretary for the British Association table at Naples. He was for many years the recorder of Section D (Zoology) of the Association and was president of the Section in 1923.

In 1901 Ashworth was appointed lecturer in invertebrate zoology at Edinburgh. Four years later the University instituted a diploma in tropical medicine, and such was the trust reposed in him that he was asked by the medical faculty to conduct a course in entomology and parasitology for this diploma. This was no easy task, since it was the first course of its kind to be given in Britain. He threw himself wholeheartedly into the work and brought to bear on it his extensive knowledge of invertebrate zoology, his teaching skill and his interest in the relationship between zoology and medicine. The course achieved conspicuous success, and from the beginning set a high standard which it has since maintained. His title now became lecturer in medical entomology and parasitology. Later, helminthology was added to the course, which was modified to furnish the basis of instruction for the diploma in public health and the diploma in tropical veterinary medicine. Students who attended these classes have come from, and are to be found in, all parts of the world. It must have been gratifying to Ashworth that so many of his former students came to visit him when on leave and kept in touch with him by correspondence. A number of them presented specimens, often illustrative of their own special lines of investigation, so that he built up an exceptionally complete teaching collection. All of this testifies to the affectionate gratitude that he inspired in his students.

In spite of heavy teaching duties, Ashworth published a number of important researches. The earlier ones were concerned with cœlenterates and marine worms, but the later included Protozoa and helminths. These papers are characterised by meticulous care and accuracy of observation, by clear and concise exposition, and are illustrated by drawings showing more than ordinary skill. The paper on "The Habits and Structure of *Arenicola marina*" (*Quart. J. Micro. Sci.*, 1898), written conjointly with F. W. Gamble, was the precursor of a series of publications on Polychætes, including the memoir on *Arenicola* in the Liverpool Marine Biological Committee Series, which is used in zoological laboratories throughout the world. He became the recognised authority on his group and was asked to write the catalogue of the Chætopoda in the British Museum, A, Pt. I, Arenicolidæ. His work on the group was by no means confined to systematics but included noteworthy contributions to anatomy and histology, particularly the paper on "The Giant Nerve Cells and Fibres of *Halla parthenopeia*" (*Phil. Trans. Roy. Soc.*, 1909). His eminence in research led to his election to the Royal Society of Edinburgh in 1911 (of which he was general secretary when he died), to the Royal Society of London in 1917, and to the award of the Keith medal of the former Society in 1916.

Ashworth early realised that the accommodation and arrangements for the teaching of zoology in the University were hopelessly inadequate, and when in 1919 he was made professor of zoology, he saw the opportunity for remedying this state of affairs. He set before himself two aims and devoted himself steadfastly to their accomplishment. They were the building up of a staff, laboratories and equipment suitable for giving a satisfactory course in general zoology, and secondly, increasing the usefulness and raising the standard of the classes in zoology for medical students, both undergraduate and graduate,

to a level worthy of the traditions of a famous medical school.

A generous donation from a personal friend, the late Mr. Lawrence Pullar of Bridge of Earn, formed the nucleus for the provision of a new department, and largely owing to Ashworth's energy and personality the necessary funds were raised. He visited many laboratories at home and in America to gather ideas for use in planning a new department. In 1927 he succeeded Cossar Ewart in the chair of natural history, and in 1929 one of his objects was achieved when H.R.H. Prince George opened the new laboratories at West Mains Road. This building was the result of careful thought, and the successful way in which it fulfils its purposes is a tribute to Ashworth's marked skill in organisation. The second object was always present in his thoughts, and not a year passed that did not see an improvement in the medical courses.

Ashworth's grasp of detail, the care with which he studied any matter requiring his attention, his sound judgment and courteous consideration for the opinions of others, enabled him to fill many executive positions in the University and in learned societies with outstanding efficiency. As a teacher he was most conscientious, painstaking and successful, and his devotion to his work was a source of inspiration to all connected with him. While his own research was in the domain of invertebrate zoology, his catholic reading and retentive memory made him at home also in vertebrate work, and there are few zoologists with such an all-round knowledge. The department is enriched by specimens he brought back from two visits to America, one to South Africa and one to Australia. To his students, colleagues and friends he gave ungrudgingly of his best, and his sudden death on the morning of Tuesday, February 4, came to them all as a deep personal loss. NATURE itself loses a constant friend, whose contributions and advice over a long period of years have been of the greatest value.

In his earlier life, Ashworth played the piano and always retained a love of music. He was a sincere and kindly man whose charm of manner and engaging personality won him many friends. He is survived by his widow, who throughout his life in Edinburgh shared his labours and achievements.

Mr. R. Southern

THE sudden and unexpected death, on December 13 in Dublin, of Mr. R. Southern, has taken away one of the keenest and most thorough students of fresh-water biology in its relation to fisheries in the British Isles.

Rowland Southern was born in 1882 at Adlington in Lancashire, and, after an early training in chemistry, obtained a post, in 1902, in the office of the City Analyst in Dublin. His natural bent was, however, towards biology, and in 1906 he received an appointment in the Natural History Section of the Irish National Museum, resigning this post in 1911 for one in the Fisheries Branch of the Department of Agriculture and Technical Instruction.

During his time in the Museum, Southern took up the study of annelids and other worms, and, in a short time, made himself a recognised authority. He continued this study while engaged in the general fishery work of the Department, publishing, at frequent intervals, papers on the various groups, mainly based on his own observations and collections.

During the Great War, Southern's application for active service having been rejected on the grounds of short sight, he was for a time in charge of the Department's efforts to promote increased utilisation of fresh-water fish as a source of food. This gave a new direction to his interests. In 1920, a Limnological Laboratory, the first adequately equipped fresh-water station in the British Isles, was established on the River Shannon close to Lough Derg, under the control of the Department, with the aid of funds supplied by the Development Commissioners, and he was put in charge. From that time, the study of fresh-water biology, mainly in its ecological aspect, was his chief preoccupation. It was in the course of his work on Lough Derg that his attention was directed to the difference in size of trout in acid and limestone waters, and the search for an adequate explanation formed the background of all his subsequent investigations, for the cause usually alleged, that of more abundant food in the alkaline waters, did not, as he pointed out, agree with the facts.

At the closure of the Limnological Laboratory in 1923, Southern's headquarters were transferred to Dublin and, with the problem of growth-rate in his mind, he planned an intensive survey of the productivity in fish food of the River Liffey and its tributaries by means of periodic quantitative collections during several years, both from the upper peaty waters and the lower limestone reaches. He also instituted the regular collection of salmon scales from the River Shannon, in order to elucidate the age and growth-rate of the fish in that river in connexion with the changes brought about by the new hydro-electric scheme. At the time of his death he was working on the collection of salmon scales, on which he had already published a first report, and was tabulating the results of the examination of an immense amount of material from the River Liffey, mainly insect larvæ, collected and named by himself and his willing helpers.

Southern's biological work, latterly, was done, for the most part, in his spare time, as his official hours were largely occupied by his manifold duties as an inspector dealing with the inland fisheries of the Irish Free State. He was an enthusiastic and expert angler and his knowledge, from practical experience, of the angling waters of Ireland, was unrivalled, and was freely put at the disposal of all inquirers at his official headquarters.

Southern was a frequent attendant at the meetings of the International Council for the Exploration of the Sea, as an expert on behalf of the Irish Free State, and was an active member of the Salmon and Trout Committee of that body. His death, in the midst of his work, leaves many friends in scientific and angling circles in Ireland and elsewhere to regret his loss. G. P. F.

News and Views

"Letters to the Editor"

IN this issue we are publishing eleven pages of communications under the heading "Letters to the Editor". While it cannot be maintained that any of these pages makes easy reading, it is probably not far from the mark to say that every page includes either a definite contribution to knowledge or one or more points worthy of careful consideration. However that may be, the addresses which appear at the ends of the various communications suggest some interesting reflections. In 'making-up' these pages, the principal considerations were to achieve a rough balance among the subjects represented and to take account of the date of receipt of communications. The result has been, we hope, a representative series of 'letters' as regards subjects, the authors of which write from London, Cambridge, Leeds, Reading and Teddington; Edinburgh; Bangor; Belfast and Dublin; Copenhagen, Cracow, Leningrad, Leyden, Moscow, Oslo and Uppsala; Chicago and Philadelphia; and Jerusalem. This list of places demonstrates better than any words of ours the widespread distribution of readers of NATURE, and substantiates the claim of science to be international in scope. In these days of political upheaval, with the exaggerated claims of nationalism imperilling the peace of the world, it is an encouraging thought that among men of science there is still a strong bond of common interest in original investigations and results, and we are gratified that they should select NATURE as the vehicle of their communications. For our part, we can only express the hope that this form of internationalism may grow, for in it we see the germs of the new order in which the spirit of the pursuit of knowledge will unify the interests and shape the destinies of mankind.

D. C. Solander (1736–82)

DANIEL CHARLES SOLANDER, the famous botanist, the bicentenary of whose birth occurs on February 28, was born in Norrland, Sweden, and ultimately became the favourite pupil of Linnæus. The son of a country parson, Solander attracted the attention of Linnæus while studying at the University of Uppsala, and was welcomed into the master's household, where he was treated with every consideration. It was the practice of Linnæus to accompany his pupils into the fields and woods in order to give them an intimate acquaintance with Nature, and Solander showed remarkable aptitude and understanding in his observations. A collection of plants which he made in his native province is still to be seen in the Linnæan Herbarium. It elicited the warm commendation of the Consistory for his diligence and skill. When the zealous London naturalists, John Ellis and Peter Collinson, requested Linnæus to send some of his pupils to encourage the study of natural history in England in 1760, Solander was selected, Linnæus recommending him as his "much loved pupil". Solander became devotedly attached to England and never again returned to his fatherland. In fact, when Linnæus procured for him the offer of the post of professor of botany at St. Petersburg, he first consulted his English friends and then declined the appointment "for many reasons" which were not given. Solander was, as a matter of fact, engaged in classifying and cataloguing in the British Museum, and he also undertook to arrange the Duchess of Portland's museum. At the British Museum, Solander became successively assistant librarian, under-librarian and keeper of the printed books.

SOLANDER accompanied Sir Joseph Banks on his voyage to the Pacific with Cook in the *Endeavour* (1768–71). The journey was very prolific in results, 1,200 new species, with a hundred genera and a multitude of animals, fishes, insects and mollusca, previously unknown, being secured. Linnæus afterwards complained that Solander had not sent him a single plant or insect from the voyage; but the explanation of the apparent lack of courtesy is to be found in the fact that the specimens were not Solander's to give. They belonged to Banks, who had incurred great expense in the equipment of the vessel. The incident made no difference to the mutual regard of the two botanists for each other. When an article by Fabricius appeared in the *Deutsches Museum* containing references disparaging to Linnæus, Solander bought up all the copies he could find and destroyed them to prevent a misconception being more widely spread. On the other hand, when Linnæus heard rumours of a proposed second visit by Solander to the Pacific, he wrote to one of his English friends: "I have just read in some foreign newspapers that our friend Solander intends to revisit those new countries discovered by Mr. Banks and himself. This report has affected me so much as almost entirely to deprive me of sleep. How vain are the hopes of man! Whilst the whole botanical world like myself has been looking for the most transcendent benefits to our science from the unrivalled exertions of your countrymen, all their matchless and truly astonishing collection such as has never been seen before, nor may ever be seen again, is to be put aside untouched to be thrust into some corner to become probably the prey of insects and of destruction". As it happened, Solander went to Iceland and not to the Pacific, and the results of his work are embodied in manuscripts preserved in the Botanical Department of the British Museum. Solander died in 1782. Most of his writings were in the form of contributions to other authors' works, the most notable being to Brander's 'Fossilia Hautoniensia" and Ellis's "Natural History of Zoophytes".

New York City Museum of Science and Industry

THE New York City Museum of Science and Industry was formally opened on the evening of February 11 in a novel manner. At 3.35 a.m. G.M.T. on February 12 (10.35 p.m. February 11, in New York), Sir William Bragg was seated in Faraday's old study at the Royal Institution before the table at which Faraday used to work; and he gave a short address to a distinguished gathering in the New York Museum, including Prof. Albert Einstein, Dr. F. B. Jewett of the Bell Telephone Laboratories, and the Mayor of New York. The American listeners then heard Sir William strike a match, with which he lit an old candle set in a candle-stick of Faraday's time; in a few instants, the entrance hall of the New York Museum was flooded with the light of two rows of mercury vapour lamps. The means by which this feat was accomplished provides an interesting demonstration of one of the many marvellous attainments of modern applied science which have resulted from Faraday's pioneer work of more than a hundred years ago. When Sir William lit the candle, the light was incident on a photo-electric cell, and the resulting electrical impulse was amplified and transmitted over telephone lines to the Post Office trans-Atlantic radio station at Rugby. The signal passing over the radio link was received at Netrong, U.S.A., by the American Telephone and Telegraph Company's station, and then re-transmitted by telephone line to the New York Museum of Science and Industry, where it was made to light a Westinghouse lamp of fifty years ago. The light from this lamp was picked up by another photo-electric cell, which in turn actuated the switches controlling the mercury vapour lamps flood-lighting the hall of the Museum.

In the course of his address, which was relayed in America by the National Broadcasting Company, Sir William Bragg referred to the first description of an ideal science museum and its uses, written by the American, Benjamin Thomson, Count Rumford, some hundred and forty years ago. The first attempt to carry out Rumford's plan was made in the Royal Institution of Great Britain, but was a failure. It remained for Sir Humphry Davy to see other opportunities for the Royal Institution and to mould its activities so that it became a school of research and a platform from which the results of scientific progress could be described to the public. Here worked Faraday, whose scientific discoveries have done more perhaps than those of any other man to influence modern thought and modern ways. It was very appropriate that the modern achievements of electrical science, the foundations of which were laid by Faraday, should be employed in the manner described above to open another science museum. The work of this museum would prove most valuable in interpreting for the common good the triumphs of the past and the hopes of the future in the realm of science. In conclusion, Sir William prayed that this new Museum of Science and Industry might go forward steadily and strongly in its task of education and conciliation, and help in its own way to lead men into the paths of unity and peace.

Radioactivity and Atomic Structure

THE Faraday Lecture to the Chemical Society was given at the Royal Institution on February 12 by Lord Rutherford. The title was "Radioactivity and Atomic Structure"; but Lord Rutherford, rightly, was less concerned with discussing the latest results in nuclear transformations than with giving a general account of the development of radioactivity in the past forty years, and relating its discoveries to the theories and ideas of the chemist. The personal note of the lecture was greatly appreciated by the audience. Lord Rutherford began by giving an account of his own work at Cambridge and Montreal in the early days, of the discovery of the emanating power of thorium, of the characteristic rate of decay of the emanation, of its odd power of 'exciting' or 'inducing' radioactivity in neighbouring solids, and the other work which led to the disintegration theory of Rutherford and Soddy in 1902–3. This was the first sustained attack on the chemist's concept of the atom as a solid and permanently stable structure, and the first hint that an explanation might be found some day for the existence of the periodic classification. He passed then to the great period 1911–13 when the nuclear theory of the atom was established, the group-displacement was put forward, and physicists and chemists were reluctantly compelled to believe in the existence of isotopes—at least for the heaviest elements.

WORK since the Great War both on the nucleus and on isotopes has gone from strength to strength. In 1919, artificial disintegration of light elements by one of the spontaneous disintegration products was clearly established. Great developments since then have become possible by the discovery of powerful electrical methods for producing streams of bombarding projectiles and by improvements in automatic methods for counting particles. In some cases, rare, but stable and already known, isotopes have been produced; in others, atoms have been artificially made which show both old and new forms of radioactivity. Concurrently with this work the mass-spectrograph has revealed the complexity of the majority of elements and determined accurately the masses of the isotopes. Some of these accurate results have been of great importance in establishing the principle of the conservation of energy in many nuclear reactions and generally in revealing the structure of the nucleus. Results like these have been a very notable contribution to one of the problems which Faraday, in his day, considered lay before chemists: "to decompose the metals, to reform them and to realize the once absurd notion of transmutation". Lord Rutherford ended by pointing out that much still remains to be done before we can hope to understand how atoms have been built up of elementary particles or grasp the significance of the relative abundance of the different atoms on our earth.

The Huxley Letters

IN the history of scientific thought there have been a few supreme occasions only on which scientific men have been compelled to enter the public lists

on behalf of a new idea. Each time the issue at stake has been fundamental—the acceptance or rejection of new knowledge, revolutionising our understanding of man's place in Nature. Each time the repercussions, arousing partisanship and controversy, have reverberated along the whole cultural front. Such a situation developed in the middle of the nineteenth century when the battle for evolution reached its climax, and Press, platform and pulpit resounded to the noise of strife. The centre of that struggle was, of course, T. H. Huxley, and his activities brought him into contact with the whole intellectual life of the period—scientific, literary, philosophic and religious. Probably more than any other man of that century, the threads of cultural life crossed him from all directions.

Two years ago, when Dr. Leonard Huxley died, there were found among his papers more than three thousand of his father's letters. A remarkable, and in many ways a unique collection, including hundreds of letters from Darwin, Lyell, Faraday, Francis Galton, J. S. Mill, Skeat, Lecky, Hæckel, Herbert Spencer, Bentham, Browning, Tennyson, Jane and Thomas Carlyle, Pusey, etc., they represent a veritable cross-section of cultural life at a critical epoch in history. The Imperial College of Science, in whose 'Huxley Building' he carried through most of his active work, is endeavouring to acquire this collection for the Huxley Museum, and in order to raise the necessary £2,500 is appealing to public subscription. The object is to maintain the collection intact and to house it in such a manner as to make it accessible to interested students of the period; for, once the letters are dispersed, the loss will be inestimable. It is in their unity that the collection exhibits one of its most valuable features. It is much to be hoped that the generation that has benefited so greatly from the result of Huxley's efforts will ensure that this necessary task is carried to a successful conclusion. Contributions should be sent to the Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7.

British Dependencies and Mandated Territories in Africa

ANY anxiety which may have been aroused by tentative suggestions relating to a future redistribution of Colonies and Mandated Territories in Africa, to which reference was made in NATURE of February 15 (see p. 249), should be dispelled, at least for the present, by the very definite pronouncement made by Mr. J. H. Thomas in the House of Commons on February 12, which stated in precise terms that no such proposals would be entertained. It is reported, however, that some misgiving is still felt in East Africa, and it is expected by leaders of the German movement in Tanganyika, according to a dispatch from the Nairobi correspondent of *The Times* in the issue of February 15, that Herr Hitler will make "a precise and firm demand within a few months". The same dispatch quotes from the *East African Standard* a passage to the effect that while the Colonial lands are theoretically the possessions of the Government, their future is not merely a matter for international negotiation. They are the inalienable homes of millions of people residing in, and developing them, who are wards of the British race. So far as concerns the Mandated Territories only, it might be argued on the other side that the mandate recognises these inalienable rights of the inhabitants, irrespective of the power in whose hands it may be vested. Past colonial history, however, and the conduct of administration by the mandatory powers since they accepted the responsibility, shows on an impartial view that under no Government, not even excepting the present administration of the Belgian Congo, of which too little has been heard, has so near an approach been made as in the British Territories to a complete adaptation of the methods of administration and of the efforts to develop the civic and social capacities of the individual to the cultural status of the African as revealed in the scientific study of his institutions.

The Galactic Nebulæ

MR. J. H. REYNOLDS delivered his presidential address to the Royal Astronomical Society on February 14, taking as his subject the "Galactic Nebulæ". At the moment, it may be said that the limelight of spectacular interest shines more strongly on the extragalactic nebulæ than on those nebulæ, more properly so called, which are to be found in our own system, although they present numerous features of great interest. They appear to be actual clouds, and are seen as dark patches in which the background of faint stars is partly or wholly obscured, unless the cloud is illuminated by an adjacent or interior star. If the illuminating star is of early type, the nebula shows a fluorescent emission spectrum excited by the ultra-violet light of the star; but if the latter is late in type, the nebula simply reflects the light. Among the galactic nebulæ are numbered the planetary nebulæ, which are now considered to have originated as gaseous shells emitted by novæ; but no planetary nebula has been found within eight degrees of the position of Tycho Brahe's very bright nova of 1572. Mr. Reynolds dealt with the nature of the dust which causes the colour excess of stars behind clouds and reflects the light of late type stars; owing to the low temperature of interstellar space, the material must be frozen solid, and may consist of particles of frozen water or solid ammonia.

Training of Industrial Physicists

AN informal discussion on "The Training of Industrial Physicists" was held under the auspices of the Institute of Physics in the rooms of the Royal Society on February 11. Among the 180 persons present were representatives of nearly every university and college in Great Britain and Ireland, of firms employing physicists, and of research associations and Government establishments. The fact that so many distinguished representatives attended is in itself a clear demonstration of the importance of the subject. The opening speakers were Mr. A. P. M. Fleming, of the Metropolitan-Vickers Electrical Co., Ltd.; Dr. W. H. Hatfield, of the Brown-Firth

Research Laboratories; Mr. C. C. Paterson, of the General Electric Co., Ltd.; Prof. R. Whiddington, of the University of Leeds; Dr. R. H. Pickard, of the British Cotton Industry Research Association; and Prof. J. A. Crowther, of the University of Reading. After the tea interval, the meeting was opened for general discussion. The important suggestions and comments made at the meeting and in writing are receiving the most careful consideration of the Board of the Institute, which it is anticipated will issue a memorandum on the subject in due course.

Salmon and Freshwater Fisheries

INFORMATION given in the Report for the Year 1934 of the Ministry of Agriculture and Fisheries Salmon and Freshwater Fisheries (H.M. Stationery Office, 1*s*. net) shows that, on the whole, despite the prolonged period of drought during the summer months of that year, no disasters of a widespread character took place. The droughty conditions have, however, inevitably affected the catch of fish to a certain extent and led to incidents of mortality from pollution of one kind or another. Although the mortality of fish attributable to furunculosis was comparatively slight, the Report wisely stresses the necessity for no relaxation of vigilance over the dangers of this disease and states that "it is regrettable that the Diseases of Fish Bill, after passing through the House of Lords, failed, owing to congestion of business in the House of Commons, to become law". There is evidence in the Report that increasing attention is being paid to problems of pollution which affect not only the fisheries, but also the use of rivers for water supply and as amenities for the general public. The appointment of an Inland Water Survey Committee will, it is hoped, produce additional information of value for the study of fishery problems by the gauging of streams and correlation of their flow with rainfall. It is satisfactory to note that the large amounts spent on sewage disposal during the last few years appear to be benefiting many rivers. There is, however, still much work to be done in this direction, and it is pointed out that sewage was probably the cause of more cases of fish destruction than resulted from industrial effluents.

Research in the Electrical Industry

THE main object of the British Electrical and Allied Industries Research Association, 15 Savoy Street, W.C.2 (the E.R.A.), is the co-operation of all sections of the electrical industry and of all those associated with it, in the general interests, of the industry and in the national interest. The sections include manufacturers of electric plant, those who supply electricity, those who make extensive use of it and scientific and technical investigators. The desired results, namely, industrial expansion and public benefit, can only be attained by team work of the highest order. The Association is well supported by the industries affected. During the last five years, the income has increased from £31,600 to £65,840. The main work done is to increase the efficiency and trustworthiness of electrical apparatus and of electrical supply. A reduction of cost is for the public benefit, and this can be achieved by expanding the field of utility and increasing the use and demand. Among other researches carried out was one on the thermal stability and ignitability of dielectrics. A range of standard heat sources was devised to simulate the conditions which occur in practice. The method of applying those heat sources when testing insulating materials for resistance to applied heat and the grading of them is described in a new report (Ref. *L*/64) issued during the year. A novel feature of interest is the standard flame, produced by a spirit burner of the Barthel type, which is reproducible to a degree of accuracy not possible with the Méker gas burner which it replaces. An extension of this work is in progress on the behaviour of ignitable materials under different ambient conditions, such as draught, with the object of devising means whereby self-extinguishing materials may be graded to better advantage.

Sixth International Congress for Scientific Management

THE Proceedings of the Sixth International Congress for Scientific Management, which have now been published (London: P. S. King and Son, Ltd.), completes the series of seven volumes containing the papers and speeches at the Congress. The six volumes issued prior to the Congress contained the papers to be presented at the various sectional meetings. The final volume includes reports on the actual discussions, and the excellent summaries of the rapporteurs give epitomes of the matter contained in the previous volumes. Full reports are given of the speeches at the first plenary sessions when "Management Problems arising from Government Intervention" were discussed. In the Educational and Training Section, the scientific worker will find much that is of interest in the discussions on sources of recruitment and methods of selection, which ranged over a wide field of personnel problems, and on objects and methods of training and further education, or on the avoidance of excess and waste of personnel selected and trained for high administrative positions. The wider use in administrative work of technical and scientific workers possessing administrative ability, while an urgent need in industry as in Government to-day, is only part of the general question of encouraging the development and securing the best selection of those possessing real administrative powers. The second plenary session, on the simplification of data, the place of statistics and the standardisation of terms, as well as various discussions in the manufacturing and agricultural sections, are also of considerable interest; for example, those on scientific methods applied to works management and on production control. For a volume designed as a permanent record, it is a pity that the subject index is so meagre.

Compressed Gas as a Fuel for Motor Transport

ON December 13, Mr. Robert Cook read a paper on "Compressed Gas as a Fuel for Motor Transport" before the East Midland Section of the Institute of Fuel and the Society of Chemical Industry at

Nottingham. This comprised a brief history of the utilisation of gas as a fuel for internal combustion engines, together with an assessment of its economic possibilities in competition with petrol and heavy oils. Comparisons of the usefulness of gas and petrol for internal combustion engines are not unfavourable to the former. A higher thermal efficiency is obtained with gas than with petrol; the carbon monoxide content of exhaust gases is very much lower than with petrol; starting is as good; flexibility and acceleration are superior to petrol when the engine is cold; and it is quite as safe in use as petrol. The chief drawback to gas as compared with petrol is, of course, the difficulty of carrying a sufficient quantity for any considerable mileage. Latterly, however, various firms have been experimenting in the production of light high-pressure cylinders. The real competitor of gas for road transport services is heavy oil, and at present virtually no comparison can be made between these two fuels, since in every case the greater the annual mileage, the greater the economic superiority of heavy oil. The balance in favour of heavy oil might be substantially reduced by a rise in its price; an allowance in respect of the weight of vehicle cylinders when assessing licence duties; development of a special engine for gas propulsion; or by the enrichment of coal or coke-oven gas. Without such adjustments, gas cannot enter into successful competition with heavy oil for road transport service.

Fireproofing of 'Fireproof' Buildings

At the discussion of the American Steel Institute at White Sulphur Springs, Va., on October 17 on 'fireproof' structures, Dr. Ingberg, of the National Bureau of Standards, stated that in steel-framed buildings it is necessary to protect the steel by a concrete covering. In a report of the discussion issued by Science Service, Washington, D.C., it is pointed out that steel supports at high temperature sag under the terrific weight of the superimposed structure. The problem before those responsible for the fire-prevention code is to ensure that sufficient covering is given to the steel members of a building to prevent the temperature giving rise to dangerous conditions. According to Dr. Ingberg, tests have shown that for moderate rises in temperature—300°–600° F.—the strength of steel girders increases as much as 25 per cent. Above 600° a decrease occurs, and hence safety considerations make it imperative that protection in the form of a complete concrete covering must be provided. Apart from the question of safety and avoiding risk of collapse of the roof and other parts of the building owing to excessive temperature rises during a fire, it is necessary to prevent excessive relative expansion between the various parts of the structure.

Oil-Finding Methods and Oil-Made Chemicals

The National Research Council recently organised a five-day, 2,000-mile tour of industrial research laboratories for fifty-two leading business men. Science Service, of Washington, D.C., gives an account of their visit to the laboratories of the Gulf Refining Company and the Mellon Institute for Industrial Research. Dr. Paul Foote, director of the former concern, described how explosions of dynamite are used to send sound waves to a depth of 10,000 ft. into the earth where they encounter rock structures and are reflected; by their speed, reflecting and refracting behaviour they indicate the nature of the underlying deposits. He was also able to show the visitors a collection of new chemicals derived from oil products, some of which have powerful destructive qualities. Dr. E. R. Weidlein, director of the Mellon Institute, pointed out that employment had been provided there for 97 trained scientific workers and 48 assistants during the last year. Their work concerned chiefly industrial problems of manufacture, but had included specifically research into the use of carbon black as a colouring material for concrete highways to minimise the glare of lights, the use of chemical metaphosphate in laundering and the bonding of tile products to steel for exterior construction use.

Animal Road Fatalities

Science Service, of Washington, D.C., gives an interesting but somewhat alarming summary of Dr. Dreyer's statistical report of animal road deaths, made during a journey of 2,550 miles. Dr. Dreyer counted sixty-one dead animals on the road. This included cats, dogs, birds, snakes and turtles. Contrary to expectations, more turtles than chickens met their death in this unhappy way, there being counted eighteen of the former and only three of the latter among the total. Of the other animals listed, after turtles, which headed the list, skunks were the most unfortunate. Dr. Dreyer's census is of particular value in that little attention has hitherto been paid to animal road fatalities in the campaign against loss of life by the motor-car.

The Population Problem in Bengal

The population of Bengal, 50·1 millions with a mean density of 646 per square mile, would seem already to have passed the stage when its needs can be met by the area it occupies. In seeking a remedy, one school supposes that if we "look after the death-rates, the birth-rates will look after themselves", and another suggests that "if we keep down the births, the deaths will keep down themselves". Cedric Dover, in a critical survey of the situation, concludes that control of the birth-rates is likely to furnish a more useful contribution than exclusive attention to death-rates (*Population*, 2, No. 1, November 1935, p. 90). A maximal population cannot be maintained above the bare subsistence level, even with radical progress in economic prosperity. The population of Bengal has already outgrown its resources, and the time seems to have come when eugenic control of population growth should be introduced.

The Nucleus of the Atom

We have received a symposium entitled "The Nucleus of the Atom and its Structure" from the Ohio State Chapter of the Sigma Xi Society which contains a quantity of information not easily accessible

in collected form (Columbus, O.: Ohio State University, Dept. of Physics, 1935, pp. 104, 1 dollar). W. F. G. Swann contributes an account of cosmic rays in which he explains his theory of particles producing secondaries frequently at first and less frequently as they lose energy in penetrating the earth's atmosphere. He also speculates on the origin of the energy of the charged particles. M. L. Pool contributes an article on the energies and products involved in nuclear disintegration and synthesis, which contains a number of extremely useful tables and data on these processes. H. L. Johnston summarises the uses of deuterium as a research tool in physics, chemistry and biology. E. O. Lawrence gives a historical survey of artificial radioactivity and an account of recent work in the California laboratory on this subject. G. Gamow contributes a short article on nuclear transformation and the origin of chemical elements which discusses the astrophysical aspect of nuclear reactions.

Spanish Archæology and the University of Oxford

AN important addition to the provision for archæological research in the University of Oxford will be made by the election by Queen's College of a research student in archæology at some time in June next. The field of research will be Spain, or some part of Spain, and the period under investigation will lie between the earliest Neolithic Age and 200 B.C. The period of tenure will be two years and the stipend £300 per annum. In view of the importance of Spain as a centre of culture, especially in the development of art, in later palæolithic times, and of the desirability of a clearer understanding of its cultural relations in that and the succeeding mesolithic period, the restriction to the early neolithic period may appear open to comment; but no doubt it was held that these periods are at present sufficiently covered by those already concerned with the prehistoric archæology of Europe generally, while development of the megalithic culture and the bronze and iron ages offer a no less fruitful and still to some extent uncultivated field to which attention may be directed to greater advantage in present conditions.

Science and Human Welfare

FOLLOWING upon an informal meeting at which persons connected with some fifteen organisations interested in sociological and scientific problems were present, a Research Co-ordination Committee was formed to draw up plans for the co-ordination of scientific research as applied to human welfare. The Committee held its first meeting on January 30 at Morley College, London, and drafted a preliminary list of problems worthy of investigation and a list of organisations that are likely to have material bearing on those problems. As an example may be cited problems arising out of the housing question in connexion with the clearance of slums. Five aspects (architectural, engineering, financial, medical and sociological) have been put down for consideration, and steps are being taken to collect the necessary information. The offices of the Committee are at Hazlitt House, Southampton Buildings, W.C.2.

Chemical Research in Czechoslovakia

THE *Collection of Czechoslovak Chemical Communications* has just completed its seventh volume. This journal continues to record the investigations in pure chemistry carried out at the Universities of Prague and Brno. It is significant that no less than thirteen papers describing polarographic researches with the dropping mercury cathode appeared last year from the laboratory of Prof. J. Heyrovský. Prof. E. Votoček and his co-workers published ten papers dealing with various sugar derivatives and their behaviour with Grignard's reagents and other organic bodies. Another fruitful field of research has been the application of organic reagents for the detection and estimation of metals. This work is being carried out at Brno by Prof. Dubský and his fellow-investigators.

An Active Group of Sunspots

A RECENT group of sunspots, not remarkable for size, complexity or visible changes of structure, has proved of interest on account of its great activity when observed spectroscopically, especially in the hydrogen line C or $H\alpha$ of the solar spectrum. The group consisted of two spots of regular outline, 10° apart in solar longitude, accompanied by two or three wide clusters of small spots, making in all a stream extending over 20° of longitude. The position of the centre of the stream was: long. 164°; lat. 27° S.; central meridian passage February 14·0, when the spots passed about 20° of latitude south of the centre of the sun's disk. The area of the stream averaged about 800 millionths of the sun's hemisphere or 930 million square miles. Between February 7 and 14 inclusive, the spots were examined as often as possible with the Hale spectrohelioscope at the Royal Observatory, Greenwich, for a total duration of 16 hours on six days, usually before 13^h U.T. During these hours of watching, equivalent to about one-ninth of the total duration of the epoch, eight bright eruptions of hydrogen were observed, so that a considerable number of eruptions is indicated by this sampling as having taken place in connexion with the spots.

MOST of the eruptions were of minor importance, but on February 14 one of appreciable extent, and involving large radial velocities of accompanying dark clouds of hydrogen, was fortunately observed in its entirety. This eruption, which occurred within a few degrees of longitude from the central meridian, began within a minute or two of $12^h\ 39^m$ and lasted until $13^h\ 27^m$ U.T. Besides the streaks of bright emission, which at their maximum intensity were about equal to that of the continuous spectrum adjacent to $H\alpha$, a dense cloud of relatively dark hydrogen was moving outwards from the sun with a maximum observed velocity of 210 km./sec. Within ten minutes, other dark patches or filaments were visible with velocities of recession, showing that the ejected hydrogen was to a large extent falling back towards the sun, and by $13^h\ 03^m$ when the outward motions had ceased, the measured inward velocities were of the order of

115 km./sec. By $13^h\ 14^m$ these latter velocities had increased to +190 km./sec., and at $13^h\ 22^m$, when the phenomenon was abruptly ceasing, a faint patch gave a measured velocity of +220 km./sec. At the time of writing (February 15), further observations of the group were impossible owing to fog and cloud. These observations, which illustrate a typical bright *Hα* eruption (probably also visible in the H and K lines of ionised calcium), are strongly suggestive of the conditions, worked out in 1926 by Prof. E. A. Milne in his theory of the solar chromosphere, for the ejection of high-speed particles from the sun. Since the active area on February 14 was favourably, though not ideally, placed on the disk for corpuscular streams to reach the earth, reports on disturbances of the earth's magnetic field and on radio reception will be of special interest.

Announcements

SIR WILLIAM BRAGG, president of the Royal Society, will open the Very Low Temperatures Exhibition in the Lecture Theatre of the Science Museum, South Kensington, at 3 p.m. on Wednesday, March 4. The chair will be taken by Sir Henry Lyons.

THE Faraday Society will hold a general discussion on "Disperse Systems in Gases; Dust, Smoke and Fog" at the University of Leeds on April 20–22. The discussion will be divided in two parts: Part I, General, to be introduced by Prof. R. Whytlaw-Gray, and Part II, Special, to be opened by Dr. R. Lessing. A number of distinguished foreign visitors will be present. Further information can be obtained from the Secretary, Faraday Society, 13 South Square, Gray's Inn, London, W.C.1.

Current Science, published in Bangalore, announces the appointment of the quinquennial reviewing committee of the Indian Institute of Science. The personnel of the committee is as follows: Sir James Irvine (*Chairman*), Dr. A. H. Mackenzie, Dr. S. S. Bhatnagar and Mr. F. F. C. Edmunds (*Secretary*). Sir James Irvine is Vice-Chancellor and Principal of the University of St. Andrews. Dr. Mackenzie is Pro-Vice-Chancellor of the Osmania University, Hyderabad, Deccan. Dr. Bhatnagar is university professor of physical chemistry and director of chemical laboratories, University of the Punjab. Mr. Edmunds, Inspector of Schools, Coorg and Bangalore, was the secretary of the last reviewing committee, constituted in 1930.

AT the annual general meeting of the Quekett Microscopical Club held on February 11 the following officers were elected: *President*, C. D. Soar; *Vice-Presidents*, J. Ramsbottom, E. A. Robins, J. T. Holder, Dr. C. Tierney; *Hon. Treasurer*, C. H. Bestow; *Hon. Secretary*, W. S. Warton; *Hon. Reporter*, A. Morley Jones; *Hon. Librarian*, W. E. Stone; *Hon. Curator*, C. J. Sidwell; *Hon. Editor*, W. P. Sollis; *New Members of the Committee*, H. G. Brown, C. H. Caffyn, H. C. Payne and P. K. Sartory.

AT the annual general meeting of the Royal Astronomical Society held on February 14, the following officers were elected: *President*, J. H. Reynolds; *Vice-Presidents*, Prof. S. Chapman, Dr. H. Knox-Shaw, Prof. E. A. Milne and Prof. H. C. Plummer; *Treasurer*, Sir Frank Dyson; *Secretaries*, W. M. H. Greaves and Dr. W. M. Smart; *Foreign Secretary*, Sir Arthur Eddington; *Members of Council*, C. R. Davidson, Dr. H. Dingle, Prof. R. H. Fowler, Dr. H. Spencer Jones, Dr. W. J. S. Lockyer, Prof. W. H. McCrea, P. J. Melotte, Rev. T. E. R. Phillips, Prof. H. H. Plaskett, Dr. R. O. Redman, Dr. W. H. Steavenson and Dr. R. H. Stoneley.

THE centenary of the foundation of the National University of Athens by King Otho will be celebrated on May 15, 1937. An International Congress of Archæology will be held at the same time, on the occasion of the centenary of the foundation of the Greek Society of Archæology.

PROF. LEO FROBENIUS, director of the Research Institute for Cultural Morphology at Frankfort-on-Main, has been awarded the Bernhard-Hagen Medal by the Frankfort Society for Anthropology, Ethnology and Primeval History.

THE first international meeting on fever therapy will be held in New York City in September 1936. The use of fever induced by physical and other agencies as a therapeutic procedure has received universal attention in the past few years. The conference will aim at collecting and crystallising available data in this field. Therapeutic, physiological and pathological phases of fever will be discussed. It is planned to translate abstracts of all the papers into French, English and German. Further information concerning the conference may be obtained from the Secretary, Dr. William Bierman, 471 Park Avenue, New York City, U.S.A.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

A junior investigator to the British Non-Ferrous Metals Research Association, Regnart Buildings, Euston Street, N.W.1—The Secretary (Feb. 21).

Assistants (Grade II) at the Royal Aircraft Establishment, South Farnborough, Hants—The Chief Superintendent (Ref. A. 922), Royal Aircraft Establishment, South Farnborough, Hants (Feb. 28).

A head of the Department of Pure and Applied Physics in the College of Technology, Manchester—The Registrar (March 2).

A professor of pure mathematics in the Egyptian University—The Dean of the Faculty of Science, Egyptian University, Abbassia, Cairo (March 15).

A member of staff of the Radio Research Board of the Council for Scientific and Industrial Research, Australia—F. L. McDougall, Australia House, Strand, London, W.C.2 (March 23).

A professor of engineering in the University of Melbourne—The Secretary, Universities Bureau, 88a, Gower Street, London, W.C.1 (June 15).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 324.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

A Limit to the Quantum Theory and the Avoidance of Negative Energy Transitions

ONE of the difficulties of modern quantum theory lies in the prediction, in certain circumstances, of high probabilities of transition to negative energy states. This difficulty comes very strikingly into evidence, as O. Klein first pointed out[1], in the example of reflection and refraction of electrons at a surface where the electric potential is discontinuous or very rapidly varying.

Bohr has expressed the opinion that these probabilities of transition acquire finite values when the electron exists in a field in which the potential rises by an amount equal to the rest energy (mc^2) of the electron in a distance equal to the Compton wavelength (h/mc). Sauter has shown[2] by the application of Dirac's equation that this expression of opinion is correct, and in his theory Klein's example is in the position of a limiting case.

It has been suggested that these results, which seem to correspond to no easily interpretable physical occurrences, indicate a breakdown of the quantum theory as it is summarised in Dirac's equation, but apparently no convincing reason for the breakdown has been offered. Our purpose here is to offer a suggestion why the equation cannot be expected to give results in accord with observation under the conditions to which Bohr's remark applies.

The quantum theory contains, as part of its doctrine, a principle which imposes a limit on what we may regard as physical changes. This is the uncertainty principle. If we apply it to an electron moving with momentum, p, along the direction of the x-axis, we conclude that we cannot describe changes in which $\Delta p \Delta x < h$ as physical events.

Let us plot points on the p,x diagram, representing possible positions and momenta in this case, and let us divide the area into small rectangles of area h. No experiment will enable us to distinguish between points lying in one of these rectangles. Let us suppose that a point lies at one of the corners of a rectangle. In illustration of the uncertainty principle, Prof. W. Wilson recently invoked Maxwell's demon. Let us call forth the demon again and place him in the rectangle, where he may displace the point to another position. But this act of devilment on the part of our imp will not annoy us, for we shall not know that it has taken place. In other words, the interchange of points within the small area corresponds to no physical change.

Another limitation has been suggested[3], which was originally associated with Schrödinger's equation. Recently, however, it has been found possible to derive Dirac's equation and this limitation as part of a general theory. It can be stated as a principle of minimum proper time, according to which, in studying the track of an electron, intervals of proper time less than h/m_0c^2 have no physical significance. This means that elements of length and time less than $h\beta/m_0c\sqrt{1-\beta^2}$ and $h/m_0c^2\sqrt{1-\beta^2}$ respectively are of no physical significance in association with the track, where β, as usual, denotes the ratio of the velocity of the particle to that of light.

It is possible to divide the p,x space into small rectangles such that $\Delta p\ \Delta x = h$, but with Δx less than the above limiting value. Cases will thus occur where correspondence with a physical event is possible as judged from one condition but not from the other.

Let us suppose that an electron moving in a field of force passes through a series of values p and x, its path being represented by a curve in the phase space (p,x). On this curve we first distinguish between neighbouring points P and P' when they lie at opposite ends of a diagonal of the rectangle $\Delta p\ \Delta x$ which has the area h. The second limitation makes it impossible to distinguish between the points unless Δx is at least equal to the above limiting value. We propose now to combine the two limitations and to suppose that no electron track of physical significance can contain two points $P\,P'$ such that $\Delta p\ \Delta x \geqslant h$, without at the same time satisfying the condition $\Delta x \geqslant h\beta/m_0c\sqrt{1-\beta^2}$. The quantum theory does not actually force this condition upon us, but it appears to be a reasonable way of ensuring that both the limitations shall be satisfied. The condition has an interesting consequence to which we direct attention here. It places a limit upon the gradient $\Delta p/\Delta x$ at each point of the electron track, for which we can deduce

$$\Delta p/\Delta x \not> \frac{m_0^2c^2}{h} \cdot \frac{1-\beta^2}{\beta^2}.$$

Suppose that the electron moves in a field of force, $E = -d\varphi/dx$, so that

$$\Delta p = eE\ \Delta t.$$

The condition then becomes :

$$eE\frac{\Delta t}{\Delta x} \not> \frac{m_0^2c^2}{h} \cdot \frac{1-\beta^2}{\beta^2};$$

or

$$eE \not> \frac{m_0c^2}{h/m_0c}\left(\frac{1}{\beta}-\beta\right).$$

For a particle at rest, the possible value of E is infinitely great, while for very rapidly moving particles the value becomes very small. For values of the velocity ranging from $\frac{1}{10}c$ to $\frac{9}{10}c$, the factor in the bracket is between 9 and approximately $\frac{1}{3}$.

Thus the upper limit for these velocities is of the order of that at which, according to Bohr and Sauter, the high values of probabilities to negative energy values begin.

The conception of an electron as a particle moving with a high velocity in fields of force of such magnitudes is not a possible one according to the condition we have introduced.

The principle of minimum proper time may thus be regarded as setting a boundary to the region to which such a conception may be applied and to the domain where the quantum equation is valid.

H. T. FLINT.

Wheatstone Laboratory,
King's College,
London.
Jan. 16.

[1] *Z. Phys.*, **53**, 157 (1929).
[2] *Z. Phys.*, **69**, 742 (1931).
[3] *Proc. Roy. Soc.*, A, **117**, 630, 638 (1927); *Proc. Nat. Acad. Science*, **14**, 322 (1927).

Positron Emission accompanying β-Ray Activity

ACCORDING to the theory of β-decay proposed by Fermi, a neutron can be transformed spontaneously into a proton with simultaneous creation of an electron and a neutrino. The probability of this process occurring is to a first approximation proportional to g^2, where g is the universal constant introduced by Fermi. Since the β-particle has an electric charge, there will be an electromagnetic interaction between the β-particle and the virtual electrons which, according to Dirac's theory of the positron, occupy the states of negative energy. As a result of this interaction, it may happen that an electron in a negative energy state during the creation of the β-particle makes a transition to a state of positive energy, so that we have a process in which a neutron is transformed into a proton by simultaneous creation of two electrons, a positron and a neutrino. Since the interaction energy between two electrons is to a first approximation proportional to the square of the charge e of an electron, the probability of this process will be proportional to $(g\,e^2)^2$ or (for dimensional reasons) proportional to $(g\,\alpha)^2$, where $\alpha = 2\pi\,e^2/hc = 1/137$ is the fine structure constant.

We get, therefore, for the ratio N^+/N^- (N^+ = number of positrons emitted, N^- = number of β-particles) the following expression

$$N^+/N^- = k\,\alpha^2,$$

where k is a dimensionless constant independent of the atomic number Z (Z will be involved only in terms of higher order in e). The constant k depends to some extent on the energy distribution of the β-rays and is generally larger the larger the upper limit of the β-spectrum. A preliminary estimate showed that in actual cases k has a value of a few units, so that N^+/N^- is of the order of 10^{-4}. This is in agreement with the experiments of Alichanow, Alichanian and Kosodaew[1], who have measured N^+/N^- for thorium C+C″ and for radium C.

Further, it is a simple consequence of the theory that the upper limit of the positron energy spectrum is smaller than the upper limit of the β-ray spectrum by an amount $2mc^2 \sim 10^6$ e.v. Now the end-points of the β-spectra of thorium C+C″ and radium C correspond to energies of $2{\cdot}2 \times 10^6$ e.v. and $2{\cdot}9 \times 10^6$ e.v. respectively[2]. This is in good agreement with the measurements of Alichanow, Alichanian and Kosodaew (loc. cit.). After subtracting the positrons originating from the internal conversion of γ-rays, these authors find in the case of thorium C+C″ a continuous positron spectrum with the end-point at an energy of about $1{\cdot}2 \times 10^6$ e.v. In the case of radium C they find in the same way a positron spectrum extending at least as far as an energy of $1{\cdot}7 \times 10^6$ e.v. In the latter case the end-point is not very well defined, since the distribution curve has a tail.

The details of the theory together with a detailed calculation of the positron distribution curve will be given later.

C. MØLLER.

Institute for Theoretical Physics,
Copenhagen.
Jan. 10.

[1] A. I. Alichanow, A. I. Alichanian and M. S. Kosodaew, NATURE, **136**, 475 (1935). **136**, 719 (1935).
[2] E. Rutherford, J. Chadwick, C. D. Ellis, "Radiations from Radioactive Substances", 406 (1930).

The Continuous Spectra of RaE and RaP[30]

THE purpose of this investigation was to study the continuous spectra of RaE and RaP[30], especially in their low energy regions.

The spectrum of RaE was investigated by focusing the electrons in a uniform magnetic field, the radius of the circles being 10 cm. The angular divergence of the beam was about 11°. The electrons were counted with a small Geiger-Müller counter, separated from the apparatus by a nitrocellulose film only $4{\cdot}5 \times 10^{-4}$ gm./cm.² thick, the apparatus itself being evacuated to a pressure of 10^{-4} mm. Hg. Eleven aluminium screens were mounted inside the deflecting chamber to exclude completely the possibility of electrons scattered by the walls reaching the counter; furthermore, in designing the apparatus, a large distance from the source to the walls and the first defining slit was provided for.

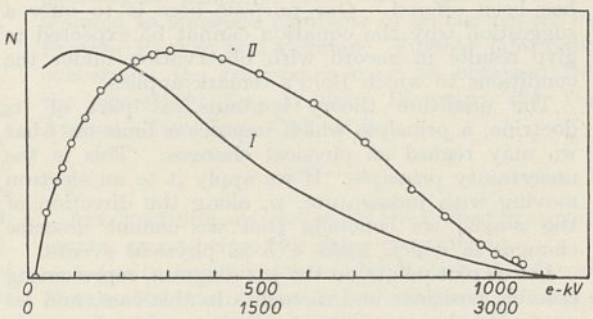

FIG. 1.

The source was an aluminium strip 3 mm. wide and $0{\cdot}5\,\mu$ thick ($0{\cdot}13 \times 10^{-3}$ gm./cm.²), on which pure RaE was deposited electrolytically. Having investigated the energy distribution curve of β-particles from this RaE source under the conditions described above, we discovered the presence of a great number of electrons with low energies. The energy distribution curve obtained, beginning from 30 kv., is given in Fig. 1 (I). There is no pronounced maximum, and the curve seems, when extrapolated, to intersect the axis of ordinates. At energies less than 60 e.kv. the absorption of electrons in the film separating the counter from the deflecting chamber becomes noticeable. Using data on absorption of cathode rays[1], the weakening of the β-ray beam in passing through the film can be taken into account, and the curve corrected for this absorption effect. In the curve given in Fig. 1, this correction has been

already applied for energies below 60 kv. When sources of RaE not free from RaD were used, the lines of the natural β-spectrum of RaD—30, 42 and 45 kv.—were observed.

A series of special experiments was carried out to verify that the observed low energy electrons were not of secondary origin. Having placed a mica screen 3×10^{-3} gm./cm.^{2} thick in front of the counter, we were able to assure ourselves that the number of electrons recorded by the counter diminished by the amount expected from absorption curves obtained with cathode rays[1].

Having put our source on the bottom of the apparatus to prevent electrons from the source reaching the counter, we were also able to ascertain that owing to the large distance from the source to the walls of the apparatus and the first slit, the number of scattered electrons was in practice very small.

The spectrum of RaP[30] was investigated in another apparatus ($\rho = 3$ cm.), the positrons being recorded in the same manner by a counter provided with a window covered with a nitrocellulose film 5×10^{-4} gm./cm.^{2} thick. The divergence of the beam focused was about 40°. The apparatus was exhausted to a pressure of about 0·05 mm. Hg. As a source, an aluminium strip 10 μ thick irradiated by α-particles of RaC from a 200 millicurie radon tube[2] was used. The measurements were always started 2 minutes after the irradiation had finished. The spectrum curve obtained is shown in Fig. 1 (II), the lower scale on the abscissa axis referring to this curve. The statistical error in this case does not exceed 3 per cent.

Thus comparing the spectra of RaP[30] and RaE, a considerable difference in the shape of the β-spectra from elements of low and high atomic number respectively is observed; in the case of RaP ($Z=15$) the spectrum curve has a distinct maximum, and tends continuously to zero energy, while the curve for RaE ($Z=83$) seems to intersect the axis of ordinates.

A detailed account of these experiments will be published in the *Physikalische Zeitschrift der Sowjetunion*.

A. I. ALICHANOW.
A. I. ALICHANIAN.
B. S. DŽELEPOW.

Physical-Technical Institute,
Leningrad.
Dec. 29, 1935.

[1] Schonland, *Proc. Roy. Soc., London*, A, **104**, 235 (1923); and **108**, 187 (1925).
[2] A. I. Alichanow, A. I. Alichanian and B. S. Dželepow, *Z. Phys.*, **93**, 350 (1935).

Use of the Micro-Thermal Conductivity Method for the Determination of Heavy Hydrogen

IN a recently published note[1], Messrs. Newell, Purcell, Gregory and Ellingham make the following statement concerning our micro-thermal conductivity method for the analysis of heavy hydrogen[2].

"In attempts to apply this method [that is, the method by A. and L. Farkas], however, we did not succeed in finding conditions yielding reliable results of the accuracy required; and, from a consideration of the factors influencing thermal conductivity, operation at a notably higher pressure seemed more promising, since the measurement then rests on a simpler and more definite physical basis."

Since such a statement is, in our opinion, liable to raise some doubt about the applicability, reliability, accuracy and physical basis of the micro-thermal conductivity method, we should like to direct attention to the following points:

(1) The method is based on the well-established temperature variation of the specific heat of hydrogen and deuterium.

(2) The method possesses a certain advantage in that the amount of gas required for a single analysis is only a few cubic millimetres (N. T. P.) and that it allows us not only to determine the percentage deuterium in a given sample but also to estimate the relative amounts of the three molecular species H_2, HD and D_2, and to discriminate between ortho- and para-hydrogen or ortho- and para-deuterium.

(3) We have had no difficulty in obtaining an accuracy in our measurements of 0·1–0·2 per cent deuterium.

(4) The method has now been in use for more than two years in several investigations including one concerning the electrolytic separation of the hydrogen isotopes[3]. The reliability of the method appears to be fully established by the fact that it is in actual use in some half a dozen university laboratories in Germany, in the United States and in Great Britain.

Why Messrs. Newell, Purcell, Gregory and Ellingham failed to obtain reliable results using the micro-thermal conductivity method for the estimation of heavy hydrogen is not evident from their note.

A. FARKAS
(Cambridge).
L. FARKAS
(Jerusalem).
E. K. RIDEAL
(Cambridge).

Department of Colloid Science,
The University,
Cambridge,
and
Department of Physical Chemistry,
The Hebrew University,
Jerusalem.
Jan. 28.

[1] NATURE, **137**, 69 (January 11, 1936).
[2] A. Farkas and L. Farkas, NATURE, **132**, 894 (1933). *Proc. Roy. Soc.*, A, **144**, 167 (1934).
[3] A. Farkas and L. Farkas, *Proc. Roy. Soc.*, A, **146**, 623 (1934).

An X-Ray Examination of Atomic Vibrations in Zinc and Cadmium

A SHORT time ago, experimental results were published by the present writer and F. W. Spiers on the X-ray scattering factors of nickel, copper and zinc atoms for copper $K\alpha$ radiation. While the observed values for nickel and copper lay on smooth curves when the scattering factors were plotted against $(\sin\theta)/\lambda$ in the usual way, in the case of zinc the scattering factors for certain reflections were found to lie well off the mean curve. It was noted at the time of publication that these discrepant results were consistently obtained and it has since been found that similar results are obtained with cadmium; both metals have a closed packed hexagonal structure with axial ratios $c/a = 1{\cdot}856$ for zinc and 1·886 for cadmium. Cadmium is a more favourable metal to investigate for, having larger lattice spacings, it gives more reflections than zinc and they are relatively stronger.

An examination of these apparent discrepancies has shown that reflections from atomic planes which make small angles with the basal plane of the cell give relatively low scattering factors, while planes

making angles approximating to 90° with the basal plane give relatively high scattering factors.

These results point either to a pronounced asymmetry of the atoms, consisting of an elongation in the direction of the c-axis, or to a similar asymmetry in the lattice vibrations. The effects are too large to be attributable to atomic asymmetry, but may be explained in terms of a greater lattice vibration along the c-axis than normal to it. This is in accord with the work of Grüneisen and Goens on the thermal expansion of zinc and cadmium; they have explained their results in terms of two mean characteristic temperatures which for zinc are $\bar{\Theta}_z = 200°$ in the direction of the c-axis and $\bar{\Theta}_x = 320°$ normal to the c-axis. Since the r.m.s. amplitude of lattice vibration is approximately proportional to $1/\bar{\Theta}$, it follows that the mean amplitude along the c-axis is *greater* than normal to it approximately in the ratio 320/200, that is, 1·60. It will be shown in detail elsewhere that the X-ray scattering factors for zinc and cadmium are in full agreement with the view that the amplitude of vibration along the c-axis is greater than normal to it, and for intermediate directions has intermediate values.

Note added to proof: February 7. Since the above was written, a theoretical paper by Zener has appeared in the *Physical Review* giving results similar to those found experimentally.

G. W. BRINDLEY
(Mackinnon Student of the Royal Society).
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Jan. 27.

Crystal Structure and Shape of Colloidal Particles of Vanadium Pentoxide

THE analysis of the crystal structure of V_2O_5 seemed to be of special interest in relation to the well-known tendency of vanadium pentoxide in colloidal solution to form rod-like particles. Further, practically nothing is known about the structure of compounds of the form A_2B_5, such as Nb_2O_5 and Ta_2O_5, as well as V_2O_5.

Rotation diagrams around the three principal axes using copper $K\alpha$- and chromium $K\alpha$-rays, of crystals isolated from fused V_2O_5, showed them to be rhombic with the following cell-dimensions:

$$a = 11{\cdot}48 \pm 0{\cdot}01 \text{ A.}; \quad b = 4{\cdot}36_0 \pm 0{\cdot}005 \text{ A.}; \quad c = 3{\cdot}55_5 \pm 0{\cdot}005 \text{ A.}$$

This elementary cell contains two molecules of V_2O_5.

An exhaustive examination of the space-groups of the rhombic system leads to the conclusion that only the space groups C_{2v}^7 and V^3 are not immediately excluded by the observed intensities. However, the structure in C_{2v}^7 alone is in accordance with the observed absence of reflections $h0l$ with $h + l \neq 2p$, and the total absence of fifth order reflections on the diagram round the a-axis. The vanadium atoms are situated on one 4-equivalent place (4b), the oxygen atoms on two 4- and one 2-equivalent place (2a):

$$2(a): 0uv, \tfrac{1}{2}\bar{u}\tfrac{1}{2} + v. \quad 4(b): xyz, \bar{x}yz, \tfrac{1}{2} - xy\tfrac{1}{2} + z, \tfrac{1}{2} + x\bar{y}\tfrac{1}{2} + z.$$

The ten parameters involved in this structure were determined, using the observed intensities only, without taking into account the spatial arrangement. The best agreement between calculated and observed intensities is obtained with the following set of values:

$$x_m = 0{\cdot}146 \pm 0{\cdot}0030 \quad x = 0{\cdot}155 \pm 0{\cdot}007$$
$$x = 0{\cdot}195 \pm 0{\cdot}007$$
$$y_m = 0{\cdot}095 \pm 0{\cdot}005 \quad y = 0{\cdot}45 \pm 0{\cdot}01$$
$$y = 0{\cdot}04 \pm 0{\cdot}01 \quad u = 0{\cdot}17 \pm 0{\cdot}02$$
$$(z_m = 0) \quad z = 0{\cdot}92 \pm 0{\cdot}02 \quad z = 0{\cdot}46 \pm 0{\cdot}02$$
$$v = 0{\cdot}11 \pm 0{\cdot}03$$

This structure of V_2O_5 can be described as built up from deformed tetrahedrons of oxygen atoms round each vanadium atom, arranged in chains along the c-axis by sharing corners; the chains are in the same way connected to form planes parallel to 010 (each tetrahedron sharing three corners) in accordance with the observed cleavage: 010 > 100 > 001.

The presence of these chains thus explains the building up of rod-like particles in a V_2O_5-sol. An investigation of colloidal V_2O_5 showed, indeed, that the particles are rods parallel to the c-axis; for example, in a two weeks' old sol: A = 15–20 A., $B < 10$ A., $C = 150$ A. This lath-like rather than rod-like form of the particles causes a hitherto unknown anisotropy effect, as it was found that in a film, formed by exsiccation of a sol, the particles were oriented with their 010-planes parallel to the film, but otherwise at random.

The investigation of the crystal structures of Nb_2O_5 and Ta_2O_5, which are isomorphous with each other but not with V_2O_5, although the cell dimensions show a close similarity, has not yet been completed.

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Leyden.
Dec. 31, 1935.

Use of Multiphase Oscillators with a Cyclotron (Lawrence) for the Production of High-Velocity Particles

THE cyclotron at present has a limited voltage amplification due, in part, to a space charge built up within the duants. The space charge density may be lowered by reducing the intensity of the ion beam alone, or by increasing the high-frequency alternating potential on the duants, thereby reducing the number of times the ion must circulate before attaining the desired velocity. These two methods of lowering the space charge are obviously undesirable. If the number of times the ions is accelerated in one revolution is increased there will be a resultant decrease in space charge density.

In connexion with the construction of a cyclotron now under way here, it is planned to experiment with multiphase oscillators connected with corresponding multisector accelerators. For example, with a three-phase oscillator connected (Y connexion with neutral connected to case of accelerating chamber) to triants A, B, C in the cyclotron, the ion will be accelerated three times per revolution (as compared with two times per revolution in the duant cyclotron); the space charge is reduced 50 per cent; capacity of the electrodes 33 per cent; and the root mean square high-frequency potential, the magnetic field, and the frequency of the oscillator are still the same. The maximum accelerating potentials, V_{AB} max., V_{BC} max., V_{CA} max. (for the three-phase triant type) for a forward direction are separated

by 120°, but for the reverse direction the maximum accelerating potentials, V_{AC} max., C_{CB} max., V_{BA} max., are separated by 240°. Thus, resonance in the forward direction is favoured and will not be critical, while in the reverse direction resonance is unfavoured and critical.

This sort of scheme should lead to higher velocities as well as to higher intensities.

ROBERT J. MOON.
WILLIAM DRAPER HARKINS.
George Herbert Jones Chemical Laboratory,
University of Chicago,
Chicago.
Jan. 17.

The Value of G

ASSUMING the validity of the theory published by Sir Arthur Eddington recently[1], and assuming his suggestion that we have

$$N = 136 \times 2^{256} \text{ exactly},$$

I have deduced an estimate of the Universal Gravitational Constant G, using only the following experimental data:

$$\begin{cases} c = (2{\cdot}9978_5 \pm 0{\cdot}0000_5) \times 10^{10} \text{ cm./sec. (ref. 2,3).} \\ F = 9648{\cdot}9 \pm 0{\cdot}7 \text{ abs. E.M.U./gm.-equiv. (ref. 2).} \\ H^1 = 1{\cdot}00756 \pm 0{\cdot}00005 \text{ (ref. 4).} \end{cases}$$

The value I obtain is:

$$G = (6{\cdot}658_8 \pm 0{\cdot}001_2) \times 10^{-8} \text{ cm.}^3 \text{ gm.}^{-1} \text{ sec.}^{-2}.$$

This does not agree well with Heyl's values, namely:

$$\left.\begin{matrix} 6{\cdot}664 \pm 0{\cdot}002 \\ 6{\cdot}674 \pm 0{\cdot}002 \\ 6{\cdot}678 \pm 0{\cdot}003 \end{matrix}\right\} \text{(ref. 5)}$$

but is in excellent agreement with the values of C. V. Boys and Carl Braun, namely[6]:

$$\begin{matrix} 6{\cdot}6576 \pm 0{\cdot}001 \\ 6{\cdot}65786 \pm 0{\cdot}0017. \end{matrix}$$

University, Reading.
W. N. BOND.
Jan. 31.

[1] *Mon. Not. Roy. Ast. Soc.*, **95**, 636 (1935); *Proc. Roy. Soc.*, A, **152**, 253 (1935).
[2] R. T. Birge, *Rev. Mod. Phys.*, **1**, 1 (1929).
[3] Michelson, Pease and Pearson, *Astrophys. J.*, **82**, 26 (1935).
[4] R. T. Birge, *Phys. Rev.*, **40**, 319 (1932).
[5] P. R. Heyl, *Bur. Stand. J. Research*, Dec. 1930.
[6] "Ency. Brit.", 10th Edn., **25**, p. 739.

Magnetic Susceptibility of Vapours of some Organic Substances

IN his well-known investigation of organic substances, Vaidyanathan[1] claimed that the molecular susceptibilities of benzene and carbon disulphide are much greater in the vapour state than in the liquid state.

Using a new method for measuring the magnetic properties of gases and vapours[2], we found that the molecular susceptibility of benzene does not change noticeably when passing from the liquid to the vapour state[3]. When our results were published, Rao and Varadachari re-examined the data previously obtained by Vaidyanathan and agreed with us so far as concerns benzene[4]. But they still claimed that the susceptibility of carbon disulphide jumps when passing from the liquid to the vapour state.

As there are no theoretical arguments for expecting a jump in carbon disulphide, we investigated the vapour with our apparatus. The substance was very pure and was many times redistilled in high vacuum. We obtained for the susceptibility of the vapour (χ_g) $\chi_g = -(0{\cdot}53 \pm 3) \times 10^{-6}$, while Vaidyanathan found $\chi_g = -0{\cdot}99 \times 10^{-6}$.

The susceptibility of liquid carbon disulphide as measured by many authors[5] lies between $\chi_l = -0{\cdot}56_5 \times 10^{-6}$ and $\chi_l = -0{\cdot}59 \times 10^{-6}$.

We may thus conclude that there is at present no evidence for a change in the susceptibility of organic substances, when passing from the liquid to the vapour state.

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[1] Vaidyanathan, *Phys. Rev.*, **30**, 512 (1927).
[2] R. Jaanus and J. Shur, *C.R.*, U.S.S.R., **2**, 465 (1934).
[3] R. Jaanus and J. Shur, NATURE, **134**, 101 (1934).
[4] S. Rao and P. Varadachari, NATURE, **134**, 812 (1934).
[5] G. Meslin, *Ann. chem. Phys.*, **7**, 145 (1906). Varadachari, *J. Annamalai Univ.*, **4**, 73 (1935).

Axial Rotation and Stellar Evolution

IF, as is now generally supposed, stars exhibiting spectra containing uniformly widened lines, commonly designated by the suffix n, are in rapid axial rotation, then the following interesting condition is imposed upon the problem of stellar evolution. It arises from the comparatively recent determination[1] that a large number of the early F-type stars (as well as B and A stars) have noticeably widened lines, while but few of the later F's and practically no G or later type stars exhibit this characteristic; and that such n stars cluster closely about the absolute magnitude $+2{\cdot}0$, and thus, by virtue of the mass-luminosity relation, about the stellar mass of twice that of the sun.

O. Struve[2] has shown that the linear speeds of rotation of many n stars are considerable, and it follows therefore that some means must be had of accounting for either a very marked loss or gain in angular momentum at about spectral class $F5$, depending on whether the course of stellar evolution is considered as proceeding down or up the main sequence of the Russell diagram. The alternative is to assume that a star retains the same spectral class throughout its life.

If, as seems probable at present, the normal course of evolution is toward later spectral types along the main sequence as a consequence of loss of mass by radiation, many stars must lose great quantities of angular momentum in passing from F to G spectral class. Or, to put it somewhat differently, since rapidly rotating stars have a strongly preferential mass of about twice that of the sun (at least for A and F stars), and since practically no stars of the sun's mass are known to rotate rapidly, much angular momentum must be lost as the star passes from mass 2 to mass 1.

It has been suggested that as a star loses mass by radiation, it rotates faster and faster in order to preserve its angular momentum, and that after a certain critical point in mass is reached, the angular speed is sufficient for fission to occur, thus causing a large transfer of rotational momentum to orbital momentum. This critical mass would imply a critical luminosity for the most rapidly rotating stars. The observed clustering of rapidly rotating stars about

absolute magnitude $+2{\cdot}0$ might be considered, therefore, as a factor in favour of the fission theory. This would not, of course, explain the existence of spectroscopic binaries, the combined mass of which is greater than twice that of the sun.

There is no *a priori* reason, however, why the process might not be reversed in direction, that is, coalition of a close spectroscopic pair into a rapidly rotating single star of mass 2. The mean combined mass of spectroscopic binaries of spectral class *F* is somewhat greater than twice the sun's mass. Many of the *n* stars, however, are known to be members of binary systems.

There is, further, no *a priori* reason for excluding the possibility that in some way angular momentum is lost directly by radiation. If so, however, it would seem more natural for the dissipation to occur gradually and continuously, rather than having a very marked peak at a mean stellar mass of slightly less than twice the mass of the sun.

Regardless of whatever theory is advanced, the observational fact remains that stars exhibiting the *n* characteristic occur only in the early spectral classes, do not diminish in number gradually as the later spectral types are approached, but fall off abruptly at about *F*5, and those of classes *A* and *F* (and possibly those of classes *B* and *O* also) seem to exhibit a strong preference for absolute magnitude of about 2, and thus presumably for mass of about twice that of the sun.

J. A. HYNEK.

Perkins Observatory,
Delaware, Ohio.
Dec. 27, 1935.

[1] *Astrophys. J.*, **82**, 338 (1935); **79**, 357 (1934); additional material in press.
[2] *Astrophys. J.*, **72**, 1 (1930).

Photographic Observations of the Planet Pluto

I HAVE found and measured the planet Pluto on four plates (Superguil) taken at the Cracow Observatory on November 4 and 5, 1935, by K. Steins, using two $4\frac{3}{4}$-in., $f/5$, twin Zeiss cameras, the duration of the exposures being two hours. The correction of the Ephemeris ("Berl. Jahrbuch", 1935) is found to be $\Delta\alpha = +0{\cdot}06^{s}$, $\Delta\delta = +1{\cdot}2''$.

The planet Pluto, being photographically of $15\frac{1}{2}$[1] magnitude, about 6,300 times fainter than the faintest stars ordinarily visible to the naked eye, has only been observed hitherto, so far as I know, with telescopes having apertures considerably greater than mine. It appears, however, that the remotest great planet is accessible even to small instruments, provided that they are of excellent quality and that a fast modern plate is used.

Pluto is seen distinctly on the Cracow photographs, which show stars down to the seventeenth magnitude. It was promptly detected, by its proper motion between the stars, with a blink-comparator, recently constructed by the Polish National Astronomical Institute.

Full details on the above observations and the method of their reduction will be published shortly in the *Bulletin International de l'Acad. Polonaise d. Sciences.*

T. BANACHIEWICZ.

University Observatory,
Cracow.
Jan. 14.

[1] *Publ. Astron. Soc. Pac.*, **46**, 218 (1934).

Length of Gestation Period and Menstrual Cycle in the Chimpanzee

THIS note should have been written a year ago, but during the preceding two years I was working at the Anthropoid Experiment Station of Yale University, in Orange Park, Florida, U.S.A., in a rather isolated place without adequate library facilities, and therefore had no opportunity to read Dr. R. C. Clarke's notes on the birth of a chimpanzee[1], in which he states: "Although the preconceived idea is that the period of gestation [in the chimpanzee] is nine months I cannot help feeling that it is five months, at any rate all the evidence points to it in this case" (1, p. 732). Dr. Clarke does not give either the menstrual history of his female preceding the time (December 1, 1933) when she was "properly served" or the date of the infant's birth. On the basis of information given in the article by J. M. Wyatt and G. M. Vevers[2] and the time of acceptance of Dr. Clarke's publication one can surmise that the infant was born in the first half of May, 1934. The parents of the infant had lived together for a period prior to the first observation of proper mating, during which time there was a "certain amount of sexual play". Because of this fact there is a possibility that the date of conception assumed by Dr. Clarke is not correct. The female may have been fertilised during one of sexual play. The December swelling and acceptance of the male do not preclude this possibility, for there are records proving that chimpanzee females may have swellings of the sex skin and be receptive during the gestation period[4].

I agree with Dr. Clarke that the prevailing notion of the nine month gestation period for chimpanzees does not seem to be correct. A year ago I analysed data kept on record at the Yale Anthropoid Experiment Station and found that the average gestation period in the chimpanzee is no longer than $8\frac{1}{2}$ lunar months. The attention of Dr. R. M. Yerkes, the Director of the Station, and of Dr. S. Zuckerman was directed to the fact. Later, Dr. Zuckerman incorporated some of the data into one of his articles[3]. Still later, Dr. A. H. Schultz and F. F. Snyder brought together[4] most of the data published by different workers. Unfortunately, in their article there are slight errors. They use data for one animal twice, make a mistake of ten days in another case, and of two days in still another.

The lengths of gestation periods (menstrual ages in days) of the cases considered here are: 264, 263, 233, 242, 232, 278, 251, 256, 237, 264, 263. The average of these eleven cases is 253 days.

Out of the available data on menstrual cycles I selected 50 cycles of 7 females, discarding those that were displayed after abortions and lactating periods, and those of young females, just becoming sexually mature. On the basis of these selected fifty cycles a composite curve was built, which shows that on the average the length of the normal menstrual cycle is $35{\cdot}5$ days. Bleeding lasts for 3 days, the sex skin being at rest. Enlargement of the sex skin begins on the 10th day of the cycle, reaches its maximum on the 17th day and persists until the 28th day, when it begins to decrease. The swelling decreases more rapidly than it is formed and by the 33rd day the sex skin is at rest. The day of the onset of menstruation is counted as the first day.

It is usually considered that ovulation in women takes place in the middle of the menstrual cycle around the fourteenth day. Hartman[5] (Fig. 6) find

that in the rhesus macaque ovulation takes place a day or two before the middle of the cycle. By analogy we may assume that in the chimpanzee, which occupies an intermediate place between man and the rhesus macaque, ovulation should be in about the middle, or slightly prior to the middle, of the cycle. The average cycle is 35·5 days, the 18th day is the middle. It seems to be justifiable to place ovulation at the 16th, or the latest, 17th day.

Therefore to obtain the average length of gestation period we should subtract from menstrual age not more than 17 days, because viability of an ovum might not be longer than 24 hours[6]. As a result we have 236 days (253 − 17), that is, that the average gestation period in the chimpanzee, as calculated on the basis of eleven cases considered here, is 8 lunar months and 12 days.

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[1] R. C. Clarke, *Proc. Zool. Soc. London*, part 4, pp. 731–732 (1934).
[2] J. M. Wyatt and G. M. Vevers, *Proc. Zool. Soc. London*, part 1, pp. 195–197 (1935).
[3] S. Zuckerman, *Amer. J. Physiol.*, **110**, 597–601 (1935).
[4] A. H. Schultz and F. F. Snyder, *Bull. Johns Hopkins Hospital*, **57**, 193–205 (1935).
[5] C. G. Hartman, Carnegie Instit. Wash. Pub. 433. Contrib. to Embryol., **23**, 134, 1–161 (1932).
[6] C. G. Hartman, "Sex and Internal Secretions" (ed. E. Allen). Williams and Wilkins Co., Baltimore; pp. 647–733 (1932).

Structure of the Nuclei in the Salivary Gland Cells of *Drosophila*

STUDIES of the structure of the nuclei in the salivary glands of various species of *Drosophila* (*hydei*, *repleta*, *funebris*, *lugubrina*, *virilis*) have shown no essential differences of structure among these species. Their structure may strictly speaking be illustrated by one diagram, which can be applied to any one of the species, allowing for slight corresponding alterations.

The bands or discs of the chromosomes are formed by the union of homologous chromomeres and are ring-shaped. In the majority of cases there are 16 chromomeres in a ring, that is, 8 in each of the partners. Such chromosomes may be regarded as octoploid, though tetraploid with half the number of chromomeres are also observed. The chromomeres are connected by the 'genonemes' that pass obliquely through the chromosome. This arrangement is caused by the intertwisting of both homologous chromosomes. The inert parts of the chromosomes are represented in the salivary glands by proximal granular areas of precise dimensions. In those species where the majority of the chromosomes possess inert regions, they may come into contact, and though giving the impression of a common granular mass, they do not lose their individuality. The granules of the inert parts or chromomeres are not scattered in disorder but form rows of rings and are connected with the genonemes in the same way as those in the chromosomes' active parts. The amount of heterochromatin in the salivary glands does not evidently increase; it is dispersed among the rows of chromomeres and has no effect on the size of this region.

The inert parts of the chromosomes in the salivary glands do not therefore correspond to the size of this part at prophase but to the number of genes in this region. Should genes be absent, this region in the salivary glands would not be represented at all. The *Y*-chromosome is embodied by several rows of chromomeres which conjugate with corresponding rows of chromomeres of the *X*-chromosome.

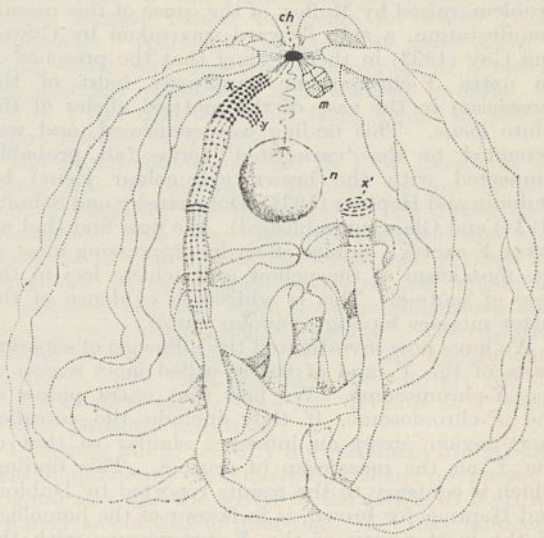

FIG. 1. Diagram of the nucleus in a salivary gland cell of *Drosophila*. *ch*, chromocentre; *n*, nucleolus; *m*, *m*-chromosome; *x*, inert part of the *X*-chromosome; *x'*, distal end of the *X*-chromosome; *y*, *y*-chromosome.

The proximal ends of all the chromosomes join by means of genonemes in the chromocentre. Should the genonemes in the preparation break, the proximal inert parts become deformed owing to the disjunction of the genonemes, and the normal arrangement of the chromomeres would thus be disturbed. The spiral thread connects the chromocentre with the middle of the nucleolus, branches out on its surface and so to say draws it up. The chromocentre and thread are stained according to Feulgen's method. I presume that the chromocentre is produced by the conjunction of the kinetic bodies of all the chromosomes, and the origin of both spiral thread and nucleolus is connected with the chromocentre, though the problem of the nature of the thread and material of the nucleolus remains still unsolved.

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Dec. 28, 1935.

Influence of the *Y*-Chromosome and of the Homologous Region of the *X* on Mosaicism in *Drosophila*

AN investigation of the manifestation of bristles and body colour in the mutation scute-8 of *Drosophila melanogaster* has shown that the characters dependent on the loci of yellow and achæte manifest themselves in a mosaic manner in this line (Noujdin, 1935). As the scute-8 chromosome contains an inversion with one of its points of breakage and reattachment close to these genes, which have thereby been brought into the neighbourhood of the bobbed locus (Serebrovsky and Kamshilov, public announcement, an unpublished MS. of 1930), it would seem that this mosaicism of scute-8 falls into the category of 'eversporting displacements', discovered by Muller (1930), that is, of chromosome rearrangements that entail a mosaic manifestation of genes located near the point of

rearrangement. Among such 'eversporting displacements' found by Muller are those producing the 'mottled' alleles of white and those producing the 'variegated' alleles of brown. In the attack on the problem, raised by Muller, of the cause of this mosaic manifestation, a step forward was taken by Gowen and Gay (1933) in their finding that the presence of an extra *Y*-chromosome suppresses most of the mosaicism in the case of the mottled alleles of the white locus. This finding was confirmed, and was extended to the 'variegated' series (all probably connected with the brown eye colour locus) by Dubinin and Heptner (1934), Dobzhansky and Schultz (1934) and Glass (unpublished). We now find that an extra *Y* exerts a similar effect in suppressing most of the mosaicism of the yellow and achæte loci in the case of scute-8. This is additional evidence of the latter mosaics having a similar cause.

We have now investigated the influence of separate parts of the *Y*, and of the so-called inert region of the *X*-chromosome. We find that extra pieces of the *X*-chromosome, if they include the so-called inert region, exert an influence similar to that of the *Y* on the mosaicism of scute-8. This finding, which is contrary to the results reported by Dubinin and Heptner for brown, is in favour of the homology of the inert region of the *X*-chromosome with the *Y*-chromosome, already proposed on other grounds (Muller and Painter, 1932). The similarity of the *Y*-chromosome and the inert region of the *X* in their action on mosaicism is moreover confirmed by the following facts. A previous investigation (Noujdin, 1935) has shown the scute-8 chromosome contains genes which decrease the frequency of mosaicism and that these genes act not only directly, but also maternally, that is, through the cytoplasm of the egg. This maternal transmission also holds in the case of the effect produced by the *Y*-chromosome (and its separate arms) and by the inert region of the *X*-chromosome. Further, our investigation of two other mosaic strains of *Drosophila* (yellow-3*P* inversion involving the yellow locus and the probable brown allele '*A*' of Dubinin and Heptner) shows that, though each of them is characterised by certain peculiar features, both are influenced in a similar manner by the *Y*-chromosome and (in the case of yellow-3*P* at least) by the inert region of the *X*, and in both strains this influence is not only direct, but also maternal. It is probable that the same would be found to apply to other 'eversporting displacements' such as those of the 'mottled' (white locus) series.

It is interesting to note that in both the *X*-chromosomes studied (scute-8 and yellow-3) and presumably also in the case of '*A*', one of the breaks occurred in the inert region. It has been remarked both by Offermann (1935) and by Muller (1935) that in all cases of 'eversporting displacements' so far known, one of the loci of breakage was in the inert region, and they believe that this probably depends on a peculiarity of the position effect of this region. Conversely, a study of 20 deleted *X*-chromosomes, where one of the breaks likewise occurred in the inert region, has shown that most of these are connected with mosaicism. Here also mosaicism is inhibited by the *Y*-chromosome (both directly and maternally).

These results support the view that most cases of mosaicism accompanying chromosome rearrangement fall into the same general category of phenomena—'eversporting displacements'. They also provide additional evidence that the problem of such mosaicism is connected with the general problems concerning the position effect and the nature of 'inert regions' of chromatin.

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Dec. 22, 1935.

Physiological Races of *Lucilia sericata*, Mg.

IN a recent communication[1] under this title, Mr. A. C. Evans states that "Ratcliffe[2] has recently suggested that there may possibly be two physiological races of *L. sericata*, as the length of the pupal period of this insect at 32° C. in Scotland is 5·4 days while in France at the same temperature it is 8 days". The latter figure was obtained by Ratcliffe (as he states) from an earlier publication of mine[3] where I was quoting Cousin[4]. Evans claims that my quotation is inaccurate and should be 4·9 days, but on further reference to Cousin's work[4], I find that it is perfectly correct.

Evans, from the references given in his communication, has misquoted me as referring to a later publication of Cousin[5], but a perusal of my paper[3] shows clearly that I was quoting from Cousin's earlier work[4]. Her later account[5] must have appeared while my work was in progress, and it is in this that she gives a figure of 116 hours for the pupal period of *L. sericata* at 33° C.

I wish, however, to agree with Evans in deprecating the "postulation of physiological races on this type of data", if, in fact, Ratcliffe's phrase "may possibly suggest" can be regarded as serious postulation. For, with only a single factor controlled, there is often a wide range in the duration of the different stages of development of *L. sericata*, and even with more than one factor controlled the range in duration is sometimes appreciable (Wardle[6]).

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Jan. 15.

[1] NATURE, **137**, 33 (Jan. 4, 1936).
[2] *Ann. Appl. Biol.*, **22**, 742 (1935).
[3] *Ann. Appl. Biol.*, **21**, 267 (1934).
[4] *C.R. Soc. Biol.*, **101**, 788 (1929).
[5] *Bull. Biol. France, Belg.*, Suppl. 15 (1932).
[6] *Ann. Appl. Biol.*, **17**, 554 1930).

Skatole as a Growth-Promoting Substance

INDOLE has been described as being inactive by Thimann and Koepfli[1], but skatole (β methyl indole) was apparently not tested. Pure skatole was obtained from B.D.H. and was twice recrystallised to remove possible impurities. Bending experiments were performed using oat coleoptiles (Argentine VI). Skatole was applied in gelatin blocks 1 mm.^{3}; the concentration used was 1×10^{-4} in water. Gelatin and water were used for controls. Permanent records of the experiments were made as shadow photographs.

Taking curvature away from the side on which the blocks were placed as positive, of a total of 70 coleoptile pairs used, those under the skatole blocks showed 662° positive curvature and 20°

negative curvature; the controls showing 179° positive and 115° negative curvature. Comparison experiments using synthetic β indole-acetic acid in a similar concentration, with 40 coleoptile pairs, gave 182° positive curvature and 14° negative curvature. Water controls gave 25° positive and 23° negative curvature.

These experiments suggest that skatole may act in the plant as a growth-promoting hormone. Both skatole and β indole-acetic acid were observed to be markedly light-sensitive.

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Jan. 17.

[1] NATURE, **135**, 101 (1935).

Reported Occurrence of European Fishes on the Tavoy Coast, Burma

IN a letter published in NATURE of January 25[1], Dr. Hora and Dr. Mukerji record the supposed occurrence of five European fishes on the Tavoy coast, Burma. The specimens were sent to me for examination, and I am able to confirm the identifications, but, as I have already pointed out in correspondence with Dr. Hora, I am of the opinion that the specimens did not come from the coast of Burma. The species in question are found in the North Atlantic, and some in the Mediterranean also, but none has ever been found in tropical seas. Without attempting to explain the manner in which the mistake has occurred, I can only reaffirm my conviction that the supposed occurrence of such fishes as *Cottus bubalis* and *Ammodytes lanceolatus* on the coast of Burma is so widely opposed to all the known facts of geographical distribution as scarcely to merit serious consideration.

J. R. NORMAN.

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British Museum (Natural History),
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[1] NATURE, **137**, 152 (1936).

Fossil Pollen in Scottish Tertiary Coals

THE application of Raistrick's method[1] of extracting microspores from Carboniferous coals to lignites of Tertiary age from Mull and Morvern, Argyllshire, has revealed that these inferior coals are rich in pollen in a good state of preservation.

The examination of the material is now in progress, and it is hoped to publish a detailed report shortly. In the meantime, it may be of interest to record that forms closely resembling the following modern types are present: *Ginkgo*, *Abies*, *Cedrus*, *Pinus* and *Podocarpus* of the gymnosperms, and *Alnus*, *Engelhardtia*, *Hamamelidaceæ* (several genera), *Magnolia*, *Planera* and *Smilax* of the angiosperms.

Spores of non-flowering plants do not seem to be present in great numbers or variety.

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Edinburgh.
Jan. 21.

[1] Raistrick, *Trans. Inst. Min. Eng.*, **88**, 142 (1934).

Recent Research on Cancer

IN the correspondence columns in NATURE of January 18, Prof. Passey criticises a statement in the editorial of the twelfth annual report of the British Empire Cancer Campaign for which I am responsible. Although the point at issue must, I think, strike any impartial observer as of a rather hair-splitting character, and scarcely worthy of notice, I feel that the exact facts should be placed before readers of NATURE.

The actual statement made by Prof. Passey in his report was as follows: "We feel we are on safe ground when we say that given a full mixed diet, infestation with the parasite *Gongylonema neoplasticum* induces no changes other than perhaps an occasional trivial hyperkeratosis of the squamous epithelium—certainly there is no papillomatosis and nothing resembling malignant disease". The editorial statement was as follows: ". . . the experiments appear to show that, provided the rats are fed on a correct diet, cancer does not develop as a result of this parasitic infection".

I entirely fail to see why my statement in the editorial should be any more misleading than Prof. Passey's original one, and the writer of the article in NATURE is surely as entitled to infer that "diet may influence the occurrence of malignant disease" from Prof. Passey's original statement as from my editorial.

While I shall always welcome any legitimate criticism, I feel that in the present instance if there was any ambiguous statement which lent itself to a false inference, it was in Prof. Passey's original report and not in my editorial.

J. P. LOCKHART-MUMMERY.
(Hon. Secretary and Editor, Annual Report, British Empire Cancer Campaign.)

THE paragraph which Mr. Lockhart-Mummery quotes from his own editorial is practically a paraphrase of the words used by Prof. Passey in his report, and as such does not appear open to criticism. But the paragraph in question deals with the negative side only of the matter, and hence might give a misleading impression to the reader. Prof. Passey's experiments upon the combined effect of deficient diet, and the presence of the parasite, have given negative results, but the original positive results of Fibiger cannot be disregarded until adequate reasons are given for their rejection.

THE WRITER OF THE ARTICLE IN "NATURE".

Oscillations in Magnetrons

IN the course of an investigation of the production of oscillations by magnetrons, I have had occasion to determine the impedance of these valves at high frequencies. The valve used in the experiments was of the split-anode type, and the impedance between the two anode segments was resolved into that of an effective capacitance in parallel with a resistance.

The variation with magnetic field intensity of the capacitance component obtained at wave-lengths of 20, 30 and 40 metres is given by the three curves in Fig. 1. Over the dotted portions of each curve oscillations were produced at the wave-length used in determining the curve. It will be seen that in the neighbourhood of oscillation the valve capacitance underwent considerable change, which was of such magnitude that in the region of minimum valve

capacitance the valve impedance was actually inductive. The reversal in sign of the valve reactance occurs decreases with increase in the magnetic field intensity.

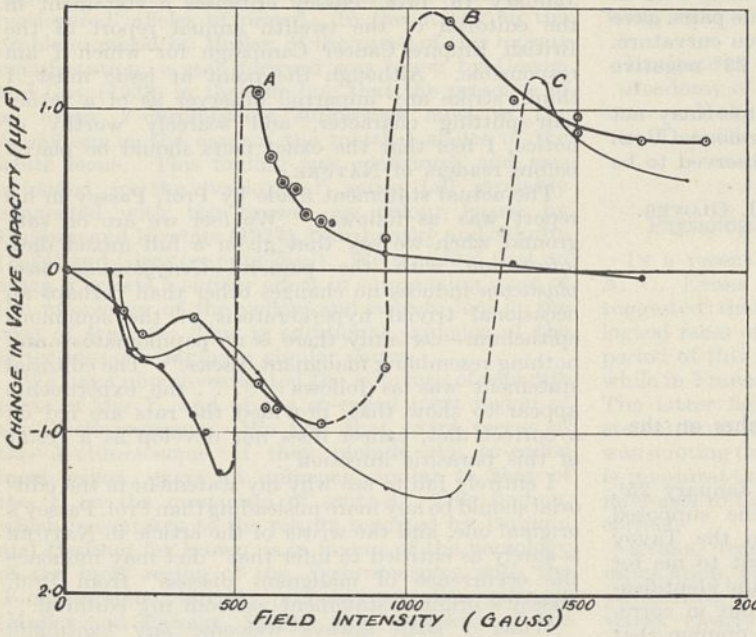

FIG. 1. Relation between capacity of magnetron and magnetic field at wave-lengths (*A*) 20 m., (*B*) 30 m., (*C*) 40 m.

in the oscillating condition indicates some sort of resonance within the valve, and the disposition of

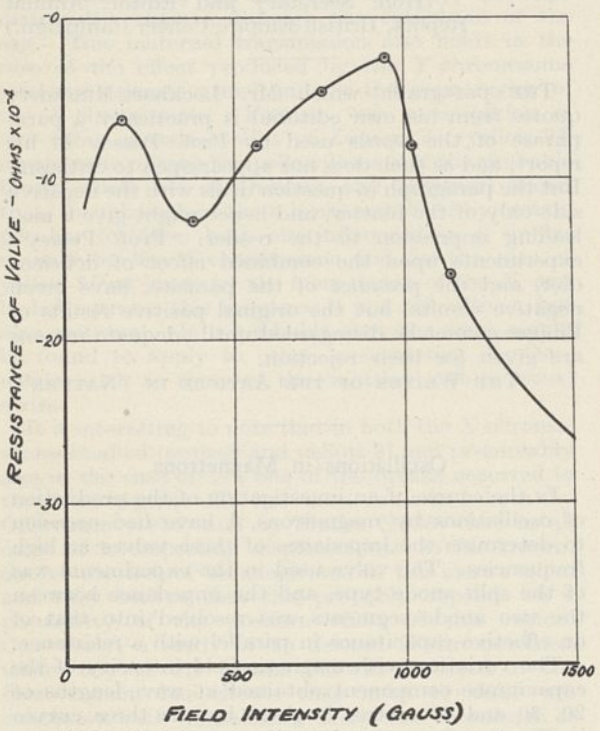

FIG. 2. Variation of resistance between segments of magnetron with magnetic field intensity at a wave-length of 30 m.

the oscillating regions in the curves in Fig. 1 shows that, for a given anode potential (120 volts in the present case), the frequency at which this resonance

The variation in the resistance component of the intersegment impedance is given in Fig. 2. The curve in this figure was obtained at a wave-length of 30 metres, but is similar in form to those found at 20 and 40 metres. The resistance is negative over a wide range of magnetic field intensities, but has two conditions for minimum value, and oscillations were limited to regions near these two minimum resistance conditions. One position of minimum negative resistance occurred for each wave-length near the 'critical' field at which the anode current varies rapidly with change in magnetic field, and the other near the condition of valve resonance as indicated by the curves in Fig. 1. There appears to be no 'resonance' condition near the 'critical' field, the small irregularities in the curves for valve capacitance in this region being explicable on the variation in value resistance alone.

The results obtained in the above experiments show that a low value of negative resistance is produced in magnetrons near the 'critical' value of magnetic field. At higher fields a second condition of low negative resistance is reached, but only at a frequency which is a function of the magnitude of the magnetic field. I have had the privilege of seeing a copy of a paper, not yet published, by E. W. B. Gill and K. C. Britton, in which they have been led to similar results, but they have not determined the impedance variation of the magnetron responsible for the apparently two distinct types of oscillation.

The work described above was carried out as part of the programme of the Radio Research Board, and is published by permission of the Department of Scientific and Industrial Research.

J. S. MCPETRIE.

National Physical Laboratory,
Teddington.
Jan. 4.

Physical Chemistry of Zein

ZEIN has been generally considered to be a simple homogeneous protein. By precipitations which followed the addition of successive amounts of pure water to zein solutions, the solvent for which was originally 70 per cent (weight) in ethyl alcohol, it was found that the purified protein could be divided into three distinct and nearly homogeneous fractions, the larger zein molecules having lower solubilities than smaller ones. There has been no evidence of irreversible changes in the state of aggregation of these fractions. The purified whole zein and the fractions have been characterised by their sedimentation constants, diffusion constants, electrophoretic mobilities and dielectric constants.

Sedimentation velocity and diffusion studies with purified zein in 60 per cent alcohol, to which had been added sufficient electrolyte to repress the Donnan

effect, gave definite indications of an inhomogeneity with respect to molecular size. Similar experiments with zein fractions gave sedimentation constants (corrected to the basis of sedimentation in pure water at 20° C.) which varied between 1·5 and $3·5 \times 10^{-13}$ cm./sec., with corresponding diffusion constants between 5·2 and $2·6 \times 10^{-7}$ cm.²/sec., depending upon the fraction used. The constituent which is present in greatest concentration and forms about sixty per cent of the normal zein has a sedimentation constant of $1·9 \times 10^{-13}$ cm./sec., diffusion constant $4·0 \times 10^{7}$ cm.²/sec., and therefore molecular weight in the neighbourhood of 35,000. The molecular weight of the light constituent is approximately one half this value.

Sedimentation velocity studies were also made with zein and zein fractions dissolved in 50 per cent aqueous urea solution to which electrolyte has been added, with results in agreement with those found in the alcoholic solutions. The particles behave as if they were rod-like in character.

Four series of measurements were made of the electrophoresis of zein. In each case the solute was a fractionated product and the solvent was an acetate or phosphate buffer made up in 60 per cent alcohol solution. In the case of three of the fractions, some non-uniformity of migration was clearly visible, indicating that our choice of the limits of alcohol concentration for the fractionation might have been improved upon. In the fourth instance, the fraction corresponded quite closely to the light constituent and the migration was more uniform. With the use of the mobility data the isoelectric point of zein was found to range between *p*H 5 and 6. The isoelectric point of the main constituent is *p*H $5·6 \pm 0·1$, that of the lighter fraction 0·3 *p*H unit higher. The critical precipitation limit for unfractionated zein was found to be in the neighbourhood of *p*H 5·4.

The results of our dielectric constant experiments, performed at about 20° C., are of interest in connexion with the homogeneity and size of the dissolved units. Measurements were made with dilute solutions of four different preparations of dialysed zein in aqueous ethyl alcohol at a number of wave-lengths between 25 metres and 1,000 metres. For the most part, the data are consistent with interpolated figures from earlier observations made over a smaller wave-length range[1]. These data pertain to *n*-propyl alcohol solutions of higher zein concentration. The dielectric constant – frequency curves again characterise the unfractionated zein as polydisperse in character.

Calculated as an *average*, the data require a time of relaxation, $\tau = 3·5 \times 10^{-8}$ sec. This is a figure corrected to the basis of an orientation in pure water and it was obtained by a method which differs from that used by Wyman in that only the viscosities of solvents are involved. By making use of the formula which permits the calculation of the molecular weight of a spherical particle from the values of the time constant[2], there is obtained the approximate result 40,000. This molecular weight corresponds quite closely to the weight one would calculate by combining weighted average values of the sedimentation and diffusion constant given above. This agreement may be accounted for, at least in part, if it may be assumed that the motion of the zein in the electrical field is a rotation around the long, rather than about the short axis[3].

We wish to express our indebtedness to Prof. The Svedberg and to his associates for their co-operation, their interest, and their assistance with the work. The diffusion constant observations were made by Mr. A. G. Polson.

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[1] Wyman, *J. Biol. Chem.*, **90**, 443 (1931).
[2] Williams, *Trans. Farad. Soc.*, **30**, 723 (1934).
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Determination of Surface Tension by the Drop-Weight Method

WHEN surface tension is determined by the drop-weight method, the drops must be allowed to fall as nearly as possible under the influence of gravity alone. In practice, the time of formation of a drop should be not less than five minutes[1].

The essential part of the apparatus is a vessel (containing the liquid under investigation) which terminates in a capillary tube with a carefully ground and accurately calibrated tip. If the height of liquid in the vessel is considerable, the drops tend to form too rapidly for accuracy. If the height is small, the time of formation in the case of a viscous liquid may be so great as to render the experiment very tedious. A device which would enable the operator to force the drop out quickly until it was almost fully formed, and would then permit the formation to complete itself and the drop to fall under very small pressure, would obviously be a convenience. Several such devices, most of them elaborate, have been proposed, and the object of this letter is to suggest one which has the merit of extreme simplicity.

In a paper by E. L. Harrington[2], we find a description of the 'rotette', "an apparatus for handling small quantities of liquids with rapidity and precision". In the 'rotette', a spiral glass tube (such as is used in a spiral condenser), containing a small amount of mercury, is mounted horizontally and attached by a flexible connexion to a pipette. When the spiral is rotated, the movement of the mercury causes an increase or reduction of pressure in the pipette.

For application to surface tension measurements, the spiral tube with its mercury bead should be attached to a *T*-tube, a second arm of which is connected to a manometer, and the third to the stalagmometer. If the liquid under examination is viscous, a known pressure can be applied by rotating the spiral, and the drop will form rapidly. When drop formation is almost complete, the spiral is rotated in the opposite direction, until the reduction in pressure is sufficient to counterbalance almost exactly the pressure of the liquid in the stalagmometer. The final fall of the drop will then be under the influence of gravity alone. If the liquid has a low viscosity, the pressure may be reduced from the start to secure a reasonable time of drop formation.

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Dec. 31, 1935.

[1] Harkins and Brown, *J. Amer. Chem. Soc.*, **41**, 509 (1919).
[2] *Science*, **77**, 21 (1933).

Points from Foregoing Letters

DR. H. T. FLINT points out that his principle, according to which intervals of proper times less than a certain value (h/m_0c^2) have no physical significance, rules out the possibility of an electron moving with a high velocity in a strong field of force. If accepted, this principle would eliminate the probability of existence of negative states of energy, deduced by Bohr from the quantum theory.

Dr. C. Møller, on the other hand, accepts the probability of transition from a negative to a positive state of energy. In this process, it appears, a neutron can be transformed into a proton by simultaneous creation of two electrons, a positron and a neutrino. Møller calculates the ratio of positrons accompanying electrons in radioactive transformations and finds that the order of magnitude agrees with that observed by Alichanow, Alichanian and Kosodaew.

Prof. A. I. Alichanow, A. I. Alichanian and B. S. Dželepow now report the emission of electrons of low energy by radium E. They submit curves showing that the energy distribution in the case of electrons from radioactive elements of high atomic number (such as radium E) differs from that of the positrons from radiophosphorus, RaP^{30}, which is of lower atomic number.

Commenting upon a recent note dealing with a suggested improvement in the conductivity method for the determination of heavy hydrogen, Drs. A. and L. Farkas and Prof. E. K. Rideal state that the original method gives the desired accuracy.

From the anomalous scattering of X-rays (copper $K\alpha$ wave-length) by cadmium, zinc and other metals, Dr. G. W. Brindley deduces a greater lattice vibration along the c-axis of the metallic crystals than normal to the c-axis. This agrees with the recent theoretical considerations of Zener and with the work of Grüneisen and Goens on the thermal expansion of zinc and cadmium.

The crystal structure of vanadium pentoxide has been investigated by means of X-ray analysis by Dr. J. A. A. Ketelaar. The existence of chains of oxygen tetrahedrons revealed in this structure may explain the tendency of V_2O_5 to form rod-like or rather lathe-like particles in colloidal solutions.

R. J. Moon and Prof. W. D. Harkins propose to reduce the space charge for a given high-frequency potential on the duants (semi-circular electrodes) of a cyclotron (voltage multiplier) by further dividing the electrode into triants. Ions are then accelerated three times per revolution instead of twice, with reduced retarding potentials, leading to higher velocities and intensities, and an advantageous forward resonance which is not critical.

Using a new method for measuring the magnetic properties of gases, J. Shur and S. Sidorov find that, contrary to the results obtained by Vaidyanathan, the susceptibility of carbon disulphide has the same value in the vapour as in the liquid state.

From the known values of the velocity of light (c), the mass of the hydrogen nucleus (H^1) and the Faraday constant (F) (the amount of electricity required to deposit, from a solution, one gram-molecule of a uni-valent substance) and assuming the correctness of Eddington's theory, Dr. W. N. Bond derives a value of the Universal Gravitational Constant.

According to the kind of light they emit, stars have been classified into seven types, A to G. J. A. Hynek finds that those stars which rotate rapidly on their axes (as indicated by the uniform widening of their spectrum lines) are mostly about twice the size of the sun, and none of them belongs to type G. It appears that many stars lose their speed of radial rotation as they evolve from the F to the G type; it is possible that this occurs suddenly, owing to fission, but alternative hypotheses are available.

A critical survey of available information leads M. I. Tomilin to the conclusion that the average menstrual cycle of the chimpanzee is 35·5 days and the average period of gestation 236 days.

A detailed structure of the chromosomes in the nuclei of cells of the salivary glands of various species of fruit flies (*Drosophila*) is diagrammatically illustrated by S. L. Frolova, who among other characteristics describes ring-shaped bands or disks of chromomeres connected by 'genonemes' that pass obliquely through the chromosome.

N. Noujdin finds that the inert region of the X-chromosome (characteristic of the female-producing reproductive cell) has the same influence upon certain characters (mosaicism of scute-8) of the fruit fly, *Drosophila melanogaster*, as the Y-chromosome of the male producing reproductive cell. This indicates that the inert region of the X-chromosome is homologous with the Y-chromosome.

Young growing shoots of oats bend away from a gelatin block containing a small amount of skatole (a constituent of fæces), due to increased growth on the side in contact with the skatole solution. This, according to J. Glover, suggests that skatole may act in the plant as a growth-promoting substance.

J. R. Norman states that although he has identified the specimens of European fishes (including *Cottus bubalis* and *Ammodytes lanceolatus*), reported to have been caught off the coast of Burma, such an occurrence would be so widely opposed to all facts of geographic distribution that in his opinion the specimens must have originated elsewhere.

Zein has been considered to be a simple homogeneous protein. It is shown by C. C. Watson, Sven Arrhenius and Prof. J. W. Williams that the purified substance can be divided into three nearly homogeneous fractions by successive precipitations as water is added to its alcoholic solutions. The zein fractions have been characterised by their sedimentation constants, diffusion constants, electrophoretic mobilities and dielectric constants.

High-frequency impedance measurements on split-anode magnetrons are described by Dr. J. S. McPetrie. With variation in magnetic field there is change in the sign of reactance as the condition of oscillation is passed through. Below this condition, the capacity is negative, but changes to positive above. The resistance is negative, but at two regions of minimum negative resistance oscillation occurs.

Research Items

South American Arrow Poisons

A FURTHER contribution to a controversy on the nature of South American arrow poisons is made by Dr. Henry Wassén of the Ethnographical Section, Gothenburg Museum, in the course of an ethnographical study of the southern groups of Choco Indians of Colombia, whom he visited in the latter half of 1934 (*Ethnologiska Studier*, Gothenburg Museum, 1935). The controversy originated in the identification, by Prof. C. G. Santesson of Stockholm, of the active principle in samples of arrow poisons used by the Choco Indians submitted to him by the late Baron Erland Nordenskiöld, to which he gave the name *pakurine*, and in the recognition that it had a specific cardiac effect. It was thus the first arrow poison having a cardiac effect to be reported from the New World. Prof. Rafael Karsten of Helsingfors, however, denied that Prof. Santesson had made out his case, and maintained on the evidence of his experience among the Indians of Ecuador that the poison of the Choco was identical in character and effect with other South American 'curare' arrow poisons, of which the active principle is curarine. Dr. Wassén has not only obtained further samples of the Choco poison, which confirm Prof. Santesson in his previous analysis, but he has also obtained evidence, which eluded Nordenskiöld, showing that the *kiérátchi* —or *pakurú*—tree is probably to be referred to the species *Perebea*, sub-species *Naucleopsis*, or possibly *Ogeodeia*, of the family Moraceæ. Prof. Santesson, in an account of his investigation, has pointed out that, whereas curarine is an alkaloid, causing paralysis by acting on the ends of the motor nerves, purarine is a glycoside, like the active element in the poisons having a cardiac effect in the digitalin group. The animal poison obtained from the *kokói* frog (now identified from two specimens as *Dendrobates tinctorius*, Schneid.) produced in a frog paralysis of the muscles, and probably of the central nervous system, and finally of the heart with contraction of the ventricle. A very small dose causes death in white mice and rabbits by paralysing the centre of the respiratory system.

Crossing-Over in Male *Drosophila*

IN recent years, exceptional crossing-over has been found by several observers in male *Drosophila*, with and without special treatment. A great deal depends on what relationship this crossing-over has with the normal process found only in the female. In order to determine the time of its occurrence, it is necessary to induce crossing-over to occur with a higher frequency than in the normal male. Prof. H. Friesen, of the Institute of Experimental Biology, Moscow (according to a communication received by NATURE), has done this by X-ray treatment of mature males heterozygous for eight genes in the third chromosome. These males were mated with recessive females at intervals of three or four days. No crossing-over was found in the batches of progeny begotten in the first seven days, but after this time an increasing proportion of cross-over progeny appeared. What was remarkable about these cross-overs was that identical cross-overs occurred in large groups; in an extreme case, 22 were of one cross-over type, due to crossing-over in a segment six units long, and all the rest (161) were non-cross-overs. Such a result would be produced if crossing-over had occurred several cell-generations before spermatogenesis. The induced crossing-over therefore occurs in the male at a different time from the natural crossing-over in the female, and an important distinction can be made between the two processes.

A Beneficial Weaver Bird

THE farmer's estimate of the damage caused to his crops by birds is nearly always too high, and insufficient attention is paid to their beneficial effects, such as the destruction of harmful insects and weed seeds. A notable instance is reported from the Philippine Islands by Canuto G. Manuel (*Phil. J. Sci.*, 58, No. 2, pp. 193–212, Oct. 1935). It is shown that a weaver bird, *Munia cabanisi*, which stood incriminated as a menace to the rice crop, usually had about four per cent of rice in its menu, the remaining ninety-six per cent being weed seeds. These figures are based upon the examination of the stomachs of eight hundred adult birds; moreover, damage to the rice fields is restricted to the visitations of flocks of the weavers when the crop is in 'head'. Scaring the birds from the crop at this time would seem to be a relatively simple process, and the cost of it could be balanced against the destruction of weed seeds throughout the rest of the year. The paper under review contains also a full and painstaking account of the habits and life-history of this particular bird.

Anatomy of *Calanus*

THE recent memoir by Miss Esther Lowe ("On the Anatomy of a Marine Copepod *Calanus finmarchicus* (Gunnerus)", *Trans. Roy. Soc. Edin.*, 58, Pt. 3, No. 23, 1935–1936) is a valuable addition to the many works on *Calanus finmarchicus*, which, economically so important, has been the subject of more researches than any other copepod, but the minute anatomy of which up to the present time was little known. This paper fills the gap in a very efficient manner, and it is moreover the first complete description of the general internal anatomy of any free-living copepod, with the exception of Hartog's work on *Cyclops brevicornis*. Endoskeleton, musculature, alimentary canal, hydrostatic organ and excretory system, circulatory, nervous and genital system are all described, and the whole is illustrated with beautifully clear figures. In view of recent researches on the movements of *Calanus*, the giant fibres of the nervous system are of special importance. A pair of longitudinal giant fibres extends along the whole length of the nerve cord, giving off branches which supply, alternately, the dorsal longitudinal muscles of the thorax (to which they constitute the only nerve supply) and the flexor muscles of the swimming feet, by means of which the rapid darting movement of the animal is accomplished. Anteriorly the two main fibres form a chiasma in the brain, and are

associated in the antennulary motor nucleus with the internal endings of a bundle of giant fibres from the motor root of the antennulary nerve. The distribution of the giant fibre system is examined in detail in relation to the muscular movements of the animal, and the evidence points to the conclusion that the system constitutes the effector portion of a reflex system governing the escape movement. The gut is without glandular diverticula, but a pair of diverticula corresponding in position to those of the *Cladocera* is present in a rudimentary condition. The author is certainly to be congratulated very heartily on tackling so successfully an arduous piece of work requiring both nicety of technique and accurate observation.

Nematode Worms of the North Sea

A VOLUME upon the free and parasitic nematodes, by J. H. Schuurmans Stekhoven, Jr., is the latest addition to that valuable series "Die Tierwelt der Nord- und Ostsee" (Leipzig : Akademische Verlagsgesellschaft m.b.H., 1935. 20 gold marks). Following the plan of earlier volumes this contains keys for the identification of species, and descriptions aided by numerous illustrations (277 text-figures), along with a summary of the recorded distribution.

Duration of Life and Respiratory Phenomena in Plants

THE relation of metabolic drifts to longevity in plants has been approached by Dr. B. N. Singh from the respiratory point of view in a recent paper (*Proc. Indian Acad. Sci.*, 2, No. 4, 387–403). His experiments have been confined entirely to the meristematic tissues, that is, that part of the plant entirely free from non-living tissues, so that the respiratory value represents the activity of all the cells in a given amount of tissue. In a group of annuals, of which the life-cycles varied from three months to more than six months, it was found that the respiratory index at successive stages of growth showed a steady and fairly rapid decline for short-lived plants, but remained almost constant in the case of plants with longer life-cycles. The initial rate of respiration in the meristematic cells, and their average respiratory rate over the whole life-cycle, are higher in the cases of the longer-lived plants, so that longevity appears to be connected in general with a higher rate of respiration. In conclusion, it is pointed out that a species will show approximately the same initial rate of respiration when F_1 and F_2 generations of the same strain are grown in successive years, and from this it is concluded that a plant may exhibit a potentiality for a certain rate of metabolism, just as it does for certain morphological characteristics.

Population Map of Greater London

THE Ordnance Survey has published, at the price of 1*s.* 6*d.*, a map showing the density of population of greater London and surrounding areas on a scale of half an inch to a mile. The sheet extends north and south from Bletchley and Saffron Walden to Haslemere and Horsham, and east and west from Chelmsford and Rochester to Aylesbury and Farnham. Railways, main roads, rivers and county boundaries are marked. Names are chiefly confined to the boroughs, chief open spaces, towns, villages and rivers. Population density is shown by eleven varying tints of brown. The scale gives density per acre, square mile and square kilometre. Open public spaces are shown in green ; other areas without resident population in white. Centres of maximum and minimum density are marked by symbols and approximate values. The map is marked with co-ordinate lines 10,000 yards apart numbered with reference to the new grid system, thus enabling precise location to be indicated easily. Accompanying this large sheet is a smaller one (price 9*d.*) giving five profiles across London and adjoining areas. In these the horizontal scale is a quarter inch to a mile and the vertical scale is exaggerated ten times. Relief is in grey : density of population in light red. Places are marked each with its co-ordinate grid position and density per acre. The datum line of all density values is the profile of the topography.

Seismograms of Californian Earthquakes

ON March 11, 1933, Los Angeles was damaged by an earthquake of intensity 10 (international scale), the vibrations of which gave rise to a very slight record at Strasbourg. M. C. Bois was thus led to examine the records of other Californian earthquakes (*Publ. Union Géod. Géoph. Intern.*, ser. A, fasc. 13, 147–166 ; 1935). The records obtained at Strasbourg between 1924 and 1933 show that eight earthquakes of intensities 8 and 9 occurred in California without giving rise to seismograms that could be analysed. Good records were, however, provided by earthquakes of intensity 10 of continental origin and also by submarine earthquakes that were felt feebly or not at all on land. M. Bois thus concludes that the relations between the intensity of an earthquake in its epicentral region and the amplitudes of the different phases recorded at a distant station depend essentially on the geographical position of the epicentre.

'End Corrections'

THE correction to be added to the length of a conducting wire which ends in a large mass of conducting material, or to the end of an organ pipe which is provided with a flange, was estimated by the late Lord Rayleigh forty years ago as 0·824 times the radius of the wire or pipe. A recalculation on the same lines by Dr. P. J. Daniell in 1915 gave the coefficient between 0·8214 and 0·8217. In the January issue of the *Philosophical Magazine*, Prof. L. V. King gives the result of a more general investigation using inversion theorems of Bessel functions. The series involved converge slowly, and give values of the coefficient which ultimately are 0·8211, 0·82125, 0·82132, and Prof. King concludes they tend towards a value within the limits found by Dr. Daniell.

Heat Radiation

HEAT radiation from the clear atmosphere at night forms the subject of a paper by P. K. Raman, research scholar at the Meteorological Office, Poona (*Proc. Ind. Acad. Sci.*, 1, No. 2, May 1935). The purpose of the investigation was to compare two formulæ in the light of all available data, namely, that of Brunt (*Q. J. Roy. Met. Soc.*, Oct. 1932) and that due to A. Angstrom (*Smiths. Miscell. Coll.*, 65, No. 3 ; 1915), which are as follows : (1) Brunt's formula :

$$S = \sigma T^4 (a + b\sqrt{e}),$$

where S = downward radiation on 1 sq. cm. from the atmosphere, T = temperature (absolute) at place of observation, e = aqueous vapour at place of

observation, σT^4 = black body radiation at temperature T, a and b are constants. (2) Angstrom's formula :

$$\frac{S}{\sigma T^4} = A - B \times 10^{\gamma e},$$

where A, B and γ are constants and the other quantities have the same significance as in equation (1). Brunt's formula is tested on longer series of individual observations than those previously used ; the correlation coefficients between $S/\sigma T^4$ and $\sqrt{e}$ from individual daily values were in some instances very small, but those for the grouped means and monthly mean values were satisfactorily large. Angstrom's formula was similarly found to hold good in a general way, but did not always give a satisfactory fit within individual series of observations. It is maintained that, within the usual range of variation of e, Brunt's equation is essentially a variation of Angstrom's, but the author's preference is for Angstrom's formula because the physical ideas underlying it are held to be clearer. Interpreting the constant a in Brunt's formula, or $A - B$ in Angstrom's, as the fraction of black-body radiation at the temperature of the place of observation that is emitted by a small quantity of water-vapour, investigation was made into the minimum value of the atmospheric radiation by considering those cases where the air was very dry. The lowest value found for a on the earth's surface was 0·49 at a height of 3,500 ft. above sea-level, but some of Angstrom's observations taken from balloons gave a figure so low as 0·38.

Coefficients of Expansions of Salts

SILVER iodide has been reported to have a negative coefficient of cubical expansion, but the results obtained by Fizeau (1867) and Rodwell (1875) were very discordant, although both agreed as to the negative sign. Since this property is almost unique, it was desirable to have it confirmed by new experimental methods. Grinnell Jones and F. C. Jelen (*J. Amer. Chem. Soc.*, 57, 2532 ; 1935) have employed a dilatometric method in which the glass dilatometer is first weighed and then filled with mercury, and the exact temperature needed to bring the mercury meniscus to a reference mark in a capillary tube is determined. Then a weighed drop of mercury is added and a new lower temperature is determined which again brings the mercury to the mark, and so on. Then a large part of the mercury is replaced by a known weight of some other solid or liquid and the process repeated. A small quantity of a wetting liquid (toluene) is added to bring about contact between solid and liquid. In this way the coefficients of cubical expansion of silver iodide and some other salts were determined. The negative value for silver iodide was confirmed between 20° and 60°, the coefficient being $-1{\cdot}6 \times 10^{-6}$, which is nearer Fizeau's result ($-4{\cdot}1$ to $-2{\cdot}7 \times 10^{-6}$) than Rodwell's ($-55{\cdot}7 \times 10^{-6}$).

Structure of Ice

THE arrangement of oxygen atoms in ice is known from X-ray measurements to be a very open one, like that of the silicon atoms in high-tridymite. Each oxygen atom in ice is tetrahedrally surrounded by four others at a distance of 2·76 A. It has been assumed that it is bonded to these atoms by hydrogen bonds, the number of hydrogen atoms being just that required to place one hydrogen atom between each pair of oxygen atoms. It is 0·95 A. from one oxygen and 1·81 A. from the other. Pauling (*J. Amer. Chem. Soc.*, 57, 2680 ; 1935) has suggested that ice may be considered to consist of water molecules arranged so that each is surrounded by four others, each molecule being orientated in such a way as to direct its two hydrogen atoms towards two of the four neighbours, forming hydrogen bonds. The orientations are further restricted by the requirement that only one hydrogen atom shall lie near each O—O axis. This agrees with the residual entropy of ice. The assumption allows a large number of configurations of an ice crystal, each corresponding to certain orientations of the water molecules, and the crystal can change from one configuration to another by rotation of some of the molecules or by the motion of some of the hydrogen nuclei. The fact that at temperatures above 200° abs. the dielectric constant of ice is of the order of magnitude of that of water shows that the orientation of the molecules can occur with considerable freedom. It is pointed out that a finite residual entropy calculated from low-temperature measurements and extrapolation to absolute zero may arise from failure to obtain thermodynamic equilibrium ; measurements made under ideal conditions and extended to sufficiently low temperatures would presumably lead to zero entropy for any system.

α-Naphthoflavone as an Indicator

THE bromine liberated during the titration of bromates has been found by Dr. R. Uzel (*Coll. Czech. Chem. Comm.*, 7, 381 (1935)) to react with α-naphthoflavone so delicately that this substance can be used as an indicator in the volumetric estimation of bromates. An orange-red colour is produced by so little as one part of bromine in a million parts of the solution, and sensitivity is found to increase with the acidity of the medium. The indicator is prepared as a 0·1 per cent solution of α-naphthoflavone in alcohol or acetic acid. Up to 1 c.c. of this solution is added for each 50–100 c.c. of solution to be titrated. The author has extended its use to the volumetric estimation of arsenic, antimony, tin, hydrazine, aniline and acetanilide.

Luminosity Effects in Stellar Spectra of Type *F*

A QUANTITATIVE study of the lines used for determining spectroscopic parallaxes in *F*-type stars has been made by J. A. Hynek (*Astrophys. J.*, 82, 338). Total absorptions of a selected group of lines in 56 stars were measured with Moll-type microphotometers on plates taken at the Yerkes and Perkins Observatories, these measures being used to calibrate estimated intensities for an additional 54 stars. The behaviour of lines used as luminosity criteria is discussed for each *F* sub-class, and some interesting results are also found for lines of Ca I and Fe I. These lines behave in a peculiar way in types *F*8 and *G*0, since they decrease with increasing luminosity in dwarfs, but increase in giants, the maximum intensity being identical for $M = +4{\cdot}5$ and $M = -3{\cdot}5$. The sharpness of lines is also discussed through the parameter width/depth, and the scarcity of rapidly rotating stars between types *F*0 and *F*5 is confirmed. The diffuse-line stars are shown to be confined to a much smaller range of absolute magnitudes than the sharp-line stars, while a discussion of intensity changes (especially of the lines [K] and Hδ) with spectral type confirms the consistency of the *H.D.* classification for both sharp and diffuse line stars.

Twenty-third Session of the Indian Science Congress

THE twenty-third session of the Indian Science Congress was held at Indore, Central India, on January 2–8, 1936. More than 350 delegates from all over India met together under the presidency of Sir U. N. Brahmachari. The session was opened by H. H. the Maharajah of Indore, who, in inaugurating the meeting, said that the greatest problem of India is her poverty. It is the problem of increasing the yield of the soil and using India's vast mineral resources, which demands the most strenuous efforts of the scientific workers of India. He referred to the efforts that are being made at Indore, at the Institute of Plant Industry, to improve the quality of the crops. The Maharajah deplored the fact that while men of goodwill are straining every nerve of science in the cause of humanity, others are degrading the great achievements of that same science to the destruction of their fellow men. He fears that as the nineteenth century in Europe lost God in the laboratory, so they may lose all that is good in their ancient heritage owing to over-enthusiasm for the new.

Sir U. N. Brahmachari selected as the subject for his presidential address "The Role of Science in the Recent Progress of Medicine". His address is dealt with elsewhere in this issue (p. 330).

Dr. T. Royd's address to the Section of Mathematics and Physics dealt especially with three solar problems. He showed evidence for the essential identity of hydrogen dark markings and prominences; the former are projections on the sun's disk and the latter profiles at the limb of the same solar feature, the lengths of which along the sun's surface are of enormous dimensions compared to their heights and widths. Lengths exceeding 400,000 miles are comparatively frequently observed for this 'ribbon development' in the sun. The main difficulty of the radiation pressure theory of support of the chromosphere is to explain the presence of H, He and O, in addition to Ca^+ atoms. The role of radiation pressure, effective only on Ca^+, is not negligible but is probably confined to the part of raising Ca^+ atoms only to that height where an unknown force operates to support the chromosphere and prominences, which are composed of all atoms present at that level. The results of spectrophotometry of Fraunhofer lines carried out at Kodaikanal Observatory have been interpreted to give the densities and pressures of electrons and of atoms of hydrogen and calcium in the lower part of the reversing layer.

In his presidential address to the Chemistry Section, Dr. P. C. Guha discussed recent developments in the chemistry of bicyclic terpenes. He described the salient features of bicyclic ring systems as a class—occurring naturally or otherwise—and their stereochemical aspect. The more important and recent advances in synthetic and degradative work on thujane, carane, pinane, camphane-fenchane, and the santane series of compounds were described. The results that have attended the experiments at the Indian Institute of Science were described, and the problems still awaiting solution pointed out. In addition to the many papers read before this Section, discussions were held on the "Utilisation of Molasses", and on "The Scope for Preparation of Fine Chemicals in India".

Mr. B. Rama Rao, in his presidential address to the Geology and Geography Section, dealt with various problems connected with the origin and classification of the crystalline schists of the Archean complex of Mysore. On the basis of the occurrence of two well-defined horizons of true sedimentary conglomerates, the Dharwar schists of southern India are tentatively classified into three divisions. The lowest amongst these forms an igneous complex composed mainly of basic lava flows, felsites, quartz porphyries, etc., and their crushed representatives. The other two divisions are formed of altered recognisable sediments, with an admixture of various proportions of volcanic material. The Dharwar schists are fully developed in the northern parts of the State, and as they are traced southwards the upper division of this proposed classification disappears, and the lower is found considerably cut up and modified by the later intrusive granites. A progressive metamorphism is indicated from north to south. A discussion was held in this Section on the classification of the Archæan rocks in India.

Dr. S. R. Bose, in his address to the Botany Section, dealt with the various aspects of Bengal *Polyporaceæ*, including their distribution, the conditions for their development in Bengal, the fossil records of *Polyporaceæ*, their morphology and systematics, the anatomy as the basis of recent classification, their general structure, nutrition, cytology of reproduction and the chemical nature of fruit-body of *Ganoderma lucidus*, their biological peculiarities, their physiology, the nature of enzymes of some local Polypores in culture and their medicinal properties and other uses. Recently, Dr. Bose has reported that in specimens of *Ganoderma lucidus* and *Ganoderma applanatus*, the basidia are succeeded after the rains by hyphæ projecting direct from the trama and bearing secondary spores at their tips, which are quite indistinguishable from the ordinary basidiospores, and probably carry on spore discharge in the dry season. It is a matter for future investigation whether the basidia themselves are transformed into such tramal hyphæ-projections. Within this Section discussions were held on "The Myxophyceæ", "Saltation in Artificial Cultures of Fungi", "The Standardisation of the Vernacular Names of Indian Plants", "Chromosome Morphology and Polyploidy", and "The Importance of Anatomy and Taxonomy".

Dr. H. K. Mookherjee, presiding over the Zoology Section, discussed "The Development of the Vertebral Column and its bearing on the study of Organic Evolution". He showed that the vertebræ in all classes of vertebrates develop in a more or less similar way—a perichordial tube is converted into a bony ring apart from the notochordal sheaths which form the vertebral centrum. With regard to the formation of the centrum, the majority of the vertebrates conform to the linear series, but there are exceptions which are explained as adaptations to changed conditions of life of the individuals concerned. Dr. Mookherjee discussed the components of the neural and lower arches in Urodela and referred to the two

additional membrane bone arches he has discovered, both in connexion with the neural arch and the lower arch. The presence of the transverse processes in the vertebrate series from Amphibia to Mammalia is recorded and their modification in certain forms, such as *Xenopus*, *Bombinator*, *Gecko* and *Naja*, is described. Successive vertebræ are yoked together in the embryonic stage by longitudinal processes that are cut into two halves by a strand of migratory connective tissue, so as to produce the articular facets. The migratory connective tissue cells divide the originally continuous perichordal tubes into vertebral segments, and the direction followed by these cells determines whether the centrum is to be of procœlous, opisthocœlous or amphicœlous type. The course followed by the migratory cells is probably influenced by the movement of the embryos.

"The Problems of the Racial Composition of the Indian Peoples" was discussed by Mr. H. C. Chakladar in his address to the Anthropology Section. The racial classification of the Indian peoples has up to date proceeded on very scanty anthropometric data and hence been quite unsatisfactory. Risley's classification of them, based upon inadequate material, into seven racial types has rightly been rejected by anthropologists. Dr. Hutton's classification in the last Census Report of India has also been questioned in various respects. The Veddaic type in India he calls Proto-Australoid, although craniological evidence makes the theory of a common racial stock for the jungle tribes of the Deccan and the aborigines of Australia quite untenable. The theory of their migration into India from Asia Minor is also disproved by the great difference in nasal index between the ancient Mesopotamian and Indian skulls. Regarding the theory of the introduction of Aryan culture into India by dolichocephalic Proto-Nordics, the Aryan-speaking brachycephals had certainly entered India earlier than this type, and Vedic culture probably originated with them, or with a people in whom the two types were already mixed before they entered India. It is also necessary to revise the theories about the racial history of the Dravidians, who are found to include round-heads with Alpine, and longheads with Mediterranean, affinities. But these two types are not peculiar to the Dravidian-speaking people alone; intensive anthropometric work among the Bengalis shows the presence of these two types among them, and their presence is indicated in other parts of India too.

In his presidential address to the Section of Agriculture, Mr. A. K. Yagna Narayana Aiyer discussed some aspects of scientific research as applied to the improvement of Indian agriculture during the past twenty-five years, with particular reference to Mysore State. Improvements in agricultural implements, in manures, in varieties of crops, and in remedial measures against plant diseases, were described. Special reference was made to the recent development of the sugar industry in Mysore State. Its rapid development has been due to the Krishnarajasagara dam across the Cauvery, which is designed to bring under irrigation something like 150,000 acres of dry land. Already, in three years, 11,000 acres have been intensely cultivated, and associated industries for the utilisation of by-products have rapidly grown up. Another instance of the co-operation between agriculture and industry is the cultivation of American tobacco in the Guntur district, an industry that has expanded to such an extent that it is able to export cigarette tobacco to Great Britain. Finally, particular emphasis was laid upon the necessity for improved agricultural marketing. A joint discussion was held with the Medical Section on "The Making of Humus and its Application".

Colonel H. E. Shortt, in his presidential address to the Section of Medical and Veterinary Research, discussed the problem of immunity in protozoal disease. The fact that most diseases due to protozoa appear to leave little or no immunity following cure has led many observers in the past to consider that the immunity responses to protozoal infections must be different from those called forth by bacterial infections. A study, however, of infections due to trypanosomes, pathogenic and non-pathogenic, malarial parasites, avian and mammalian, Leishmania, visceral and dermal, and the various species of Babesia clearly brings out three points. The immunity mechanisms are essentially the same whether the invader be bacterium, protozoan, or any other foreign substance. The immunity is intensely specific, even to the extent of being specific to strains within a single species. In most cases the immunity is dependent on the continued presence in the host of the specific organism.

In his address to the new Section of Physiology, Prof. W. Burridge discussed some future lines of advance in physiology and medicine. The behaviour of rhythmical structures when stimulated and the laws governing their stimulation are additions to physiological knowledge. Living organs when stimulated obey these laws and behave like rhythmical structures. They therefore possess inherent rhythm. This new knowledge further demonstrates that the electrical excitation of muscle and nerve is a laboratory artefact and not the natural stimulation it has been presumed to be. Physiologists, however, have built their science on this and other false presumptions. The time is ripe for discarding the pseudo-science built thereon, and to rebuild on the surer foundations of the new and easily verifiable facts. A joint discussion was held with the Medical Section on "The Problem of Nutrition in India".

Mr. J. M. Sen, presiding over the Psychology Section, took as the subject of his address "Measurement in Education". In all problems of education, two things are of fundamental importance: one is the child who is to be educated with his inherited traits, and the other the environment in which he grows up. But both are variables; no one can fully predict what a child is going to be, nor is it impossible to change the environment to a certain extent. Education is therefore a function of two real variables. A detailed study of the intelligence quotients and intelligence deviations of children shows that educability can be transmitted, but the results of education cannot be transmitted. On account of individual differences it is not possible to have a homogeneous grouping for class purpose. It is much better to have an 'ability grouping' rather than 'achievement grouping' for the purpose of class teaching. The general nature of a pupil's abilities may be registered by a single point in a tridimensional record or graph, the co-ordinates of the point being the values of the three independent factors G (general intelligence), W (persistence of motives), and C (originality or cleverness) described by Spearman, Webb and Maxwell Garnett respectively. All three factors cannot be identical even in two cases, not to speak of three or more cases. Hence it is necessary to develop the potentialities of a pupil during his school age by

creating for him an atmosphere of study and character congenial to all and not inimical to the best interests of the society as a whole.

During the session, the first annual meeting of the National Institute of Sciences of India was held under the presidency of Sir Lewis Fermor, who took as the subject of his address "Methods used in the Correlation of Archaean Rocks". During the meeting it was announced that Prof. N. Bohr, Prof. A. Einstein, Sir Thomas Holland, Sir Frederick Gowland Hopkins, Sir Guy Marshall, Lord Rutherford of Nelson and Sir Charles Sherrington had become the first honorary fellows of the Institute.

At the annual meeting of the General Committee of the Indian Science Congress Association, it was unanimously resolved to celebrate the silver jubilee of the Science Congress in January 1938 by inviting a deputation of scientific workers from the British Association and elsewhere to join in the meeting. Should this materialise, it is likely to be a landmark in the progress of science in India, and it is to be hoped that adequate financial support for this venture will be forthcoming. W. D. WEST.

Science and Progress in Medicine

IN his presidential address to the twenty-third Indian Science Congress, held in Indore on January 2–8, Sir U. N. Brahmachari discussed the role of science in the recent progress of medicine. He said that no apology was needed for his choice of subject, since health is the foundation of all happiness ; moreover, it is customary at the annual meetings for the president to refer to the recent advances in science, and as the progress as well as the future achievements of medicine depend to a great extent upon the help that she has had and may yet get from the other sciences, it was only suitable for him to give a review of the important contributions made by some of these other sciences in recent times towards the advancement of medicine. He also referred to some recent facts which may be of medical interest in the future.

The president then reviewed briefly recent contributions to knowledge made by the sciences of biochemistry and chemistry, physiology, physics and mathematics, psychology and genetics. He emphasised the importance of diet and referred to the statement that man's place in future history will depend in no small degree on the food he eats. He pointed out the gaps in our present knowledge of nutrition, such as our ignorance of what is the optimum intake of protein or fat. The minimum animal protein required for human consumption is an interesting subject for research, and the future may show that it may be influenced by climatic conditions, as well as by its relationship to other constituents of the diet. He suggested that certain obscure diseases of India should be investigated from the point of view of a mineral deficiency being the cause. He also referred to the work carried out by Tilak and his assistants on balanced diets for Indians : the dietary worked out by them includes, with the staple food grains in common use, soya beans, dried skimmed milk, rice polishings, fresh ground-nut cake and a preparation of sprouted seeds. Such dietaries may help to solve the problem of obtaining a reasonably good diet at a price the people can afford. Perhaps the science of nutrition will one day form part of the Department of Preventive Medicine of the State.

In the field of chemotherapy, Sir U. N. Brahmachari referred to his own and his colleagues' work on various aminoquinoline derivatives as antimalarial agents : they have found that the introduction of a hydroxy group increases the toxic action of the compounds on Paramecia, whilst that of a methoxy group abolishes their toxicity. He also mentioned some work on the hypnotic properties of extracts from the root of *Rauwolfia Serpentina*, and then briefly reviewed his investigations on the treatment of kala-azar with preparations of antimony, culminating in the discovery of urea stibamine, which to-day is pre-eminent in the treatment of this disease. Turning to the future, he envisaged the possibility that the isotopes of elements may play an important part in the maintenance of health and that they may vary in disease.

The contribution of physics to medical science has been partly in the domain of diagnosis and partly in that of treatment. For diagnosis come such instruments as the electro-cardiograph, the oscillograph, the ultra-violet microscope, the infra-red camera, the X-ray tube and the spectrograph : for treatment, radium, light and electrotherapy and the X-ray also, the latter having been used as well for crystal analysis. It is possible that X-ray analysis may solve the problem of the order of the unit groups in a protein chain and so ultimately the structure of living matter. In fact, when we survey the immense development in the use of light waves, visible, ultra-violet, X-ray and others in the investigation of structures and the treatment of disease, with their future potentialities, it may be said without conceit —truly we are beginning to see through a glass less darkly.

In his concluding remarks, Sir U. N. Brahmachari said that it is clear that the various sciences can be of great service to medicine, and that some of them have contributed very substantially to the relief of human suffering from disease. The science of medicine, which was once mostly limited to the study of disease, is now concerning herself with the study of health, by the increasing knowledge of nutrition, environment and eugenics. Life is adapting itself to many varied conditions and to considerable extremes of environment. The capacity of man for adaptation has been achieved and can be maintained only by the possession of an almost changeless and constant medium, the blood, which acts as the direct environment of his most valuable possession, namely, the brain : surely the level at which the essential blood constituents are maintained may be called the constant of and for man, as fixed as other physical constants. Whether mankind advance or regress in the future, medicine and civilisation will advance and regress together for all time.

The contribution of medicine to civilisation aided by the other sciences is great. A healthy body means a healthy mind, and such minds are less likely to cause internal or external strife. A day may be conceived when physical warfare will give place to warfare of the intellect. There will be no jealousy, and superiority or inferiority complexes will cease to exist. Man will live by making every part of the world healthy and habitable by improved methods of hygiene, thereby minimising the need for the control of population, the overgrowth of which has been considered to be, to a great extent, responsible for many wars of the past. Further, a day may come when the war mentality of individual statesmen, which may lead to war psychosis among the people, will be analysed and corrected by the psychiatrist and the psychologist.

Although the mechanism of life cannot be explained by the physics and chemistry of to-day, some of it may be explained by ultra-physico-chemical laws that may be discovered in the future: yet even then one may not be able to say wherein enters the breath of life.

British Industries Fair

Scientific Exhibits

THE British Industries Fair, 1936, which opened on February 17, is not only the largest trade fair in the world, but it is also this year larger than it has ever been since it was first held in 1915. Its object is to assemble before the greatest number of potential buyers, both from Great Britain and from overseas, the greatest possible concentration of British manufactures. Only goods manufactured or produced within the British Empire are permitted to be displayed, and no exhibitor may exhibit articles other than those of his own manufacture. Thus the Fair forms a visible microcosm, showing the variety, range and character of the goods manufactured or produced within the British Empire. It would, of course, be an impossible task to attempt to review the twenty-four miles of exhibits that constitute the combined stand frontage at London (including Olympia and the White City) and Birmingham. All that can usefully be attempted here is to direct attention to some features, selected somewhat arbitrarily, of the scientific exhibits at Olympia.

The most striking of these exhibits is that of the scientific instrument manufacturers, who have this year excelled their previous efforts to produce, by a combined or, rather, grouped exhibit, a massed impression of the great variety and range of their products. Truth to tell, it could be more impressive still, for, although most of the leading scientific instrument manufacturers are well represented, there are obvious and notable absentees. It must be allowed that this is in part due to the fact that many of the scientific exhibits, more particularly of electrical instruments used largely in industry, are to be seen at Birmingham, where they are more appropriately shown in the company of the engineering exhibits. Moreover, it is probable that some scientific instrument manufacturers, especially those whose products appeal more particularly to the research worker or to the educationist, deem the annual exhibition of the Physical Society a more suitable occasion for the display of their latest products. But the British Industries Fair is of the utmost national importance; it attracts visitors from almost every quarter of the world; and such visitors cannot help but take away with them a vivid, and perhaps lasting, impression of what British industry in general and, what is more to our present point, the British scientific instrument industry in particular, is like, regarded as a whole. It would be a pity if, from lack of support from some important firms in the industry, the impression should be gathered that the industry is less comprehensive, less varied in the range of its products and less remarkable in its achievements than in fact it is.

Nevertheless, those who have been responsible for the organisation of the grouped exhibit of scientific instruments at this Fair are to be warmly congratulated on a notable and effective display. This year it occupies the record space of 5,840 square feet, the central and dominating feature being a scale model of the Eddystone Lighthouse which has been erected by Chance Brothers and Co., Ltd., of Birmingham. This firm shows, besides the usual mouldings for lenses and prisms, sample plates of various types of optical glass, including didymium glass, and a set of colour filters. In another case it is exhibiting specimens of laboratory ware, micro cover-glass and four shades of Crooke's glass.

Projection apparatus is well to the fore. Ross, Ltd. show the latest appliances for cine-photography, both for the silent and the sound film, as do Soho, Ltd. and Kalee, Ltd. A new feature in connexion with such apparatus is the exhibit of heat-resisting glass for the condensers, towards the satisfactory production of which a good deal of recent research has been directed. The firm of Charles Baker shows a new type of episcope, with a $f/4$ anastigmat lens, the body incorporating a new system of ventilation, so that it remains relatively cool even when the apparatus is run for long periods. This firm also exhibits a new production, the 'universal lantern', again embodying a special system of cooling the body; and the 'ultra pack illuminator', which has been designed to take the place of the older form of vertical illuminator and hitherto has been made only abroad.

Barr and Stroud, Ltd. show a full range of varied types of binoculars. They reserve the exhibition of their navigational range finders for the Shipping Exhibition which is held later in the year. Their binoculars include the central focusing and separate focusing types, prismatic binoculars of extra wide angle, and a series of prismatic monoculars. They should be congratulated also on issuing, among their literature, an admirably lucid and concise little booklet, entitled "Choosing a Binocular", which will prove most useful to the potential purchaser, whatever make of binocular he may eventually buy.

Ross, Ltd. also exhibit on their stand a wide range of their binoculars, including those of extra wide angle and those of great light-gathering power. They show also a large number of types of their photographic lenses, fitted to various makes of camera, and exhibit several types of telescopes. Perhaps their most striking exhibit is a recent product, a massive epidiascope capable of projecting the image of an object 13 in. square. The illumination is derived from four 1,000-watt lamps, and a cooling fan, electrically driven, is incorporated.

Among the exhibits of R. and J. Beck, Ltd. are to be noticed many types of their microscopes, from the microscope for school use to that used for advanced research. They include the angular microscope (an entirely new design), a combined binocular and monocular microscope, and the Wrighton metallurgical outfit, made to a specification prepared in the Research Department, Woolwich. Attention should also be directed to the projectograph exhibited by this firm, which has been designed to give a well-illuminated picture either by the shadowgraph method, showing the outline of an object, or by the opaque method, giving a view of the actual surface.

W. Watson and Sons, Ltd. exhibit, besides the usual range of their microscopes, several new products, including a machine for polishing metal specimens and useful for petrological work, and a profile-projecting apparatus. They show also a new camera, the Sayce-Watson camera, which depends fundamentally upon the use of standard 35 mm. cinematograph film. It is designed to replace a variety of photographic equipment by one apparatus, in which the objects sought have been primarily economy, compactness and simplicity. Mention should also be made of the Watson-McArthur microscope, a portable microscope having the minimum of movable parts, which was described in the *Journal of the Royal Microscopical Society*, January, 1934.

Tintometer, Ltd. show some new models of comparators for the testing of various media by means of colour matching, and new colorimeters are shown by Bellingham and Stanley, Ltd. W. F. Stanley and Co., Ltd. exhibit some interesting examples of planimeters, which are the first and only British-made planimeters, this type of instrument having been previously obtainable only from abroad. Two main types are shown, the sliding bar pattern and the radial pattern.

We have space only for brief mention of the chemical exhibits at Olympia. The theme of the main stand of the Imperial Chemical Industries, Ltd. is the technical service offered to their customers. They show a working exhibit of the water-treatment service and another concerning dyestuffs and dry-cleaning. The first of the 'Solacet' colours is shown. These have only just been introduced, and are the culmination of prolonged research on the problem of producing the perfect dyes for the direct dyeing of acetate silk. Monastral Fast Blue *B S* is shown on the stand of the Association of British Chemical Manufacturers, and is claimed to be the chemical achievement of the year. It is the first blue pigment to have been discovered since ultramarine in 1826. A simplified model of the Billingham coal-oil plant will arouse much interest and so will the sheets of the new plastic product, 'Perspex', shown on the stand of Mouldrite Limited, a subsidiary of Imperial Chemical Industries, Ltd. Among the other numerous and impressive chemical exhibits, mention may be made of the stands of Hopkin and Williams, Ltd. and the British Drug Houses, Ltd. The former exhibit phenyldi-iodarsine, the optical properties of which were found by Anderson and Payne (NATURE, 133, 66; 1934) to render it a very valuable medium in the examination of precious stones by refractivity methods.

Lastly, bare mention may be made of the 'Vitan' lamp (a fused quartz mercury vapour lamp), of the highly refractory re-crystallised alumina ware, and of the fused silica and vitreosil ware to be seen on the stand of the Thermal Syndicate, Ltd.

Taken altogether, science shows up well at this Fair, and in particular do the exhibits make manifest the truth of the slogan printed over the combined exhibit of scientific instruments: "Science aids Industry".

Educational Topics and Events

CAMBRIDGE.—Dr. P. W. Richards, fellow of Trinity College, will deliver two lectures in the Department of Botany on March 6 and 13 at 5 p.m. on "The Tropical Rain Forest". The lectures will be based on Dr. Richards's work in Borneo, British Guiana and Southern Nigeria.

Sir William Pope and Prof. H. C. Gutteridge have been appointed delegates of the University to the tercentenary of the University of Utrecht to be held on June 22–24.

OXFORD.—Dr. Edwin P. Hubble, astronomer at the Mount Wilson Observatory, has been appointed to deliver the Rhodes Memorial Lectures for the year 1936–37.

THE Le Play Society has arranged the following programme of visits to various European countries: Morocco, with Mr. W. Fogg (also a botanical group); a survey from north to south of Portugal, including Lisbon, with Dr. L. Dudley Stamp; Holland and its galleries, with Dr. G. Furlong; Glendalough, Co. Wicklow, a regional study, with Dr. D. K. Smee and Mr. T. W. Freeman; and the Cotswolds, a training course in field studies, with Miss C. A. Simpson. All these visits are open to lecturers, teachers, students and others who are interested in the studies undertaken. Further information can be obtained from Miss Margaret Tatton, The Le Play Society, 58 Gordon Square, London, W.C.1.

IN an address to the American Association for the Advancement of Science at its recent meeting in St. Louis, Dr. Oscar Riddle, of the Carnegie Institution of Washington, discussed the position of biology in American Schools. He stated that great numbers of high school and college students complete their school-days with their education incomplete in that it includes little or nothing of information about biological subjects. Apart from the danger, due to biological ignorance, of unintelligent pressure for retrograde points of view (as seen in the anti-evolution laws), there is the greater danger that scientific research may advance so rapidly in relation to the biological knowledge of the people in general, as to become quite out of touch with their daily life. It would be the greatest misfortune to science as well as to the populace were neglect of instruction in biological subjects in the schools to make scientific progress a sealed book to all but a few other than professional scientific workers.

Science News a Century Ago

The House of Commons and Railway Bills

IN the course of a debate in the House of Commons on February 22, 1836, on the procedure to be taken regarding the second reading of railway bills, Sir James Graham is reported as follows: "When they took into consideration the number of those bills that had already been introduced, the number that was still likely to be introduced and the amount of capital —not less than £45,000,000 he understood—that was about to be embarked in such speculations, he was sure that it would be admitted on all hands that the subject was one of the highest importance, and well worthy of the attention of the Government and of that house. It was to be remarked, that with regard to all other public works they had well framed standing orders; but as regards railways, the standing orders relating to the construction of canals had been rudely and imperfectly made to fit railways. . . . So far from looking upon the postponement of the second reading of the railway bills at present before the house as unadvisable, he should like to see the progress of all railway bills postponed for a whole session. He should like to appeal from the country drunk to the country sober. There seemed to exist at present a perfect mania for speculations for this description." A few days later *The Times* stated that a Select Committee of the House had drawn up a statement showing that thirty-two railway bills, involving an estimated outlay of £28,000,000, had been read a first time. The petitions submitted to the House in connexion with these bills included 36,978 assents, 6,575 dissents and 7,475 neuters.

Projects for Arctic Explorations

AT a meeting of the Royal Geographical Society held on February 22, 1836, three communications regarding arctic expeditions were read, by Sir John Franklin, Sir John Barrow and Captain Beaufort respectively. After Sir John Franklin had explained in detail his plan for an expedition to examine the north-eastern extremity of the American continent by way of Wager River, Hudson's Bay, Sir John Barrow stated his opinions at length on the existence and practicability of a north-west passage between the Atlantic and Pacific Oceans, observing that the question had become a national one and that an obligation had been contracted to persevere in the attempt to solve it, so long as any hope of success remained. Captain Beaufort said that he entirely agreed with Sir John Barrow as to the interest attached to the discovery of a passage and thought that there would ever be "intolerable disgrace" if after all that England had done towards narrowing the field of investigation, it were first actually traversed by a foreign flag. He thought Sir John Franklin's plan the best and he urgently exhorted the Council to recommend it to the favourable consideration of His Majesty's Ministers.

The Royal Society

AT a meeting of the Royal Society held on February 25, 1836, a paper was read "On an Artificial Substance resembling Shell" by Leonard Horner, the paper being accompanied by an account of an examination of the substance by Sir David Brewster. Horner had noticed a singular incrustation on the surfaces of a wooden dash wheel, used in bleaching, at the cotton factory of Messrs. J. Finlay and Co., at Catrine in Ayrshire. He described it as being compact in texture, with a metallic lustre presenting in some parts a beautiful iridescent appearance. Its resemblance to shell had led him to inquire into its structure and the circumstances of its formation. The substance was found to consist of carbonate of lime and animal matter. The former was due to the cotton cloths being steeped in lime water, while the latter was traced to the glue used to stiffen the warp for the looms. Brewster, in his examination of the mechanical and optical properties of the substance, had found it to be composed of laminæ the plates of which when separated were almost always covered with an iridescent film of the most brilliant and generally uniform tint, which exhibited all the colours displayed by these films or polarising laminæ. The new substance, he said, might be regarded as having the same optical relation to calcareous spar that mother of pearl had to arragonite.

Arago and French Forests

IN the French Chamber of Deputies on February 27, 1836, a discussion took place on a motion by the Minister of Commerce relating to the question of a general clearance of woods in France. Among the speakers was Arago, then regarded as one of the leading men of science. In the course of his remarks, Arago said that the clearing of woods may be attended with effects of various kinds. A report of Arago's speech appeared in the *Moniteur* and a translation of it in *The Times* of March 2, 1836. "You will, perhaps, be surprised, he said, to hear that a few centuries ago, in the vicinity of Paris, the summer heat was much greater than it is in our own time. This is a fact, however, which is proved by various documents, among others a charter allowing the vine growers of Amiens to compete with the other districts of France for the honour of supplying the most perfect wine to the table of Philip Augustus. It is certain that forests exercise a great influence over electric phenomena. In clearing the mountains of woods, you would perhaps increase the liability to hail of the adjacent districts to a ruinous extent. In countries cleared of woods all rivers have the character of torrents. In a short time volumes of water are sent forth with excessive rapidity, and in many parts of the year they are quite dry. In Italy, since they have cleared away the wood from the Alps, the rivers carry down a quantity of mud much greater than formerly. I am borne out in this fact by the opinion of M. de Prony. I think there is room for an inquiry on the matter. You will find in the archives of science sufficient to direct your decision."

Deaths of Philosophers

THE issue of February 27, 1836, of the *London Medical and Surgical Journal* has the following note: "The first public meeting of the Royal College of Physicians took place on Monday last, and was attended by the Prime Minister, Lord Melbourne, the Archbishop of Canterbury, several of the judges and other distinguished characters, and a great number of the profession. Sir H. Halford read a paper on the 'Piety of the most renowned British Philosophers in their last moments'; among whom he mentioned the names of Locke, Boyle, Newton, Addison, Johnson, etc. The composition and style of the paper were chaste and elegant, and the crowded assembly heard it read with deep attention and much pleasure."

Societies and Academies

LONDON

Royal Society, February 13. L. HOGBEN and D. SLOME: The pigmentary effector system. (7) The chromatic function in Elasmobranch fishes. (8) The dual receptive mechanism of the amphibian background response. Experiments, in which the effects of illumination from above and below, and of illumination with monochromatic lights of different wavelengths, have been compared, show that the visual chromatic ('background') response of vertebrates depends on distinct localised retinal elements. The ventral photoreceptors involved in the black background response activate the archaic pituitary mechanism present in Cyclostomes, Elasmobranchs and Amphibia, in all of which removal of the whole gland or part (neurointermediate lobe in Elasmobranchs and Amphibia) abolishes the black background response. The black background response can be evoked in hypophysectomised Elasmobranchs or Amphibia by extracts of which the active constituent is not identical with the pressor or oxytocic substances. Quantitative estimates based on the melanophore index show that more extreme pallor results from removal of the neurointermediate lobe alone than from removal of the neurointermediate lobe along with the pars tuberalis. This reinforces evidence previously adduced to support the existence of a second humoral component, the *W*-substance in the pars tuberalis of Amphibia. Removal of the pars glandularis of Elasmobranchs abolishes the white-background response, as does the removal of the pars tuberalis in Amphibia. This points to the conclusion that the same dual mechanism of endocrine control exists in the cartilaginous fishes. C. H. WADDINGTON, J. NEEDHAM and JEAN BRACHET: Studies on the nature of the amphibian organisation centre. (3) The activation of the evocator. The power of performing an induction can be caused to appear in those parts of the amphibian gastrula which do not normally possess it (such as the ventral ectoderm) by exposure to a temperature of 100° C., or treatment with organic solvents. It is now shown that the same effect can be brought about by the action of a respiratory catalyst such as methylene blue upon the isolated ectoderm. Subsequent implantation of these isolated pieces next to competent tissue leads to the formation of a neural tube, or to lesser degrees of neuralisation, in the host or in the graft, or in both simultaneously. This is interpreted as signifying the liberation of the natural evocator from previously inactive combination. The nature of this inactive combination is discussed and the suggestion is made that it is a complex of the type protein-glycogen-evocator. From this point of view the present position of our knowledge of the metabolism of the organisation centre, especially with regard to glycogen, is critically considered. Preliminary measurements of the oxygen uptake of the dorsal lip of the blastopore and ventral ectoderm in a micro-respirometer indicate that only a very small, if any, difference in respiratory rate exists between these regions. The significance of this in relation to other findings on the metabolism of the gastrula may be considerable. C. H. WADDINGTON, J. NEEDHAM, W. W. NOWINSKI, R. LEMBERG and A. COHEN: Studies of the nature of the amphibian organisation centre. (4) Further experiments on the chemistry of the evocator. The presence of an evocator substance in the digitonin precipitate of the unsaponifiable material of ethereal extracts of crude glycogen from mammalian liver is confirmed. Atempts at fractionation of the sterolic portions of the unsaponifiable material of adult mammalian liver are described. It is shown that acetone extracts of adult mammalian brain, which should contain no kephalin, may be active, and that the activity of kephalin preparations may persist after the destruction of the lipin by saponification.

DUBLIN

Royal Irish Academy, January 27. W. J. MCCALLIEN: The Strabane pillow lavas. The best exposures occur at Strabane and Artigarvan, south of Londonderry. For the most part the lavas are in the condition of hornblende-schists, but porphyritic texture is frequently retained. Limestone and slate occupy the interspaces between the pillows. Associated with the lavas are green schists of sedimentary origin, in the condition of epidote-albite-schists with biotite and chlorite. T. J. NOLAN and T. G. BRADY: The pigment of the flowering currant (*Ribes sanguineum*) vars. *splendens* and *atrosanguineum*. Robinson in his survey of anthocyanins described the presence in the rose pink flowers of the flowering currant (*Ribes sanguineum*) of an anthocyanin of a novel type readily soluble in amyl alcohol and giving a pure blue solution in aqueous sodium carbonate; in addition, a 3-pentose glucoside of cyanidin was present. Two deeply pigmented varieties of *Ribes sanguineum*, namely, *atrosanguineum* and *splendens*, have been investigated. These varieties were found to contain none of the novel anthocyanin referred to by Robinson, but from them was isolated by a rapid and simple method cyanidin 3-rhamno glucoside, identical with the antirrhinin of Scott-Moncrieff, and presumably the same as keracyanin obtained by Willstätter from the sweet cherry.

PARIS

Academy of Sciences, January 13 (*C.R.*, **202**, 101–176). JULES HAAG: The asymptotic study of oscillations of relaxation. JEAN BAPTISTE SENDERENS and J. ABOULENC: The action of the anhydrous alkaline earths on the monohalogen derivatives of fatty hydrocarbons. The vapours of *n*-butyl, isopropyl and tertiary butyl chlorides and of *n*-butyl and isopropyl chlorides were passed over calcium or barium oxide at temperatures between 275° C. and 310° C. Hydrochloric acid is removed, and the corresponding ethylene hydrocarbon obtained. No carbon is deposited at these temperatures. VLADIMIR BERNSTEIN: The characteristic properties of indicators of growth. ALBERT TOUSSAINT and MIROSLAV NÉNADOVITCH: Contribution to the theory of rigid biplanes of infinite spread. JACQUES VALENSI: Aeroplane wings: the pressures in the axis of the nucleus of marginal vortices. ALBERT ARNULF: A method for the measurement of the apparent diameters of stars. The method is based on the detection of diffraction fringes of a star when there is occulation by the moon. The image of the star is photographed on a rapidly moving plate, and the negative analysed with the microphotometer. By this method it was found that the apparent diameter of Regulus is certainly less than 0·003″, and is probably between 0·0018″ and 0·0020″. PIERRE BIQUARD: The existence of diffusion of ultra-sound waves in liquids. PIERRE VERNOTTE: The theory of cellular vortices

of Bénard. The experiments of Bénard with spermaceti agreed closely with Lord Rayleigh's theory as regards the dimensions of the vortices; but differed widely as regards the limit of stability. The author shows that by a modification of the equations of convection assumed, the disagreement between the theory and Bénard's experiments disappears. MLLE. SUZANNE VEIL: The Volta effect of electrolytic solutions against water and the characters of acidity and basicity. MLLE. MARGUERITE QUINTIN: The activity coefficient of the ions. Discussion of the meaning of the parameter a in Debye's theory, with experimental results tending to show that a for cadmium and chlorine possess different values. JACOB NEUFELD: The mathematical expression of the hysteresis curve. An expression is developed for the cycle of hysteresis, as a functional relation between the magnetic induction and the intensity of the magnetic field. CHOONG SHIN PIAW: The absorption spectra of the oxides of tellurium, TeO_2 and TeO. Results of a qualitative and quantitative study of two new spectra belonging to the molecules TeO and TeO_2. RENÉ LUCAS and FERNAND GALLAIS: The magnetic rotatory power and the dispersion of the alkaline mercurtetraiodides. The exceptional properties of the mercurtetraiodides can be explained by the influence of an absorption band, without the aid of any additional hypothesis. RENÉ AUDUBERT: The spectral domain of emission of chemical reactions. HANS VON HALBAN, Jun. and PIERRE PREISWERK: The existence of new resonance levels for the capture of neutrons. MARCEL GUILLOT and GEORGES GENESLAY: The chemical formula of malachite. Malachite has been prepared artificially by several methods, all possessing the same percentage composition and giving X-ray spectra identical with natural malachite. The formula proposed is $8CuO, 4CO_2, 5H_2O$. ARAKEL TCHAKIRIAN, MICHEL LESBRE and MICHEL LEWINSOHN: A new method of preparation of the alkyl and trihalogenaryl derivatives of tin. ANTOINE WILLEMART: Researches on the dissociable anthracene oxides: the influence of tolyl groups in the meso position. PAUL GAUBERT: Liquid crystals of some compounds of cholesterol and their crystalline surfusion. MICHEL WOLAROWITSCH and MLLE. ANNE LEONTYEWA: The measurement of the specific volume of fused diabase. The specific volumes of three diabases over a temperature range of 1,090°–1,370° C. are given. PIERRE MARIE: The microfauna of the Middle and Upper Cretaceous with bathyal facies of North Morocco. ERNEST CHAPUT: Geological observations in the southern regions of central Anatolia. GEORGE CANELLOPOULOS: Contribution to the dynamical study of climate. M. and MME. FERNAND MOREAU: The action of glycerol on the Saprolegniæ. ROBERT DOUIN: The photogeotropism of peduncular and capitular thallus of the Marchantiæ. ALBERT BESSEMANS, AREND RUTGERS and EMILE VAN THIELEN: Thermal measurements in the field of diathermy by short waves. Quartz thermometers filled with benzene are preferable to glass thermometers containing mercury or alcohol or to thermocouples, since they do not show a rise in temperature when exposed to the direct action of short waves. MLLE. MARIE LOUISE VERRIER: The retina of diurnal birds and the theory of duality of vision. JACQUES MONOD and GEORGES TESSIER: The concentration of food, as a quantitative factor of increase of populations of Infusoria. MICHEL MACHEBŒUF and JOSEPH DIÉRYCK: The preparation of a chemiovaccine producing in the rabbit a marked immunity towards tuberculous infection. MAURICE PIETTRE: Concerning the permeability of the mammary cell. MARCEL LISBONNE and RAYMOND SEIGNEURIN: The bactericidal action of mercury. Distilled water, after remaining thirty-six hours in contact with metallic mercury, acquires a powerful bactericidal action. The form in which it is present in the water is uncertain; but traces of the metal can be detected. GEORGES MOURIQUAND, PAUL SÉDALLIAN and ANDRÉ CŒUR: Antidiphtheric immunity by anatoxine and irreversible dystrophy by disturbed food equilibrium (avitaminosis C). J. LAIGRET and E. BONNEAU: The long persistence of immunity by vaccination for yellow fever. Proofs that the immunity remains four years after inoculation.

MELBOURNE

Royal Society of Victoria, December 12. E. S. HILLS: Records and descriptions of some Australian Devonian fishes. G. BAKER: The petrology of the You Yangs—a study of contamination. The You Yangs giant granite has been contaminated by the assimilation and granitisation of igneous (diabase) and sedimentary (shales, etc.) inclusions. Orthite, new to the mineralogy of Victorian granitic rocks, occurs, associated with xenoliths, basic schlieren and clots of ferro-magnesian minerals. Corundum occurs in sedimentary xenoliths. Heavy mineral indices and assemblages indicate variations between the granite of the You Yangs and outcrops a few miles to the west. Joints, studied from aerial photographs and measurements of strike in the field, occur in two major directions, and control the strike of some of the dykes. All the dykes cut the granite, and contain partially digested xenoliths, indicating some degree of advance by stoping. A small dyke of nepheline monchiquite has been noted. F. CHAPMAN and D. E. THOMAS: The Cambrian Hydroidea of the Heathcote and Monegeeta Districts. In this paper further evidence of the occurrences of Palæozoic hydroid remains in Victoria is summarised. The fossil remains previously regarded as algæ from the Heathcote area have now definitely been correlated with the occurrence at Monegeeta. By the associated trilobite fauna a Middle Cambrian age has been established.

SYDNEY

Royal Society of New South Wales, December 4. A. R. PENFOLD and F. R. MORRISON: The occurrence of linalool in the essential oil of *Melaleuca ericifolia*. The essential oil was examined in 1922 by Baker and Smith, who showed the principal alcoholic constituent to be α-terpineol. This alcohol could not be detected in the oils now examined. The chemical and physical constants of the various consignments of leaves were determined. The presence of cineol (13–18 per cent) and terpenes was confirmed, but the sesquiterpenes are being re-examined. Linalool is an important constituent of perfumes of the bergamot type. Its occurrence in the essential oil of *M. erecifolia*, one of the most widely distributed tea trees in Australia, is of considerable commercial importance. M. B. WELCH: Notes on shrinkage of wood (2). The results of a number of shrinkage and density determinations are given, based on green sawn timber received from different parts of New South Wales. In some species, for example *Doryphora sassafras*, the ratio of radial to tangential shrinkage is approximately $1 : 3\frac{1}{2}$, but in general the ratio is less than 1 : 2. G. J. BURROWS

and E. P. SANFORD: Compounds formed from copper salts and tertiary arsines (1). Cuprous halides combine with phenyl dimethyl arsine or diphenyl methyl arsine to form compounds containing either one or two molecules of the arsine. Cupric salts on treatment with these arsines are reduced to the cuprous condition, yielding products identical with those obtained directly from cuprous compounds. Diphenyl methyl arsine on treatment with cupric chloride yields isomeric compounds of the composition $Cu_2Cl_3(Ph_2MeAs)_3$. The constitution of these compounds is discussed. A. P. ELKIN: Initiation in the Bard Tribe, North-West Australia. Initiation rites in this tribe consist of three series: the first includes the operations of tooth-knocking and circumcision, together with rites of separation and mourning and a period of seclusion which is terminated by a ritual reaggregation. In the second, the most important, the initiand is made a full partaker of the secret life of the tribe by a blood rite—both anointing and drinking—and by the revelation of the bullroarer and the myths associated with it. In the third series, the new man receives the finishing touches of his initiation (cicatrices, subincision and arm-ligaturing for the purpose of obtaining blood for ritual purposes), and is invested with the pearl shell apron.

Forthcoming Events

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

Monday, February 24

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—C. P. Skrine: "Baluchistan before and after the Earthquake".

INSTITUTE OF EDUCATION (UNIVERSITY OF LONDON), at 5.30.—Prof. Edwin Mims: "Present Educational Tendencies in the United States".*

Tuesday, February 25

UNIVERSITY COLLEGE, LONDON, at 5.30.—T. D. Kendrick: "The Archæology of the Scandinavians in England".*

UNIVERSITY OF BIRMINGHAM, at 5.30.—Sir Joseph Barcroft, F.R.S.: "The Influence of Chemical Conditions on Mental States" (Huxley Lecture).

Wednesday, February 26

ROYAL SOCIETY OF ARTS, at 8.—Sir Daniel Hall, F.R.S.: "Can Agriculture Provide Substantial Relief for Unemployment?"

Thursday, February 27

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION), at 4.30.—Viscount Bledisloe: "The Maori Race".

UNIVERSITY OF LONDON ANIMAL WELFARE SOCIETY, at 5.30.—(at the College of the Pharmaceutical Society, 17 Bloomsbury Square, W.C.1).—Discussion on "Poisons for Rodents". Speakers: J. G. Wright, J. D. Hamer and T. Howard. Discussion to be opened by Dr. G. D. Lander.

Friday, February 28

ROYAL INSTITUTION, at 9.—Lord Sempill: "World Air Transport".

ASSOCIATION OF TECHNICAL INSTITUTIONS, February 28–29. Annual General Meeting to be held in the Goldsmiths' Hall, Foster Lane, Cheapside, E.C.2.

February 28, at 10.30.—Lord Plender: Presidential Address.

Official Publications Received

Great Britain and Ireland

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 30: The Nitro-Chromic Reaction and its Application to the Estimation of Small Quantities of Alcohol. By D. A. Webb. Pp. 281–284. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*. [42

London Shellac Research Bureau. Technical Paper No. 6: Sulphitation of Lac. By Dr. R. Bhattacharya and Dr. Lal C. Verman. Pp. 20. (London: London Shellac Research Bureau.) [42

Scottish Marine Biological Association. Annual Report, 1934–35. Pp. 24. (Glasgow: Scottish Marine Biological Association.) [52

The Journal of the Institute of Metals. Vol. 57, No. 2, 1935. Edited by G. Shaw Scott. Pp. 311+23 plates. (London: Institute of Metals.) 31*s*. 6*d*. [52

Report of the Third Imperial Botanical Conference, London, August 1935. Pp. 20. (Kew: Royal Botanic Gardens.) 1*s*. net. [52

The *Engineer* Directory and Buyers Guide, 1936–37. Pp. 252. (London: The *Engineer*.) [52

Proceedings of the Royal Society of Edinburgh. Vol. 55, Part 2, No. 12: The Experimental Analysis of the Growth of an Insect Population. By Dr. D Stewart MacLagan and Edward Dunn. Pp. 126–139. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 1*s*. 3*d*. [102

The University of Manchester: The Manchester Museum. Museum Publication 108: Report of the Museum Committee for the Year 1934–35. Pp. 24. (Manchester: Manchester University Press.) 6*d*. [102

Department of Scientific and Industrial Research: Forest Products Research Records. No. 6 (Timber Series No. 1): The Properties of an African Mahogany (*Khaya anthotheca* C.DC.). Pp. ii+4+1 plate. 6*d*. net. No. 7 (Timber Series No. 2): The Properties of Mansonia (*Mansonia altissima* A. Chev.). Pp. ii+4+1 plate. 6*d*. net. (London: H.M. Stationery Office.) [122

Other Countries

Det Kongelige Departement for Handel, Sjøfart, Industri, Håndverk og Fiskeri. Norges Svalbard- og Ishavs-undersøkelser. Meddelelse Nr. 28: Arctic Nervous Diseases. By J. Baashuus-Jessen. Pp. 310–345. Meddelelse Nr. 29: Til Ost-Grønlands Historie, av Oluf Kolsrud; De Første Efterretninger om Ostgrønlaendingerne 1752, av H. Ostermann. Pp. 48. Meddelelse Nr. 30: Hvitserk og Blåserk. Av J. Kr. Tornoe. Pp. 15. Meddelelse Nr. 31: Holonemareste aus dem Devon Spitzbergens. Von A. Heintz. Pp. 8+1 plate. Skrifter om Svalbard og Ishavet. Nr. 40: The Downtonian and Devonian Vertebrates of Spitsbergen, 5, Suborder *Cyathaspida*. Part 1: Tribe *Poraspidei*, Family *Poraspidæ* Kiaer. By Johan Kiaer and Anatol Heintz. Pp. 138+40 plates. 25.00 kr. Nr. 64: Die devonischen Ostracoden Spitsbergens. 1: *Leperditiidæ*. Von Gerhard Solle. Pp. 61+4 plates. 5.50 kr. Nr. 65: Zoological Results of the Norwegian Scientific Expeditions to East-Greenland, 4. 1: Apiden aus Nordost-Grönland, von H. Friese; 2: Hemiptera aus Nordost-Grönland, von Håkan Lindberg; 3: Collembolen aus Nordost-Grönland, von Walter M. Linnaniemi. Pp. 25. 2.50 kr. Nr. 66: Zoological Results of the Norwegian Scientific Expeditions to East-Greenland, 5. 1: The *Isopoda* collected during the Norwegian Expeditions to East-Greenland, 1929, 1930, 1931 and 1932, by Åke Nordenstam; 2: Die *Amphipoden* der Norwegischen Expeditionen nach Ost-Grönland in den Jahren 1929, 1930, 1931 und 1932, von A. Schellenberg; 3: *Crustacea decapoda*, *Auphausidacea* and *Mysidacea* of the Norwegian Expeditions to East Greenland, 1929, 1930, 1931 and 1932, by Erling Sivertsen. Pp. 54. 5.00 kr. (Oslo: Norges Svalbard- og Ishavs-undersøkelser). [32

School of Tropical Medicine, San Juan, Puerto Rico. Report of the Director for the Year ending June 1935. Pp. 66. (San Juan: University of Puerto Rico.) [32

U.S. Department of Agriculture. Circular No. 363: The Migration of North American Birds. By Frederick C. Lincoln. Pp. 72. 10 cents. Technical Bulletin No. 484: The Composition and Constitution of the Colloids of certain of the Great Groups of Soils. By Horace G. Byers, Lyle T. Alexander and R. S. Holmes. Pp. 39. 5 cents. (Washington, D.C.: Government Printing Office.) [42

Annuaire de l'Académie Royale de Belgique, 1936. Pp. 94+137+4 plates. (Bruxelles: Académie Royale de Belgique.) [62

Geological Survey of Uganda. Bulletin No. 2: A Short Record of Progress relating to some Investigations in the Field and Laboratory, and of some Results obtained Therefrom. Pp. 84. (Entebbe: Government Printer.) 5*s*. [102

The Indian Lac Research Institute. Bulletin No. 22: Further Notes on the *Chalcidoid* Parasites of *Laccifer lacca*, Kerr. By P. M. Glover. Pp. 4. 1 rupee. Annual Report for the Year 1st April 1934 to 31st March 1935. Pp. 36. (Namkum: Indian Lac Research Institute.) [102

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 59: A Study of Persistence in certain Introduced Pasture Grasses. By Dr. A. McTaggart. Pp. 16. (Melbourne: Government Printer.) [102

Department of Agriculture: Straits Settlements and Federated Malay States. General Series, No. 22: Reports of the Field Branch for the Year 1934. Pp. iii+198. (Kuala Lumpur: Department of Agriculture.) 50 cents. [102

Catalogues

Apparatus fitted with Interchangeable Ground Glass Joints. (List No. 107.) Pp. 24. (London: A Gallenkamp and Co., Ltd.)

Catalogue of Books and Journals relating to Agriculture and Botany. (No. 474.) Pp. 50. (Cambridge: W. Heffer and Sons, Ltd.)