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Land Drainage in England and Wales

ONE of the most insistent problems of recent years in the domestic legislation of Great Britain has been that of land drainage. There are many and extensive areas in England and Wales where efficient drainage is a vital necessity to the safety, health and welfare of the inhabitants. Inundations which have afflicted such districts in the past, and even now, in spite of definitely organized preventive measures, can still cause widespread devastation with loss of life and property and possible epidemics of disease, have been a source of constant and anxious concern to successive Governments. Ultimately, a Royal Commission was appointed to investigate the matter, and in 1927 its report appeared, making a series of recommendations of a striking and drastic character, which, supported by public opinion, were, after full discussion, embodied in the Land Drainage Act, 1930. Since that date, a fundamental and revolutionary change has been taking place in the drainage administration of the country; and an account of the operations and proceedings taken under the Act has recently appeared*.

The main difficulty of the situation prior to the passing of the Act was the existence of a heterogeneous collection of drainage authorities, totalling some 361, with miscellaneous constitutions, powers and jurisdictions. Moreover, these bodies, however active and well-intentioned, were inadequately provided with funds and lacked the necessary resources for coping with conditions which had naturally changed more or less fundamentally with the lapse of a long period of years since they were first instituted. Some of them, notably the so-

called "Commissions of Sewers" (the word "sewer" originally signified an open watercourse), dated back to a very remote epoch, and these were preceded by a body, still legally in existence, "the Lords, Bailiffs and Jurats of Romney Marsh," which has had an effective career of nearly seven hundred years. Commissions of Sewers were first appointed in the fifteenth century, but were placed on a more permanent basis by the Statute of Sewers of Henry VIII's reign (1531). Thereafter, other bodies were created, either by private Act of Parliament *ad hoc*, or arising out of the provisions of local inclosure awards in connexion with the inclosure of common lands, a process which was at its height in the closing years of the eighteenth and early years of the nineteenth century.

Of this complicated and cumbersomely ineffective machinery the new Land Drainage Act made a clean sweep, and it repealed all the enactments in regard to flood prevention which had been made through centuries of English history, substituting for them a properly organized and co-ordinated system of administration through authorities designated Catchment Boards, taking their title from the drainage unit adopted by the Royal Commission; namely, the catchment area of each river, which is bounded by the natural watershed or water-parting. These catchment areas vary considerably in character, extent and rateable value. Some areas are largely agricultural, such as the Great Ouse, Rother, Severn, Wye, etc., while others include industrial regions, such as the Yorkshire Ouse, Trent, Mersey and Irwell and the mid-Glamorgan rivers. Another feature of notable contrast is the relative proportion of lowlands and uplands. In the catchment area of the Romney and Denge Marsh Main Drains, the percentage of

*Report of Operations and Proceedings under the Land Drainage Act, 1930, from the passing of that Act (1st August, 1930) to 31st March, 1937. Pp. iv+75. (London: H. M. Stationery Office, 1937.) 1s. 6d. net.

lowlands is 72.75, while in the Bristol Avon area it is only 3.22.

At the outset, the Act scheduled forty-seven catchment areas—not by any means an exhaustive list, but as many as it was considered possible to deal with at the start. Provision was made for additions, and as a result of these and some amalgamations, there were at the date of the report under consideration forty-eight catchment boards in England and Wales.

The responsibilities of catchment boards are not limited to the drainage or discharge of water from their respective areas. In a number of cases they have the contingent duty of protecting the low-lying marshlands on the sea or estuary frontage from tidal flooding. Thus, in the case of the Essex Rivers Catchment Area, there are, in addition to a length of 380 miles of main river, no fewer than 320 miles of sea or estuary embankment and defences along the north bank of the Thames from the outskirts of London to Dovercourt, and these need constant supervision and repair.

The term 'main river' requires explanation. It is rather difficult to define with exactitude, though the meaning is fairly obvious. But, for the purposes of the Act, the signification has to be a little elastic. The 'main river' may include more than one channel, and, in fact, consist of several independent streams. It has not been altogether easy in some cases to decide where the main river or main channel should end, or what tributaries should be included.

The existence of tributaries and auxiliary streams has given rise to the formation, under the Act, of internal drainage boards, with duties subordinate to those of the catchment boards. Internal drainage boards can be formed for areas "capable of deriving benefit or escaping danger as a result of drainage operations," so that, in certain cases, a drainage district may exist where there is no catchment area.

The financial depression which set in almost immediately after the passing of the Act hampered, to no small extent, the initiation of important schemes of flood protection works, though a little was done where the need was urgent and perhaps desperate. Prior to March 31, 1934, only ten schemes, totalling nearly £300,000, were approved for the purpose of receiving grants out of monies provided by Parliament towards the expenditure incurred by catchment boards in respect of the improvement of existing works or

the construction of new works. Of this amount, £179,000 was urgently required for sea defences in Rye Bay and north Norfolk. In the former locality, the sea actually breached the defences in November 1930, washed away a number of bungalows and left a widening gap in the natural shingle bank, which was the only defence at that point. When the financial situation eased, as it did after April 1934, fuller advantage was taken of Government assistance, and greater facilities were afforded for dealing with improvement schemes of a general character. Up to March 31 last, seventy-one such schemes had been approved, between fifty and sixty of which are still in course of execution, at an estimated outlay of upwards of six millions sterling.

Attention may appropriately be directed to a feature of the functions of catchment boards having an important bearing on a subject which has often been mentioned in these columns. We have in the past pointed out repeatedly how essential it is in the general interests of the country to institute an effective national survey covering all available water resources. After considerable pressure had been brought to bear on the Government by the British Association, jointly with the Institution of Civil Engineers, a Survey was set up a couple of years ago under the auspices of the Ministry of Health, and two annual reports of its activities have already been issued. Whatever misgivings we may have felt about the limitations apparently imposed on the Survey by its association with a department which cannot be said to be interested in the industrial and commercial use of water, the fact remains that, at present, it is the only organization existing for the purpose.

The Survey, however, cannot carry out single-handed all the operations which it is desirable should be covered, and it will have to rely very largely on the co-operation of external organizations. The catchment boards, with their control over the main rivers in their respective areas, can make a very effective contribution to the data necessary for the Survey, by undertaking a comprehensive study of their rivers, and by installing an adequate number of gauges to record the daily flow, so as to determine the run-off under varying conditions corresponding to the incidence of the local rainfall. This is a very important matter, and we are glad to see—even if only in the final sentence of the report—that attention is directed to it in the account of work being done under the Land Drainage Act.

The British Polar Year Expedition to Fort Rae

British Polar Year Expedition, Fort Rae, N.W. Canada, 1932-33

Vol. 1: Discussion of Results; Meteorology, Terrestrial Magnetism and Aurora, Atmospheric Electricity. Pp. xv + 336 + 5 plates. 21s. net. Vol. 2: Tables; Meteorology, Terrestrial Magnetism, Atmospheric Electricity. Pp. ix + 228. 15s. net. (Published under the direction of the British National Committee for the Polar Year, The Royal Society, Burlington House, London.) (London: Percy Lund, Humphries and Co., Ltd., 1937.)

THE great scientific enterprise of the Second International Polar Year, 1932-33, is now bearing fruit in the publication, by the various co-operating nations, of the reports of their work. It will be remembered that the enterprise was a repetition and extension of the work of the First Polar Year, 1882-83, its main object being to obtain geophysical observations of various kinds at a number of high-latitude stations (mainly temporary) during a complete year; an associated programme of intensified observations in middle and low latitudes was also carried out during the same period.

After the jubilee of the first polar year had been adopted as a suitable date for the project, and while plans were being made, the great economic crisis occurred. Nevertheless, largely through the enthusiasm and energy of Dr. La Cour, president of the International Polar Year Commission, the project was carried through with great success. As regards the British participation, H.M. Government, through the Air Ministry, placed £10,000 at the disposal of the Royal Society for the purpose; this fund was administered by the British National Committee for the Polar Year, of which Sir Henry Lyons and Sir George Simpson were respectively president and secretary.

The British National Committee devoted the major part of its funds to the re-establishment of a station for comprehensive meteorological, magnetic, atmospheric electrical and auroral observations at Fort Rae, on the Great Slave Lake, Canada, where in 1882-83 the joint British and Canadian expedition had had its base. During the Second Polar Year the Canadian Government established its own very valuable Polar Year station at Chesterfield. The report of this second Fort Rae expedition has recently been issued; though it is not the first of the national Polar Year reports to appear, it is one of the most

complete. A few months before, the Royal Society had published in its *Philosophical Transactions* the report of another enterprise subsidized by the British Polar Year Committee, namely, the expedition for radio exploration of the ionosphere at Tromsø, organized mainly by Mr. R. A. Watson Watt and Prof. E. V. Appleton.

The Fort Rae expedition was led by Dr. J. M. Stagg, who made a preparatory visit to Fort Rae in 1931. He was assisted, in 1932-33, by four specialist scientific officers and a steward-mechanic (Messrs. Morgans, Sheppard, Grinstead, Stephenson and Kennedy). Of the six members of the expedition, all but one (Stephenson) were seconded by or drawn from the Meteorological Service, which in this and many other ways gave invaluable support to the expedition. The first Fort Rae expedition had been led by Captain (later Colonel) Dawson, who lived to see the start, though not the return, of the second expedition; its members, like its leader, had been drawn from the army, and military discipline was observed on the expedition. The second expedition, more specialist in character, worked under freer conditions with not less care, patience and success.

The journey to Fort Rae in 1882-83 was arduous and adventurous. Even in 1932 the outward journey took a month, the last part being by boats with a 16-mile land portage. The cost of transport of the five hundred cases of equipment and stores taken by the expedition from England to Fort Rae was still high—nearly a shilling a pound. It may incidentally be noted that despite the prevailing financial stringency, more than fifty firms had made generous gifts of food supplies, clothing and instrumental equipment to the expedition.

Up to 1931, Fort Rae had remained one of the most isolated trading posts of the Hudson's Bay Company, but then a reputedly rich discovery of gold and pitch-blende ores to the north of Fort Rae led to a rush of prospectors, which continued during 1932-33. An air service to the mining camps was organized, and Fort Rae was used as a fuelling station; this enabled the Fort Rae expedition in 1933 to return by aeroplane to the railway at Edmonton, 1,000 miles away. A general narrative of the expedition is given by Dr. Stagg in the introduction to the report; it is graphic and fascinating, and happily does not omit reference to some of the lighter incidents that occasionally enlivened the very full and arduous labours of the party.

The original site of Fort Rae had been abandoned since 1882-83, and the expedition made its headquarters at the new settlement, about fifteen miles away. The old site was, however, intermittently occupied by a section of the expedition, as a sub-station for magnetic observations and for taking auroral photographs simultaneously at the two sites. A telephone line was laid to connect the old and new Fort Rae; the line was slung partly from trees on the lake shore, but mainly on posts cut from similar trees, let into holes cut in the ice of the lake after this had frozen early in October. Had the line not been raised well above the snow-covered ice, it would soon have been severed by the passage of dog sleighs on the winter trails of the Indians.

Space does not permit a detailed description of the many kinds of work undertaken by the expedition, or of the difficulties and accidents besetting such work in the circumstances of Fort Rae. But mention may be made of the dispatch into the stratosphere of twenty-eight balloons carrying meteorographs, designed to register meteorological conditions during their passage through the troposphere and lower stratosphere. One great difficulty in this work was the low chance of recovery of the meteorographs in the difficult and almost uninhabited region round Fort Rae. To increase the chance of discovery of the fallen instruments by Indians on their trapping trails, a brilliantly coloured ribbon, $\frac{1}{4}$ - $\frac{1}{2}$ mile long, was attached to each meteorograph. Actually only two were found and returned, each with satisfactory records: it may be hoped that others may yet become available in years to come.

The report now published consists of two volumes. The basic data obtained are presented in 287 detailed tables, forming vol. 2; 159 of these are meteorological, 111 geomagnetic, and 17 refer to atmospheric electricity. Their choice and arrangement follow lines drawn up by the Publica-

tions Sub-Committee of the International Polar Year Commission to facilitate comparisons between the results of different national expeditions. The International Commission has also made reduced copies of all the photographic magnetic records on Leica film, for the use of investigators who need such complete material; this applies to Fort Rae and most of the other Polar Year stations.

The first and larger volume is devoted to the discussion of the data set out in vol. 2. The parts relating to geomagnetism (including auroras), meteorology, and atmospheric electricity are respectively due to Messrs. Stagg, Morgans and Sheppard, and occupy approximately 180, 110 and 25 pages. A future publication on the photographic auroral work of the expedition, not discussed in the present volume, is referred to in the introduction.

Of the three discussions in vol. 1, it may in general be said that they maintain the high standard set by the British Meteorological Office in its Observatories Yearbook, and are worthy of the fine observations on which they rest. It is specially satisfactory that the discussion has been and could properly be undertaken by those who, having made them, best know their errors and their excellences.

Over many years, the magnetic records of a series of British antarctic expeditions were entrusted for discussion to the late Dr. C. Chree, whose temperament and expert knowledge made him exceptionally suited for this important task. Dr. Chree is no more, but happily the mantle of Elijah has fallen on Elisha, and in the present discussion Dr. Stagg, a former collaborator and part disciple of Dr. Chree, has fully risen to the important opportunity it afforded. His work as leader, as chief scientific officer in carrying out the observing programme, and as author of the largest and most difficult section of the report, is of outstanding merit.

S. C.

Indirect Rule in Nigeria

Law and Authority in a Nigerian Tribe: a Study in Indirect Rule. By Dr. C. K. Meek. Pp. xvi + 372. (London, New York and Toronto: Oxford University Press, 1937.) 17s. 6d. net.

DR. C. K. MEEK'S investigations into Nigerian anthropology have for long been recognized as standard works of great value, owing to the eminently sound, practical, common-sense point of view with which he discusses subjects which are too often made the pegs upon which to hang fantastic or doubtful speculative theory. This new

book of his does not depart from that high standard which his other works have led us to expect.

We have all come to regard northern Nigeria as so much the home and classic example of 'indirect rule' that it is of especial interest to read, in this scholarly work, of the application—and misapplication—of the principles involved in this great ideal, to the so-called 'pagan' areas in the south.

The writer of this notice has for long pointed out that one of the dangers which still menaces the successful application of indirect rule lies in

the misconception which still exists in many quarters regarding the true status and functions of *soi-disant* African 'kings' or native rulers, and of the democratic basis which underlies every form of indigenous African Government, however apparently autocratic it may seem. To the West African, democracy implies that the affairs of the State must rest, not in the hands of the few, but in the keeping of the many.

In this book, Dr. Meek—besides giving us a very full and interesting account of Ibo customs and beliefs—tells us calmly of the happenings that led to, and resulted in, 'the women's riots' of November 1929. These disturbances developed from an almost total disregard of certain fundamentals, and were the sorry penalty the Nigerian administration had to pay for their misconception of the Africans' idea as to what forms the elementary basis of their social law and order.

The principal native executive officers, in the persons of the chiefs—so dearly beloved by a certain type of administrative officer—had gradually assumed the titles and functions of highly despotic rulers. The efficient and quite intricate decentralized system of government, which had once upon a time enlisted the co-operation of private, family, kindred and tribal groups in the administration of law and order, had gradually come to be ignored or brushed aside. The kind of indirect rule which Mary Kingsley, half a century before, had declared to be a parody, became the recognized form of administration.

African women, as once again Miss Kingsley could have foretold, rose—very literally—in arms. It was, indeed, a sorry tale, but at any rate the story need never be repeated if those who have the welfare of African peoples in their hands will only study carefully such a work as this.

Dr. Meek's advocacy for the inclusion of young educated Africans, that is, those educated on European standards, is also one of very real necessity if this great experiment in trusteeship is to have a full chance of success. After all, it is in the hands of such that the future of black Africa will surely lie.

The reviewer of this excellent book has only one minor complaint to make. It seems strange to note the complete absence, in a volume dealing with Nigeria and indirect rule, of even the name of the founder of this African Empire and of this African ideal—Sir George Goldie. Yet, long before the phrases 'dual mandate' and 'indirect rule' were ever coined, he had laid down the foundations of both, and formulated his policy, in words which cannot be bettered, even to-day.

"If the welfare of the native races is to be considered, if dangerous revolts are to be obviated, the general policy of ruling on African principles through native rulers must be followed. . . ."

The book is printed and produced as befits the traditions of the Oxford University Press.

R. S. RATTRAY.

Catalytic Reactions

(1) The Catalytic Action of Surfaces

By J. E. Nyrop. Second edition. Pp. 102. (Copenhagen: Levin and Munksgaard; London: Williams and Norgate, Ltd. 1937). 7s. net.

(2) Katalytische Umsetzungen in homogenen und enzymatischen Systemen

Von W. Frankenburger. Pp. xi + 444. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1937.) 36 gold marks.

IT is probably true to say that the problem of the mechanism of heterogeneous catalysis has been and still is one of the most hotly debated topics in physical chemistry. A wealth of papers and books advocate rival theories, each supported by an abundance of experimental fact which can scarcely be discussed critically and impartially by one author.

(1) In the book under review, a rather novel viewpoint is adopted in order to attempt to bring heterogeneous reactions within the confines of one co-ordinating theory. Dr. Nyrop makes two

postulates in his theory: (a) adsorption is accompanied by ionization of the adsorbed molecules, the latter being thus held to the surface by ionic forces; (b) the lower the ionization potential of the impinging molecule, the higher its degree of adsorption. These postulates immediately imply that catalysis will not be observed unless the surface is capable of ionizing the interacting molecules. Furthermore, if two different kinds of molecules interact, it is necessary to ionize both.

Support for these views is initially mainly derived from experiments on the activation of molecules by low-voltage electrons in which ionization invariably precedes reaction. The question as to whether this idea can be applied *mutatis mutandis* to catalytic surfaces is one best settled by the reader of the book. There can be no doubt that some of the kinetics of heterogeneous reactions, such as the inhibiting effect of reactants and of products, may be accounted for by a consideration of the relative ionization potentials of such molecules. But whether surfaces normally

employed in catalysis are capable of effecting ionization of molecules requiring some 10–15 volts, when the work function of the surface in question may be less than half this value, is rather a moot point upon which judgment must be reserved. None the less, this monograph is a bold attempt to break away from the conventional and explore other methods for the elucidation of the intricacies of heterogeneous catalysis.

(2) While heterogeneous catalysis is at present treading a somewhat thorny path, homogeneous catalysis progresses in a more deliberate and systematic manner. Dr. Frankenburger's book in its thoroughness and completeness is the best proof of the latter contention. In fact, it might fairly be asked if this subject comprises the whole of that part of chemistry dealing with reactions with the exception of heterogeneous phenomena in the gas phase.

The book is naturally divided into three sections, preceded by an introduction to chemical dynamics, which is given in a straightforward manner without digressing too far into rigorous methods. This is the best compromise since, for the understanding of the remainder of the book, a detailed treatment is not necessary and indeed might prove a 'potential barrier' over which many readers would be disinclined to pass. The first section comprises an

account of well-known homogeneous catalytic actions such as the effect of moisture on chemical change, a brief but sufficient description of number of typical chain reactions, together with a discussion of simple gas-phase bimolecular reactions. In the second section, acid and base catalysis is given an adequate treatment. Included in this section is an account of oxidation in the liquid phase, with a return to the chain treatment of these processes. The section is brought to a close by a discussion of some reactions in organic chemistry, such as condensation, dehydration, etc. Finally, the last section treats heterogeneous catalysis in the liquid phase, namely, enzymatic reactions. A few pages are also devoted to reactions induced by colloidal metals.

The field thus covered is so large that exhaustive treatment of every aspect of the subject cannot be expected. The great merit of the book, however, lies, as it should, in the ease with which the reader may consult and understand any small portion without having to read the preceding hundred pages.

After perusal of these books the reader has every reason to inquire of the chemist: Are all chemical reactions catalytic? He would be a bold person who would answer in the negative.

H. W. MELVILLE

Measurement of Radiant Energy

Measurement of Radiant Energy

Edited by W. E. Forsythe. Contributors:— Charles G. Abbot, Elliot Q. Adams, Loyal B. Aldrich, Ernest F. Barker, Bentley T. Barnes, William W. Coblenz, Paul H. Dike, Gustave Fassin, William E. Forsythe, Kasson S. Gibson, George R. Harrison, Herbert E. Ives, Loyd A. Jones, Lewis R. Koller, Henry F. Kurtz, A. Herman Pfund, Bartholomew J. Spence, Donald C. Stockbarger, A. Hadley Taylor, Willibald Weniger, Archie G. Worthing. Prepared under the direction of A. C. Hardy, Herbert E. Ives, and W. E. Forsythe. Pp. xiv + 452. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 30s.

THE successive chapters of this book deal with fundamental ideas; sources of radiation; principles of analysis; spectrometers, general and particular; thermal, photo-electric and photographic measurement; densitometers; galvanometers; spectrophotometry; pyrometry; photometry; special problems. Many of these topics are each the subject of treatises as long as this book; accordingly it was necessary for the

editorial committee to decide exactly what was the gap in the literature that they proposed to fill.

In my opinion they have not performed their duty satisfactorily, and for this reason the book, in spite of excellence in some details, falls much below the high standard which the publishers have set themselves in other books of the same series. The editors might have aimed at an encyclopaedia mentioning every problem that might possibly arise in their field and indicating where a complete discussion of it was to be found. They might have aimed at an original work, discussing only problems that have been unduly neglected. Or they might have aimed at criticism, selecting from the vast amount of recorded knowledge that which is of special and permanent value. Actually they have confused all three aims. A few topics receive more than their proper share of space, because something new has to be said of them. Although every topic appears to be mentioned, the text, combined with the references, is sometimes quite inadequate to convey important information concerning them (luminescence, heterochromatic photometry, 'barrier-layer' photo-cells are examples). While so

sections are admirably critical, others are mere compilations of quite elementary facts and ideas.

The best sections are undoubtedly the most critical. Chapters iv (spectrometric instruments and their adjustment), vi (radiometry), x (galvanometers), xii (pyrometry) appear to me admirable; if the other chapters had shown equal knowledge and insight, the book, though it would have been a mere set of essays on slightly related subjects, might have been of great value. Chapter viii (photographic measurement) approaches the encyclopædic ideal, but is open to the objection that other works of greater length discuss the same matter with equal skill and in necessarily greater

detail. Chapter i (fundamental ideas) might have been abbreviated to a simple list of formulæ; on the other hand, not even Messrs. Forsythe and Ives can treat photometry (chapter xiii) adequately in 18 pages. The remaining chapters seem to me satisfactory so far as they go, but undistinguished; it is difficult to guess to whom precisely they are addressed.

These are, however, all matters of opinion; the editor's and authors' names are a sufficient guarantee that there will be no serious errors; I can only hope that others will find in this work a higher value than I have been able to put upon it.

NORMAN R. CAMPBELL.

Nutrition and Dietetics

(1) The Little Things in Life :

the Vitamins, Hormones and other Minute Essentials for Health. By Prof. Barnett Sure. Pp. xii + 340. (New York and London: D. Appleton-Century Co., Inc., 1937.) 8s. 6d. net.

(2) Elements of Foods and Nutrition

By Mary T. Dowd and Prof. Alberta Dent. Pp. xiii + 279. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 8s. 6d. net.

(3) Dietetics Simplified :

the Use of Foods in Health and Disease. By Prof. L. Jean Bogert. With Laboratory Section by Mame T. Porter. Pp. ix + 637. (New York: The Macmillan Co., 1937.) 12s. 6d. net.

THIS series of American books dealing with nutrition illustrates some of the methods by which the results of scientific inquiry may be made generally available for the benefit of a community.

(1) The method adopted by Prof. Sure is to present the more dramatic aspects of the subject in a form which may appeal to the intelligent layman. In "The Little Things of Life" he describes the part played by vitamins, mineral elements and hormones in the regulation of living processes, his main theme being the influence of these chemical substances on nutrition and therefore on health. Though written in "non-technical language", the account he gives is more detailed than might be expected from the title. Laymen introduced for the first time to the new knowledge of nutrition might digest more easily a plainer story, in which less attention is given to the chronological sequence of individual discoveries. The general public is usually content with getting some grasp of the main significance of scientific discoveries and is not deeply interested in settling questions of priority.

Nevertheless, the persistent reader will obtain much interesting information from this volume, and he should be duly impressed with the way in which recent biochemical work is being applied to the prevention and treatment of human disease.

(2) The little book by Dowd and Dent is avowedly a text-book for use in schools, and fulfils well its purpose of providing a basis for the teaching of good food habits to children in their more advanced forms. The subjects dealt with include not only the physical and chemical properties of the individual components of food and their function in nutrition, but also the principles of food selection for the purpose of securing good nutrition, with due regard to the cost of living. A useful chapter is added on common food fallacies, in which the fantastic views of certain types of food faddist are exposed. Numerous illustrations are included.

(3) The last of these books, "Dietetics Simplified," is again a text-book, but with an appeal to a more specialized audience—students of domestic science, hospital dietitians, nurses, medical students and perhaps intelligent housewives. The first two sections contain a clear and practical exposition of the principles of nutrition as applied to the normal human being. These are followed by a section devoted to the use of diet as a therapeutic agent in disease. It is shown how the normal good diet may be modified to suit the particular requirements of the subjects of disease. The reasons for advising the suggested modifications are given and these are in accord with current medical and scientific thought. The last third of the book is a practical manual of menu-planning and cookery. All those whose work includes the planning of diets for promoting health and treating established disease will find in this volume a mine of valuable information.

A History of Psychology in Autobiography (International University Series in Psychology.) Vol. 3. By James Rowland Angell, Frederic Charles Bartlett, Madison Bentley, Harvey A. Carr, Sante De Sanctis, Joseph Fröbes, O. Klemm, Karl Marbe, Charles Samuel Myers, E. W. Scripture, Edward Lee Thorndike, John Broadus Watson, Wilhelm Wirth. Edited by Carl Murchison. Pp. xvii + 327. (Worcester, Mass.: Clark University Press; London: Oxford University Press, 1936.) 22s. 6d. net.

THE thirteen American, English, German and Italian psychologists whose autobiographies appear in this volume were selected in 1928, like those in the two previous volumes of the series, by a committee of five members of whom the editor was one. The idea of making eminent representatives of one branch of science tell the story of their intellectual development is not a new one, and was probably suggested in this instance by the series edited about fifteen years ago by Prof. L. G. Grote of Halle, in which the history of medicine of the present time is related in an autobiographical form.

Undoubtedly the most vivid autobiography in the present volume is that of the late versatile Prof. Sante De Sanctis, who although he claimed to be "above all and essentially a physician", was also the author of important work on psychology in relation to children, religion, criminology and dreams. In addition to the lively narratives of F. C. Bartlett and C. S. Myers, reference should be made to the contributions of Harvey A. Carr, notable for his work on the psychology of animals, O. Klemm, the author of a history of psychology and works on experimental and racial psychology, E. W. Scripture, the pioneer in experimental phonetics and speech neurology and E. L. Thorndike, well known for his work on child study, educational psychology and the measurement of intelligence. Several contributors discuss the educational aspects of psychology, especially F. C. Bartlett, who maintains that all teaching in psychology should be as informal as possible, and emphasizes the importance of a good practical training in physiology, biology and the elements of physical science as well as some instruction in philosophy and logic. Fröbes stresses the value of his five years' work as a teacher in mathematics, physics and chemistry in relation to his subsequent career, and Angell modestly declares that his influence on the course of psychological development was due less to his own investigations than to his students, who afterwards had highly successful careers.

The usefulness of the work would have been considerably increased if a bibliography had been attached to each autobiography.

Glastechnische Fabrikationsfehler

Von Dr. Hans Jebson-Marwedel. Herausgegeben mit Unterstützung der Deutschen Glastechnischen Gesellschaft E.V. Pp. x + 295. (Berlin: Julius Springer, 1936.) 48.60 gold marks.

Most glass technologists will be familiar with Dr. Peddle's book "Defects in Glass", published some ten years ago, and will remember how this systematic

exposition of the faults in glass-making was welcomed. They will, if they read German, also be familiar with Dr. Jebson-Marwedel's papers dealing with the melting and refining of glass, devitrification and kindred problems.

In the book now under review much of this work reappears in a connected form. The pace of the advance in glass technology is well illustrated by the difference in scope of the English and German work and by the wealth of documentation in the present one. Whilst in the latter Dr. Jebson-Marwedel draws heavily on his own work, he does not rely entirely on it by any means, for of 639 references which are scattered throughout the book at the ends of the various sections, his name only appears in something less than ten per cent. The value of the work is enhanced by the lavish use of illustrations, both photographic and diagrammatic. The 295 pages contain in all 441 figures, and one colour plate is reproduced from the *Glastechnische Berichte* to show the effect of the 'oxygen pressure' in the melt on the colour of iron-containing glasses. Even those whose knowledge of German is rudimentary may learn much from the figures. Special mention may perhaps be made of the 'three dimensional' one illustrating the effect of diameter and temperature on the rate of rise of a bubble through a glass melt, and of the one showing the effect of furnace atmosphere and temperature on the residual SO_2 in the melt.

The setting out is clear, the type and reproduction of the figures excellent, and, save for a few understandable mistakes in names foreign to the producer, typographical errors are remarkably few for a first edition.

Altogether, the volume represents a notable contribution to the glass technologist's reference library, and, though its price will probably prevent many from putting it there, it cannot be regarded as unduly expensive.

M. PARKIN.

Field Tests for Minerals

By E. H. Davison. Pp. viii + 60 + 12 plates. (London: Chapman and Hall, Ltd., 1937.) 7s. 6d. net.

IN spite of the existence of other books of this type designed as ready aids to mineral determination by relatively simple methods, Mr. Davison may be congratulated on producing a comprehensive summary of field tests in a form convenient for the traveller, whether in settled or unsettled lands, at a relatively low price. The book, as it should be, is practical and includes tests for all the minerals the student or prospector is likely to find. There is little room for criticism, but it might perhaps be possible to include in future editions black-and-white sketches of the results of microchemical tests, such as the "colourless highly refracting plates" characteristic of antimony; to many such would be more useful than some of the illustrations given of hand specimens. For one who has to 'travel light' in places where even the simplest apparatus or common reagents are unobtainable, a list of indispensable articles might save both time and inconvenience.

The book will prove useful to students, whether beginners or advanced.

J. P.

Die Fernrohre und Entfernungsmesser

Von Dr. Albert König. Zweite Auflage. Pp. v+242. (Berlin: Julius Springer, 1937.) 24 gold marks.

SHORTLY after the Great War, Dr. König, whose association with Messrs. Carl Zeiss of Jena eminently fitted him for the task, published his book on the telescope and range-finder. It dealt particularly with the more important fighting service optical instruments such as binoculars, sighting telescopes, submarine periscopes and range-finders, with the intricacies of which so many people through necessity had become familiar.

The second edition, in comparison with the first, which appeared at a time of great depression, is an excellent production, well illustrated and printed. It is stated in the preface, which modestly describes the book as a "Büchlein", that about half the original illustrations have been discarded and replaced by twice the number of new ones. The text has been correspondingly revised not only in the practical but also in the theoretical portions. A new section has been devoted to the important recent developments of anti-aircraft height- and range-finders of various types.

Many readers will find the historical descriptions of interest and particularly the additional chapter at the end which summarizes the history of the telescope from Lipperhey to Porro. Its invention has been attributed to Lipperhey in preference to Janssen, to whom Borel accorded the honour.

The use of abstruse mathematics has been avoided to an even greater extent than in the first edition, but the usefulness of the book to the student has not been prejudiced thereby. This excellent edition embodies so much new material that it may be read with advantage by those already familiar with the contents of the original work. J. W. F.

Zusammenhänge zwischen physikalischen Eigenschaften und chemischer Konstitution

Von Prof. Dr. Robert Kremann. Mitbearbeitet von Dr. Max Pestemer. (Wissenschaftliche Forschungsberichte: Naturwissenschaftliche Reihe, herausgegeben von Dr. Raphael Ed. Liesegang, Band 41.) Pp. xvi+225. (Dresden und Leipzig: Theodor Steinkopff, 1937.) 16 gold marks.

It is characteristic of the present state of natural science that books appear with increasing frequency dealing with borderland subjects between physics and chemistry. This is all to the good, since boundaries have been needlessly rigid in the past.

In the book before us, it is natural that the molecule forms the basis of discussion, but stress is laid upon the relation between physical properties of the molecule as such, and the constitutional effects which derive from them. A particularly welcome chapter is that concerned with the forces of cohesion and surface potential, which concludes with some useful information about melting points. The interest of the volume is that the authors have produced a compact treatise upon chemical physics, rather than upon the conventional physical chemistry. The diagrams are too cramped to be very helpful, but the text is clear and concise. F. I. G. RAWLINS.

Lectures on College Algebra:

a Text Book for the use of Intermediate Students of Indian Universities. By S. B. Dandekar. Pp. xii+402. (Indore City: Vinayak and Co., 1936.) 3 rupees; 5s.

THE author of this very interesting volume claims to present a course in algebra, suitable for the use of intermediate students of Indian universities, in a manner quite different from that given in other books. An attempt is made—with commendable success—to deal with fundamental principles and methods in a simple, logical and connected form which will at once arouse the student's interest in, and enthusiasm for, the subject.

Beginning with preliminary notions, the topics considered, taken in order, include surds, theory of indices, ratio, proportion, variation, complex quantities, theory of quadratics, the progressions with applications to interest, annuities and scales of notation, logarithms, permutations and combinations, the binomial and exponential theorems, partial fractions and determinants. There is no doubt that it would be difficult to find any other book that deals with so comprehensive a course in such an order. It is certainly a long way from preliminary notions to complex quantities; yet the latter form the subject matter of chapter iii. There are, however, alternative courses of reading suggested to suit the particular needs of different types of student.

The whole treatment, whilst being very succinct, is quite sound, and the style of presentation one which compels interest from the beginning.

F. G. W. B.

Volumetric Analysis

By A. J. Mee. Pp. vii+223. (London: William Heinemann, Ltd., 1937.) 7s. 6d.

THIS useful text-book is meant primarily to cover the course of volumetric analysis necessary for the various school and university examinations. It deals especially with the growing tendency on the part of examiners to set questions dealing with the application of titrimetric methods to the solution of practical chemical problems. While this does not convert the work into a treatise suitable for the industrial chemist, it certainly covers a surprisingly large field and will be found of value not only to students but also to many others who make use of such methods of analysis. The subject-matter is quite up to date, and contains sections dealing with the use of ceric sulphate, titanous sulphate and chloride, potassium bromate with special reference to the evaluation of 8-hydroxyquinoline in metal complexes by means of bromate-bromide mixture and, in addition, there are given numerous interesting precipitation methods.

The text is set out mainly in the form of exercises which the student is expected to carry out, these being carefully and lucidly described and adequately explained. Additional exercises are given at the end of each chapter and there are also included a large number of problems. Two short appendixes deal respectively with automatic burettes and pipettes and with mixed and universal indicators, while a third appendix contains a list of materials required in working out the various problems. G. R. D.

Chemotherapy of Amœbicides*

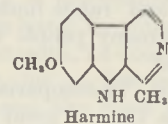
By Dr. F. L. Pyman, F.R.S.

RESEARCH on amœbicides was greatly facilitated by the technique developed by Dobell and Laidlaw (1926), and Laidlaw, Dobell and Bishop (1928) for testing amœbicides *in vitro*. Emetine has for long been the principal drug used in the treatment of amœbic dysentery, but it has some undesirable by-effects, amongst others a nauseating effect. In a search for substances having the amœbicidal action of emetine without its nauseating effect, a number of alkaloids very closely related to emetine in chemical structure were made at an earlier period. When tested by Dale and Dobell (1917), by an early laboratory method, several of them, *O*-methylpsychotrine (a substance which differs from emetine structurally only in containing two hydrogen atoms fewer) and *N*-methylemetine, for example, were found to be more toxic to *Entamoeba histolytica* than emetine itself. Clinical trials of *O*-methylpsychotrine (Jepps and Meakins, 1917) and *N*-methylemetine, however (Low, 1915; Wenyon and O'Connor, 1917), showed them to be of little or no value in the treatment of amœbic dysentery.

The method of Dobell and Laidlaw, however, depending on the cultivation of amœbæ in a medium consisting partly of solid (inspissated fresh horse serum) and partly of liquid (egg-white diluted with Ringer's fluid) with a little starch, gave results which fell into line with the clinical results. Emetine was found to be fifty times as toxic to amœbæ *in vitro* as *N*-methylemetine, *iso*-emetine, and *O*-methylpsychotrine, which are clinically inactive. Later, Laidlaw, Dobell and Bishop described a simpler medium, consisting of 1 part of sterile horse serum, 8 parts of Ringer's fluid with a small quantity of sterile solid rice-starch, disodium hydrogen phosphate being added as a buffer. In this medium they found that the amœbæ were destroyed in four days by emetine 1 in 5,000,000, provided that the medium did not become too acid. We have made use of this method in the work which I am about to describe.

A homologous series of normal alkylharmols, from methylharmol (harmine) up to dodecylharmol, was examined, and it was found that both bactericidal and amœbicidal activity increased, on ascending the homologous series, up to a point and then started to fall. Peaks of bactericidal activity were reached at butyl for *B. typhosus* and at amyl

for *S. aureus*, whilst the peak of amœbicidal activity was reached at *O*-*n*-nonylharmol.

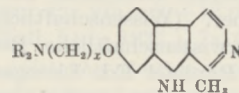


Compound.	B.W. Coefficients.		Minimum concentration lethal to <i>Entamoeba histolytica</i> .
	<i>B. typhosus</i> .	<i>S. aureus</i> .	
Harmol	1	—	1 in 40,000 to 1 in 80,000
Harmine	<1	—	
<i>O</i> -ethylharmol	25	—	1 in 80,000
<i>O</i> - <i>n</i> -propylharmol	225	75	1 in 80,000 to 1 in 120,000
<i>O</i> - <i>n</i> -butylharmol	350-400	150	1 in 20,000 to 1 in 80,000
<i>O</i> - <i>n</i> -amylharmol	350	250-300	1 in 100,000 to 1 in 200,000
<i>O</i> - <i>n</i> -hexylharmol	50	45-50	1 in 100,000 to 1 in 200,000
<i>O</i> - <i>n</i> -heptylharmol	30-35	45-50	1 in 200,000
<i>O</i> - <i>n</i> -octylharmol	15	35-40	1 in 200,000 to 1 in 300,000
<i>O</i> - <i>n</i> -nonylharmol	10-15	15	1 in 200,000 to 1 in 500,000
<i>O</i> - <i>n</i> -decylharmol	10	—	1 in 100,000
<i>O</i> - <i>n</i> -dodecylharmol	5	—	1 in 100,000 not lethal

The salts of this and other high members of the series were very sparingly soluble in water, and consequently a further series of compounds was prepared, with the hope of obtaining more readily soluble compounds.

The method adopted was to add a further salt-forming group to the molecule in the form of a terminal dialkylamino-group, such as is employed in the antimalarials, plasmoquine and atebtrin.

In this way there was made a series of derivatives of harmol having the general formula given below, the salts of which proved, as had been expected, to be readily soluble in water.



The size of both R (the N-alkyl groups) and *x* the number of carbon atoms in the chain separating N from O was varied, and the results may be illustrated by reference to a series in which the decyl group (*x* = 10) was a common factor, whilst the dialkylamino group was varied.


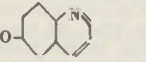
Compound.	Minimum concentration lethal to <i>Entamoeba histolytica</i> .
<i>O</i> - <i>x</i> -dimethylaminodecylharmol	1 in 300,000 to 1 in 500,000
<i>O</i> - <i>x</i> -diethylaminodecylharmol	1 in 200,000 to 1 in 500,000
<i>O</i> - <i>x</i> -di- <i>n</i> -butylaminodecylharmol	1 in 750,000 to 1 in 2,000,000
<i>O</i> - <i>x</i> -di- <i>n</i> -amylaminodecylharmol	1 in 750,000 to 1 in 3,000,000
<i>O</i> - λ -di- <i>n</i> -butylaminoundecylharmol	1 in 750,000 to 1 in 4,000,000
<i>O</i> - <i>n</i> -nonylharmol	1 in 200,000 to 1 in 500,000
Emetine hydrochloride	1 in 2,000,000 to 1 in 10,000,000

It was thus found that the activity of members at the peak of the series, such as *O*- λ -di-*n*-butylaminoundecylharmol, was many times that of

* From the presidential address entitled "Researches in Chemotherapy" to Section B (Chemistry) of the British Association, delivered at Nottingham on September 2.

O-nonylharmol, and this fact led us to suspect that the harmol residue might not be an important contributor to the amoebicidal properties of the molecule.

A number of compounds were then prepared in which dibutylaminodecyl (or undecyl) groups were introduced into molecules of varying structures. The last columns in the following tables show the limits of the range of the minimum concentration found lethal to *Entamoeba histolytica* in three days, under the conditions laid down by Laidlaw, Dobell and Bishop (*loc. cit.*).

Compound.	Minimum concentration lethal to <i>Entamoeba histolytica</i> .
$(C_4H_9)_2N.(CH_2)_{11}$ 	1 in 750,000 to 1 in 4,000,000
$(C_4H_9)_2N.(CH_2)_{11}$ 	1 in 100,000
$(C_4H_9)_2N.(CH_2)_{10}.CO.CO_2H$	1 in 100,000
$(C_4H_9)_2N.(CH_2)_{10}.CO.C_6H_5$	1 in 100,000
$(C_4H_9)_2N.(CH_2)_{10}.N.(C_6H_5)_2$	1 in 2,000,000

It was thus shown that the attachment of the group $(C_4H_9)_2N.(CH_2)_{10}$ to a simple substituted amino group gave very high efficiency.

A long series of tetraalkyldiamino paraffins of the general formula $NRR'.(CH_2)_n.NRR'$ was then prepared, and the minimum amoebicidal concentration under the optimum conditions for emetine determined.

In the first place, derivatives of heptane and decane were examined; of the heptane series the tetraethyldiamino and tetra-*n*-butyldiamino compounds were prepared and tested. The tetrabutyl member of the series was superior as an amoebicide to the tetraethyl one, but neither showed more than a fraction of the efficiency of the best harmol derivative. More promising results were obtained with the corresponding decane derivatives, and ultimately the efficiency of dibutylaminoundecylharmol was equalled or even, in some of our tests, surpassed.

The following table shows the results of a test in which a number of decane derivatives of the general formula, $R_2N.(CH_2)_{10}NR_2$, were examined simultaneously, so that the 'peak' of the series could be ascertained. This was found at $\alpha\alpha$ -tetra-*n*-amyldiaminodecane, which was used as a standard of comparison in later work. For brevity, it is referred to below as T.A.D.D.

Compound.	Minimum concentration lethal to <i>E. histolytica</i> .
<i>αα-Decanes</i>	
Tetra- <i>n</i> -propyldiamino . . .	1 in 250,000 not lethal
Tetra- <i>n</i> -butyldiamino . . .	1 in 1,500,000
Tetra- <i>n</i> -amyldiamino . . .	1 in 3,000,000 (or less)
Tetra- <i>n</i> -hexyldiamino . . .	1 in 1,000,000
Tetra- <i>n</i> -heptyldiamino . . .	1 in 250,000 not lethal

A similar test indicated that the corresponding

series of undecane derivatives also showed the peak with the tetraamyldiamino member.

Next, keeping a tetrabutyl or tetraamyl group constant, the hydrocarbon residue was varied. The following table shows the results of two tests on these series of compounds.

Compound.	Minimum concentration lethal to <i>E. histolytica</i> .
Test 1.	
<i>αα</i> -Tetra- <i>n</i> -butyldiamino-	
nonane	1 in 800,000
decane	1 in 1,000,000
undecane	1 in 2,000,000
dodecane	1 in 1,500,000
tridecane	1 in 1,000,000
Test 2.	
<i>αα</i> -Tetra- <i>n</i> -amyldiamino-	
octane	1 in 400,000
nonane	1 in 1,000,000
decane	1 in 2,000,000
undecane	1 in 1,500,000
dodecane	1 in 200,000

As the results of the foregoing experiments, $\alpha\alpha$ -tetra-*n*-amyldiamino-*n*-decane (T.A.D.D.) was selected for further study. The conditions of all the amoebicidal tests described above were those most favourable for emetine, that is, in a faintly alkaline medium. It is well known (Laidlaw and others; Henry and Brown, 1923) that the exceedingly high efficiency of emetine *in vitro*, of the order of 1 in 5,000,000, is only found in alkaline, neutral or only very faintly acid media. Our results afford abundant confirmation of this fact. When endeavouring to assess the value of an amoebicide in the treatment of amoebic dysentery by comparison with emetine *in vitro*, it appears therefore necessary to consider carefully the hydrogen ion concentration likely to be met with in the areas infested with amoebæ.

We have been unable to find any reference to the actual hydrogen ion concentration in the amoebic ulcer, but Knowles and others (1923) found that the pH of a number of stools containing motile amoebæ averaged 6.22. They also reported the results of experiments on kittens artificially infected with *E. histolytica* in which the colon and rectum of the animals were minced in saline and the hydrogen ion concentration of the suspension determined. The average pH value obtained in these experiments was 6.33, and the livers when similarly treated showed an average pH value of 6.34.

Furthermore, a considerable amount of work has been carried out upon the reaction of living, dead and diseased body cells, and the work of Rohde (1927) and Chambers and others (1927) suggests that the contents of the ulcers may have a hydrogen ion concentration more acid than pH 7.0.

A consideration of these papers suggested that in any comparisons of amoebicides with emetine

in vitro the effect of acidity should be studied, particularly when the amœbicides are to be administered orally, and that tests should be carried out at a pH value of 6.2 or 6.3.

Under these conditions T.A.D.D. is three to five times as efficient as emetine. Moreover, when blood is added to the medium even at pH values otherwise favouring emetine, T.A.D.D. and emetine are of very similar amœbicidal value, the former at times showing a definite superiority.

The toxicity of T.A.D.D. to mice has been compared with that of emetine, with the following results :

	Median Lethal Dose (mgm./gm.)		
	Oral.	Subcut.	Intraven.
α -Tetra- <i>n</i> -amylidiaminododecane dihydrochloride	0.45	0.35	0.04
Emetine dihydrochloride	0.04	0.06	0.013

It has thus only one tenth of the toxicity of emetine when administered orally to mice and one sixth on subcutaneous injection. Its therapeutic index is therefore much more favourable than that of emetine, and it appeared to be an exceptionally promising compound for clinical trial in conditions of ill-health due to infestation with *Entamoeba histolytica*. At this point, it was

recommended to and accepted by the Therapeutic Trials Committee of the Medical Research Council for clinical trial. It was tried clinically by Prof. Warrington Yorke, who has kindly allowed me to state his results. He finds that T.A.D.D. has some action in amœbic dysentery, when administered orally, but is not sufficiently active to be of any real value. Unfortunately, it cannot be given intramuscularly, subcutaneously or intravenously, as it is intensely irritating.

It appears, therefore, that the comparison of the amœbicidal values of emetine and T.A.D.D. with a faintly alkaline medium gives a better indication of their relative clinical value than the comparison in a slightly acid medium. This knowledge will be of value in further work on the subject.

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A New Conception of Supraconductivity*

By F. London, Institut Henri Poincaré, Paris

5. According to these conceptions, *there cannot exist any magnetic flux 'frozen' in the interior of pure supraconductors*; a permanent flux should only be found confined to the *hollows of supraconducting rings*. The topological connectivity of a supraconductor, therefore, is a property extremely characteristic of its behaviour: the multiplicity of its connectivity, diminished by one, immediately indicates the number of independent conservative quantities, that is, of independent invariant magnetic fluxes.

Actually, however, in the classical experiments of Kamerlingh Onnes, already there have been found magnetic fields 'frozen' in even simply connected supraconductors. It was these permanent fluxes which seemed at that time directly to indicate the elementary phenomenon: an *infinite conductivity*. We, on the contrary, do not consider these experiments as representing the elementary case of the phenomenon, but rather as a relatively complicated affair which can be reduced to a still more elementary phenomenon.

According to our conceptions, we interpret these magnetic fluxes 'frozen' in the interior of the supra-

conductors as follows⁶: One knows that the presence of a magnetic field exceeding a certain critical value H_T (depending on the temperature T) destroys the supraconductivity. Now it can happen that some magnetic fluxes are confined in certain regions of the metal in such a manner that the critical magnetic field is there exceeded, whereas in the supraconducting regions the supraconductivity is maintained. Thus the appearance of the permanent fluxes should be conditioned by the formation of a complicated structure of the supraconducting and the normal phases in the metal in such a way that the supraconducting regions constitute rings embracing the magnetic fluxes in their non-supraconducting hollows.

6. It is easy to see that, even in very simple experiments, such a *mixed structure of the two phases* must automatically arise. This can be shown by considering, for example, a supraconducting sphere which is brought into a homogeneous magnetic field.

The sphere pushes back the magnetic lines of force and compresses them in the region near the equator. An elementary calculation shows that the intensity of the field immediately on the

*Continued from page 796.

equator (H_e) is one and a half times greater than that (H_∞) at great distance from the sphere :

$$H_e = \frac{3}{2} H_\infty$$

With an external field $H_\infty = 2/3H_T$, therefore, the field on the equator attains just the critical value H_T , whereas everywhere else it is smaller than H_T . When we now intensify the field a little, the supraconductivity will be destroyed in the sphere immediately behind the equator. But then the magnetic field can enter this region and the magnetic lines of force will be less compressed. As a consequence the magnetic field at the equator will be a little less than H_T , and the supraconducting state will here reappear. If now we intensify the field a little more, the supraconductivity will be destroyed anew immediately behind the equator, whilst the supraconducting layer just formed will move farther into the interior of the sphere.

7. At first sight it seems extraordinarily difficult to make such a microstructure of layers accessible to theoretical treatment. To do this it would be necessary to solve a very complicated boundary problem for which the shape of the boundaries has still to be determined, whilst even their number is not yet known. It is possible, however, to avoid this practically insoluble problem, if one abstains from determining that microstructure in detail and rather restricts oneself to considering the *mean values* of the field strengths taken over this microstructure of the phases. Actually it is these mean values of the fields which are above all the object of the experimenter.

The theory of this mixture of the two phases⁷, sometimes called 'intermediate state' is, therefore, nothing but a consistent application of the theory of the 'pure supraconducting' phase ; but formally it forms for itself an independent whole⁸. Here we will only give some of the results.

The variables of the theory of this intermediate state are the *averages* of \mathbf{h} and of \mathbf{e} taken over the microscopic structure. These are the quantities which Lorentz identifies with the quantities \mathbf{B} and \mathbf{E} of Maxwell's theory :

$$\mathbf{B} = \bar{\mathbf{h}} \quad \text{and} \quad \mathbf{E} = \bar{\mathbf{e}}$$

Here we will restrict ourselves to the pure magnetostatic case. The theory can be completely characterized by indicating the free energy F which, it has been calculated, is given by :

$$F = H_T \left[\sqrt{B_x^2 + B_y^2 + B_z^2} - \frac{1}{2} H_T^2 \right] \quad (10)$$

(for $|\mathbf{B}| \leq H_T$)

By its derivatives with respect to B_x, B_y, B_z , the free energy defines the quantities H_x, H_y, H_z

of the macroscopic Maxwell equations. One gets :

$$H_x = \frac{B_x}{\sqrt{B_x^2 + B_y^2 + B_z^2}} H_T, \text{ etc.} \quad (11)$$

This equation can be simply interpreted by stating that in the intermediate state there is a diamagnetic permeability dependent on \mathbf{B} which for $\mathbf{B} \leq H_T$ is given by

$$\mu = \frac{|\mathbf{B}|}{H_T}$$

Moreover, one has the equations

$$\text{curl } \mathbf{H} = 0 \quad \text{div } \mathbf{B} = 0$$

and the usual boundary conditions.

Although on account of equation (11) this theory is not a linear theory (like the theory of the pure supraconducting state or the ordinary Maxwell theory), it is nevertheless of extreme simplicity ; (11) simply states that the magnetic field strength \mathbf{H} is always parallel to the magnetic induction \mathbf{B} , but that it has always the absolute value H_T , independently of the value of \mathbf{B} . From this, among other things, it follows that, in the domain of the magnetostatics of the intermediate state, the magnetic lines of force are always straight lines.

For $\mathbf{B}=0$, however, according to (11) the field \mathbf{H} is not defined as to its intensity or as to its direction. This comes from the fact that for $\mathbf{B}=0$ the pure supraconducting regions become unlimitedly large, which signifies that the description with the mean values \mathbf{B} and \mathbf{H} can no longer be legitimate and that one has now explicitly to apply the equations of the pure supraconducting state to the superconductor as a whole. Obviously the case $\mathbf{B}=0$ cannot simply be considered as a limiting case of the non-linear theory.

8. We cannot enter here into a detailed discussion of the relation between theory and experiment. On the whole, one can say that the results of the theory agree fairly well with the experiments. With respect to the pure supraconducting state there is full agreement. Practically there exist three phenomena only : (1) the permanent current in a ring ; (2) the current without electric field in an open supraconducting wire, which is fed by normal conducting leads ; (3) Meissner's experiment. The consistent representation of these experiments was the basis of our theory. The greater part of the experiments (actually the Meissner effect also) concerns the transition between the normal and the supraconducting state and deals therefore with the intermediate state. Particularly striking in this respect are recent experiments of De Haas and Guinau, of Mendelssohn and of Shoenberg⁹ as to the transition, qualitatively discussed above, of a sphere in a magnetic field. These experiments are in very

good agreement with the statements of our theory of the microstructure. In many cases, it is true, the experiments¹⁰ of the transition phenomena seem yet to be obscured by hysteresis and other retardation effects, which prevent the realization of thermal equilibrium and render difficult the theoretical discussion. The theory can also account qualitatively for these disturbing effects¹¹, though there still remains something to be done. But for a reasonable discussion of these questions we would have to occupy ourselves with much more detail than could be given here.

The macroscopic theory we have discussed shows that it is possible to interpret the phenomena in a way which avoids the paradoxes that seemed hitherto to render impossible any theory of supraconductivity. The new interpretation includes, moreover, a very simple description of the phenomenon in the language of wave kinematics. The next stage will have to be the

development of the electronic basis of this theory. One might presume that the new aspect here presented of supraconductivity may also give an indication for the construction of a molecular model of the superconductor¹².

¹⁰ The following interpretation seems first to have been given by Gorter, C. J., *NATURE*, **132**, 931 (1933). Gorter, C. J., and Casimir H., *Physica*, **1**, 305 (1934).

¹¹ London, F., *Physica*, **3**, 450 (1936); *NATURE*, **137**, 991 (1936).

¹² The magnetostatic part of this theory has also been developed by Peierls, R., *Proc. Roy. Soc., A*, **155**, 613 (1936), quite independently of our conceptions, as a pure phenomenological description of a new 'intermediate' state, different from both the pure supraconductive and the normal state. But it can be shown⁷ that, thermodynamically speaking, the intermediate state has not to be considered as a further independent phase but as a *mixture* of the two phases.

⁹ De Haas, W. J., and Guinau, A., *Physica*, **3**, 182, 534 (1936). Mendelssohn, K., *Proc. Roy. Soc., A*, **155**, 558 (1936). Shoenberg, D., *Proc. Roy. Soc., A*, **155**, 712 (1936).

¹² For example, De Haas, W. J., and Casimir-Jonker, M. J., *Physica* **1**, 291 (1934).

¹¹ London, H., *Proc. Roy. Soc., A*, **152**, 650 (1935). Keesom, W. H., and Van Laer, P. H., *Physica*, **4**, 499 (1937). Grayson Smith, H., *Trans. Roy. Soc. Canada*, **31**, 31 (1937). De Haas, W. J., Engelkes, A. D., and Guinau, O. A., *Physica*, **4**, 595 (1937).

¹² (Added in the proofs). In a paper just published (*Phys. Rev.*, **52**, 214 (1937)), J. C. Slater has tried to sketch such a molecular model for our theory. See also Slater, J. C., *Phys. Rev.*, **51**, 195 (1937), and London, F., *Phys. Rev.*, **51**, 678 (1937).

Bicentenary of the Birth of Galvani

Celebration at Bologna

THE great contribution of Luigi Galvani to the advancement of the sciences of electricity and electro-physiology has been fittingly celebrated by a scientific congress held on October 17-20 at the invitation of the City and University of Bologna, the historic centre of learning where Galvani worked.

Galvani was born on September 9, 1737. In his early years it is recorded that he wished to enter the Church, but that on the insistence of his family he took to the study of medicine, and at twenty-five years of age had become lecturer in anatomy in the University of Bologna. Here his work lay in the field of anatomy and physiology until his great electro-physiological discovery made in 1791. It has been stated that the discovery arose from an observation that when animals were suspended on iron railings by copper hooks, a twitching of the muscles resulted. His published work states, however, that he observed the twitchings in the dissected muscles of a frog's leg whenever a spark was passed from a neighbouring electric machine to some other object, the only condition being that the animal should be in contact with some metal or other good conducting substance. A further experiment showed that the same convulsions could be obtained by the "sole application of some conducting arc", of which one extremity touched the muscles and the other the

nerves or spine of the frog. The motion was believed by Galvani to result from a union of the negative charge of the muscle with the positive electricity proceeding along the nerve.

The discovery attracted the attention of Volta working in Como, who thereupon made an extensive series of experiments. He showed in particular that convulsions could be excited in the legs or other members of the animals by "metallic touching either of two parts of a nerve only or of two muscles" provided only that an arc consisting of two metals was employed. He ascribed the effect seen to the electricity produced by the contact of dissimilar metals, and showed also that the electric current acted not on the muscles directly but through the medium of the nerves. These results, which were communicated to the Royal Society in 1793 by his countryman Cavallo, led directly to his construction in 1800 of the voltaic pile.

At the opening session of the recent Congress attended by the King and Queen of Italy and members of the Government, Prof. Q. Marjorani delivered a commemorative address on the life and work of Galvani. Later in the day the delegates were invited to a formal opening of a library and collection of records of Galvani. For these sessions Bologna made public holiday. The streets were lined with troops; girls from the villages paraded

in traditional costume, the Balilla were out in force, and the sober black of the party uniform contrasted vividly with the splendour of historic costumes and academic robes. We cannot, it seems, compare with the totalitarian States in our devotion to men of science of the past.

The scientific work of the Congress was divided as was fitting into sections dealing with physics, experimental biology and radiobiology. At the plenary session, addresses were delivered by Prof. Niels Bohr on biology and atomic physics, by Prof. E. D. Adrian on the electrophysiology of the sense organs and by Prof. A. Gunsett on radiobiology and radiotherapy.

Prof. Bohr discussed the bearing on biological problems of the latest developments of atomic theory. In particular he discussed how far the limitation of the classical idea of causality resulting from the "Principle of Uncertainty" could serve to harmonize the mechanistic and vitalistic views of biological processes. He pointed out that the absorption of only a few light quanta or perhaps one light quantum is sufficient to produce a retinal impression, and that the limitation to the efficiency of the eye is almost certainly imposed by the atomic nature of the light quantum. It seems probable also that other organs have similar limits. Furthermore, it appears that the regularities peculiar to atomic processes which are foreign to causal mechanics are at least as important for the understanding of the behaviour of living organisms. Atomistic features are therefore of essential importance in biological processes.

The recognition of this importance is not, however, sufficient for a comprehensive explanation of biological processes, and it becomes necessary to examine the position of the vitalists, that a peculiar force unknown to physics governs all organic life. Prof. Bohr believes, however, with Newton that the foundation of science is the belief that Nature under the same conditions will always exhibit the same regularities. If, therefore, the analysis of the mechanism of living organisms could be probed as far as that of atomic phenomena, one would scarcely expect to find any features differing from the properties of inorganic matter.

It is necessary to remember, Prof. Bohr continued, that biological experiments differ from physical experiments in the necessity for keeping the organism alive, and that this restriction imposes uncertainties as to the physical conditions to which they are subjected. It might well be that this uncertainty is just sufficient to allow the organism to conceal from us the secrets which are connected with life, just as in physical experiments the disturbance produced by observation often prevents a strictly causal description of the phenomena. Great caution should, however, be

exercised in such considerations, and he considered that quite unwarranted applications of the "Principle of Uncertainty" have been made by many writers.

Prof. E. Fermi gave an account of the beautiful experiments carried out by his school in Rome on the properties of neutrons and on the important information obtained on the position and life of excited states of nuclei. He described experiments which show that fast neutrons lose the greater part of their energy on scattering by heavy nuclei such as lead.

Prof. G. v. Hevesy gave an account of his work on the use of radioactive phosphorus as an indicator in biological processes. Radiophosphorus, which can be produced in large quantities by a transmutation process, emits electrons and decays with a convenient period of 14 days. By adding radiophosphorus to the food of animals, the path of the phosphorus atoms can be traced through the different stages of the metabolic process. Thus the greatest part of the phosphorus enters the blood stream, and after a few minutes the bulk of the phosphorus atoms present in the blood in the phosphate stage will exchange places, principally with those present in the skeleton but also with those present in the muscles and other organs. At an appreciably slower rate proceeds the synthesis of the numerous organic phosphorus compounds present in the organism.

Prof. P. Debye described new experiments on the dielectric loss in liquids, using undamped electric waves having a wave-length of the order of a centimetre. The experiments show that molecular rotation does not play a great part in the dielectric loss, probably owing to the rotation being prevented by the quasi-crystalline structure of the liquid. The loss seems rather to result from relative motion of the component units of the molecule.

Prof. W. Bothe gave two new examples of the existence of radioactive isomers—atomic nuclei having the same charge and mass but having different decay constants. Thus ^{80}Br can be produced either by adding a neutron to ^{79}Br or by detaching a neutron from ^{81}Br . In both cases two radioactive products are produced having half-lives of 18 min. and 4.2 hours. He gave also new information on the resonance energies of light nuclei, showing that the same resonant states can be produced by different types of transmutations.

Prof. W. Heisenberg discussed the mechanism of shower production by cosmic rays. He differentiated between two processes. In the cascade process, showers are built up from the successive conversion of electron energy into radiation, radiation into pair production and then further loss of electron

energy to radiation. This process, described theoretically by the theories of Oppenheimer and Coulson, Bhabha and Heitler seems to be confirmed by Wilson chamber photographs of Street and Stevenson showing the 'build up' of the shower. A second process results from the conversion of the energy of a heavy particle into positive and negative electrons through the intermediary of proton-neutron transitions. Experimental results on cosmic rays were discussed by Prof. B. Rossi.

Dr. F. W. Aston gave an account of his recent measurement on the masses of nuclei by the method of close doublets, and Prof. M. L. E. Oliphant and Dr. J. D. Cockcroft described other recent work at the Cavendish and Mond Laboratories, Cambridge, including a description of the new High-Voltage Laboratory and its equipment and the recently reported peculiar properties of liquid helium.

In all, about twenty physical papers were communicated to the Congress.

Obituary Notices

Mr. W. S. Gosset: "Student"

WILLIAM SEALY GOSSET, who died after a short illness on October 16, was best known to statisticians throughout the world by his pseudonym "Student", under which his scientific contributions were published. He was born on June 13, 1876, and became in turn a scholar at Winchester and at New College, Oxford, where he worked at mathematics and chemistry. In 1899 he joined the firm of Arthur Guinness, Son and Company, and a few weeks before his death had been appointed head brewer; his handling of statistics was only one of many duties.

Gosset's work brought him at an early stage against the problem of interpreting routine tests in chemical analysis, and at the suggestion of one of his chiefs he turned his mind to the question of what help the theory of probability could bring to the practice of brewing. He first met Karl Pearson in the summer of 1905, and a year later went to London to spend some months in the Biometric Laboratory at University College. Throughout his life he was to gain much from the continuation of this contact between 'student' and 'professor', but from the very beginning he launched out on research lines of his own which were to prove of very great importance to the development both of the theory and practice of mathematical statistics.

Under Galton, Weldon and Pearson, the Biometric School had been mainly concerned with the handling of comparatively large samples from biological populations, but Gosset in his daily work was forced to attempt to draw conclusions, leading to executive action, from the analysis of relatively small numbers of observations. Thus he might need to answer such a question as, "What is the accuracy of this arithmetic mean based on 8 observations (the population standard deviation being unknown)?" Thirty years ago a statistician was forced to reply somewhat as follows: "Following the method appropriate for large samples the odds are 19 to 1 that your unknown population mean lies between (say) 22.1 and 24.6, but as the sample is so small this statement is entirely unreliable." Gosset's work has, however, made possible a far more useful answer, namely, "If you have taken reasonable precautions to see that your sample is randomly selected, the odds are 19 to 1 that the

limits 21.8 to 24.9 include the unknown population mean." At the expense of somewhat broadening the limits which before had little meaning, definite information has replaced a counsel of despair. The process of making full allowance within the statistical test itself for uncertainty regarding the standard deviation due to small numbers, by use of what in fact are ratios instead of absolute measures, has sometimes been termed 'studentizing'; the conception involved has been the basis of a rapid theoretical advance without which many of the problems of agriculture and industry could scarcely have been brought within the range of statistical inquiry.

But Gosset's contribution was only in part theoretical one; he recognized the risks involved in basing action on the application of statistical calculations to few observations, yet all his work as a practical statistician in industry went to show that, with due precaution, these risks could be taken with economic advantage. Thus all that he wrote, whether on the reliability of the mean and standard deviation, methods of measuring correlation, on the problem of counting cells with a hæmocytometer or on the checking of routine analysis, helped to give confidence to those who were trying to apply similar methods in the face of scepticism or even opposition.

Besides dealing with questions which concerned the chemist and biologist, Gosset's work led him into the field of agricultural experimentation. His paper of 1923 "On Testing Varieties of Cereals" was one of the most important early contributions to an enterprise which has been notable for the introduction of precise statistical methods into agricultural research. His influence spread very widely in later years, not only through the medium of his written papers, but also through a correspondence which linked him with experimenters all the world over. He was always ready with advice and friendly criticism, and must have gained from his suggestive mind the initial ideas which have borne fruit in their later research.

Much could be written, if space allowed, of the charm of Gosset's personality, with its modesty, unobtrusiveness, conventionality and tolerance. It is to be hoped that it will be possible to do fuller justice elsewhere to a man who has occupied a very special place in the hearts of so many friends in Great Britain and abroad.

E. S. P.

The Right Hon. J. Ramsay MacDonald, F.R.S.

THE sudden death of Mr. Ramsay MacDonald from heart failure, on Tuesday night, at seventy-one years of age, while on a voyage to South America, will be deeply regretted by his many friends in scientific circles. He left England on November 4 for a three months' holiday, which he described as "the first he had ever had free from care", and a wireless message stating that he passed away on November 9, at 8.45 p.m., was received a few hours later.

Mr. MacDonald's last speech in public was made at the Royal Institution on October 22, when he delivered the Radford Mather lecture of the British Association on "Science and the Community". The main part of this discourse was published in *NATURE* of October 30, and it is of melancholy interest to record that the same issue contained personal appreciations of the work and influence of his friend, Lord Rutherford, to whom he referred in terms of affectionate regard in his lecture.

As a young man, Mr. MacDonald was a keen student of science, and it was through the accident of circumstances that his interests were diverted into social and political fields. When he went to Bristol more than fifty years ago, to take charge of a boys' club, his ambition was to become a science teacher, and he took particular interest in geology. It happened, however, that he came into contact with a very remarkable group of social reformers in Bristol at that time and soon associated himself with their movement. Even when he left Bristol to come to London he continued his studies of scientific subjects at the Birkbeck College and privately with the view of obtaining a scholarship or exhibition upon successful results in the old Science and Art Departments examinations. It was impossible, however, for him to find sufficient time for the intensive study required, outside his daily working hours, to prepare himself for one of the scholarships then tenable at the Normal School of Science, South Kensington, now the Royal College of Science, and he had to abandon his early hopes.

It was through his social work that Mr. MacDonald became associated with the daughter of Dr. J. H. Gladstone, F.R.S., the distinguished chemist, and niece of Lord Kelvin, and they were married in 1896. They worked together for social reform in complete sympathy until Mrs. MacDonald's death in 1911; one of their two sons is Mr. Malcolm MacDonald, Secretary of State for Dominion Affairs.

After Mr. MacDonald had resigned his office as Prime Minister and First Lord of the Treasury in 1935, he became Lord President of the Council, and as such was responsible to Parliament for the reports of the Department of Scientific and Industrial Research, in the work of which he took particular interest. He was elected a fellow of the Royal Society in 1930 under the special rule which provides for the election of a limited number of persons who "have rendered conspicuous service to the cause of science". He was elected a member of Parliament for the Scottish Universities in 1936 and held this seat at the time of his death. This is not the place to survey

his political career or his influence as a statesman, but we are glad to express grateful appreciation of the encouragement he always gave to scientific work and to record the esteem in which his memory is cherished in scientific circles.

Prof. E. J. Rapson, F.B.A.

WE regret to record the death of Prof. E. J. Rapson, professor of Sanskrit in the University of Cambridge, which took place suddenly at Cambridge on October 3, at the age of seventy-six years.

Edward James Rapson, the son of the Rev. E. Rapson, vicar of West Bradley, Somerset, was born on May 12, 1861, and was educated at Hereford Cathedral School and St. John's College, Cambridge, where he was elected a classical foundation scholar in 1883. He studied Sanskrit under Cowell and Bendal, taking a first class in the Classical Tripos of 1883 and the Indian Languages Tripos two years later. He was awarded the Brotherton Sanskrit scholarship in 1885 and the Le Bas prize in 1886, and was elected to a fellowship at St. John's in the following year. In the same year he became librarian of the Indian Institute, Oxford, where he was associated with the then Boden professor, Sir Monier Monier-Williams. A few months later he joined the staff of the British Museum, taking charge of the collection of Indian coins. In 1903 he was appointed professor of Sanskrit in University College, London, and in 1906 went to Cambridge, where he occupied the chair in Sanskrit until his retirement in 1936, when he was accorded the title of emeritus professor.

Pre-eminent as scholar and teacher in Sanskrit, it was through palæography and numismatics, and more especially the numismatics of the early Indian dynasties, that Rapson made his outstanding contributions to Indian studies. When he joined the staff of the British Museum, knowledge of the early history of India was largely a blank. It was in great part owing to his studies that this gap has been filled to no little extent. Of this the evidence will be found in his "Indian Coins" (1897), his contributions to the British Museum catalogue of Indian coins, and his communications in the *Numismatic Chronicle*, of which he was editor, the *Journal of the Royal Asiatic Society*, and other scientific and learned periodicals. His abilities as scholar and historian found wider scope as editor of the first two volumes of the "Cambridge History of India". The first volume, on Ancient India, to which he himself contributed four chapters, was published in 1922; but the second is still uncompleted, though the later volumes have appeared.

WE regret to announce the following deaths:

Prof. H. B. Fantham, Strathcona professor of zoology in McGill University, Montreal, since 1933, professor of zoology and comparative anatomy in the University of the Witwatersrand, Johannesburg, in 1917-32, on October 27, aged sixty years.

Dr. J. A. Voeleker, C.I.E., consulting chemist to the Royal Agricultural Society of England, on November 6, aged eighty-three years.

News and Views

Royal Society Medallists and Officers

HIS MAJESTY THE KING has been graciously pleased to approve the following recommendations made by the council of the Royal Society for the award of the two Royal Medals for the current year: Prof. N. V. Sidgwick, in recognition of his distinguished, stimulating and continuous work on valency and on molecular structure; Prof. A. H. R. Buller, in recognition of his researches on the general biology and sexuality of the Fungi. The following awards have been made by the president and council of the Royal Society: Copley Medal to Sir Henry Dale, in recognition of his important contributions to pharmacology, particularly to the pharmacology of muscle and of neuromuscular transmission; Davy Medal to Prof. Hans Fischer, in recognition of his work on the chemistry of the porphyrins, particularly his determination of their detailed structure by degradation and his syntheses of porphyrins of biological importance; Buchanan Medal to General F. F. Russell, in recognition of his work in relation to public health problems in many parts of the world on behalf of the International Health Division of the Rockefeller Foundation; Sylvester Medal to Prof. A. E. H. Love, in recognition of his researches in classical mathematical physics, particularly the mathematical theories of elasticity and hydrodynamics; Hughes Medal to Prof. Ernest O. Lawrence in recognition of his work on the development of the cyclotron and its application to investigations of nuclear disintegration. The following is a list of those recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on November 30: *President*, Sir William Bragg; *Treasurer*, Sir Henry Lyons; *Secretaries*, Sir Frank Smith and Prof. A. V. Hill; *Foreign Secretary*, Sir Albert Seward; *Other Members of Council*, Prof. R. Whytlaw-Gray, Prof. G. P. Thomson, Prof. J. Proudman, Prof. D. M. S. Watson, Dr. F. L. Pyman, Prof. E. J. Salisbury, Prof. S. P. Bedson, Prof. M. Greenwood, Prof. J. Mellanby, Sir Thomas Holland, Dr. G. T. Bennett, Prof. J. Chadwick, Prof. D. Keilin, Prof. J. Graham Kerr, Sir Robert Pickard, Mr. H. R. Ricardo.

Ludwig Stieda (1837-1918)

CHRISTIAN HERMAN LUDWIG STIEDA, an eminent German anatomist, was born at Riga on November 19, 1837, the son of a tradesman. His medical education was carried out at Dorpat, where his teachers in anatomy were Reissner, Bidder and Kupffer, and he won a silver medal in anatomy. After qualifying in 1861 he went to Giessen, where Leuckart inspired him with an interest in the anatomy of worms, and later to Erlangen, where he studied under Gerlach and Herz. In 1862 he moved to Vienna, where he attended lectures by Oppolzer, Skoda, Hebra, Hyrtl

and Bruecke, with the last of whom he studied histology. In 1864 he was appointed prosector Dorpat and in the following year lecturer on comparative anatomy in the veterinary school there. In 1866 he was elected extraordinary professor of anatomy and nine years later full professor in succession to his former teacher Reissner. He held this office for ten years, during the last three of which he was dean of the medical faculty. In 1885 he was appointed director of the anatomical institute at Königsberg, where he remained until his retirement in 1912. His death took place at Giessen on his birthday on November 19, 1918. As well as being a successful and attractive lecturer, Stieda was a man of very wide interests and a prolific writer, as shown by the bibliography of his works compiled by Peisler (*Anat. Anzeiger*, 52, 134-42; 1919-20). His anatomical investigations included comparative studies of the central nervous system in vertebrates, the formation of bone, and the development of the lungs, thymus, thyroid and carotid glands. His interest in the history of medicine is shown by his biographies of naturalists and medical men. He was also the author of several articles and reviews on archæological, anthropological and ethnographical subjects.

The Writings of Galvani

IN connexion with the commemoration at Bologna of the bicentenary of the birth of Galvani, attention may be directed to an interesting memoir in *Annals of Science*, 1, No. 3, July 1936, by Prof. J. M. Fulton and Prof. H. Cushing, of the Yale University School of Medicine, entitled "A Bibliographical Study of the Galvani and the Aldini Writings on Animal Electricity". Modest and shy, Galvani showed the greatest indifference to having his name appear in print, and thus out of all the known courses or lectures prepared by him during the twenty-five years between his professorial appointment and the appearance of his famous "De vitiis electricitatis", only three, making a total of thirty printed pages, appear to have been published. Galvani's lack of self-assurance was not, however, shared by his nephew Giovanni Aldini (1762-1834), professor of physics in the University of Bologna, and it was he who took up the cudgels in defence of his uncle's thesis. Galvani's memoir appeared early in 1791 and two reprints were issued the same year. Next year, after Volta's criticism of Galvani's views, Aldini published an edition with annotations, and a German translation was made by Dr. J. M. Mayer (1752-1807) in 1793. The subject of animal magnetism had by then become a matter for widespread controversy. Galvani died in 1798, but a year or two later Aldini visited England, gave lectures on galvanism at Guy's and St. Thomas's Hospitals and was presented with a gold medal. His "Improvement

in Galvanism", printed in London in 1803, has the title-page embellished with a representation of the medal. Altogether twenty-eight items are included in the bibliography, all of them being very fully described, while there are photographs of several of the title-pages.

Radcliffe Observatory, Pretoria

THE date of completion of the 74-inch reflector for the new Radcliffe Observatory at Pretoria has been further postponed by a second unsuccessful attempt to cast the disk of Pyrex glass for the large mirror. The first disk was cast by the Corning Glass Company in July 1936, and on being taken from the annealing oven in the following December was found to be useless. A second disk was cast in June of this year, and the disappointing, and unexpected, news has recently been received that this disk also has been a failure. The company is proceeding to make a third disk, and it is to be hoped that on this occasion better fortune will attend its efforts. The other arrangements, though somewhat behind schedule, have been proceeding with greater smoothness. The buildings of the Observatory on the magnificent site to the south-east of Pretoria, 600 feet above the city, which was generously presented to the Radcliffe Trustees by the municipality, are nearly completed. They consist of an office block, three residences and the circular building of brick and concrete to house the telescope.

THE Radcliffe observer (Dr. H. Knox-Shaw) and Mr. E. G. Williams, the second assistant, have already taken up residence at the Observatory, but Dr. R. O. Redman, the chief assistant, is remaining in England for the present to superintend the construction of subsidiary apparatus. The steel revolving turret, under construction by the Cleveland Bridge Company, is due to reach Pretoria early in the new year, to be followed a couple of months later by the mechanical parts of the telescope, which Sir Howard Grubb, Parsons and Co. have nearly finished. It had been planned to have the large mirror for the 74-inch telescope aluminized when completed, in view of the marked success of this form of reflecting surface as applied to the large mirrors in America. There is, however, no apparatus in England capable of dealing with a mirror of this size, and the estimated cost of the outfit, vacuum chamber and pumps, namely, £1,500, is much more than the resources of the Radcliffe Trustees, already greatly strained by the recent rise in the cost of materials, can afford. It seems likely, therefore, that the new telescope, although thoroughly up to date in other respects, will have, at any rate to begin with, a silvered mirror.

Exhibition of Wilson Track Photographs

It is now twenty-five years since C. T. R. Wilson first succeeded in making visible and photographing the tracks of single ionizing particles by his condensation method. An exhibition has been arranged at the Science Museum, South Kensington, to

illustrate the great variety of effects which have been investigated by means of Wilson chambers during the past twenty-five years. The exhibition will be open free to the public from November 19 until the end of February 1938. The centre-piece of the exhibition is Wilson's original apparatus with which the photographs published in 1912 were taken; the apparatus has been kindly lent by the Cavendish Laboratory, Cambridge, where Wilson's pioneer work was carried out. The remainder of the exhibition consists of a collection of more than eighty photographs, which have been contributed by research workers from many countries. An introductory group of twelve photographs illustrates in as simple a way as possible some of the main properties of alpha and beta rays, X-rays and cosmic rays, for the benefit of those who are not familiar with them. The main collection of photographs is arranged in a series of groups showing typical effects produced by alpha, beta and gamma rays, X-rays, protons, deuterons, neutrons and cosmic rays, while a small group illustrates the phenomenon of induced radioactivity. The section devoted to cosmic rays includes a copy of the photograph taken by Anderson in 1932 which gave him conclusive evidence for the existence of the positive electron, while the discovery of cosmic-ray 'showers' is illustrated by copies of Skobelzyn's pioneer photographs, from which he showed that pairs and groups of 'straight' cosmic ray tracks occur more frequently than is to be expected by chance. In order to bring home to visitors to the exhibition the three-dimensional character of Wilson tracks a number of pairs of stereoscopic transparencies have been mounted for viewing in turn in a stereoscope. A small handbook (London: Science Museum, or H.M. Stationery Office, 6d., by post 7d.) has been prepared by Dr. F. A. B. Ward, an officer of the Museum, who has arranged the exhibition.

Indian Hydro-electric Development

THE hydro-electric power scheme, known as the "Ganges Grid", was formally inaugurated on November 2, when Sir Harry Haig, Governor of the United Provinces, opened two new generating stations near Meerut, which are supplied with water-power from the Ganges Canal. The potentialities of the canal as a source of power were first investigated in 1920 in connexion with a series of local applications, and these gradually led to the development of the available resources on a larger scale, in order to extend the benefits of agricultural irrigation over a wide area. The exploitation of the "Grid" project has cost Rs. 343 lakhs (more than £2,500,000) and it now produces a gross output of 29,000 kilowatts. The energy is distributed by means of some four thousand miles of transmission lines to 1,600 sub-stations scattered over the eight western districts of the United Provinces; thence it is supplied to 88 towns for the purpose of pumping water from rivers or from State tube-wells for land irrigation. The power is also utilized to work agricultural machinery on private farms. Sir Harry opened at the same time the State tube-well irrigation system, consisting

of considerably more than a thousand wells, the greater number of which are in operation and irrigate an area of a million and a half acres. The capital outlay on the system has been about Rs. 126 lakhs (£945,000). The execution of the "Grid" project has been in the hands of Sir William Stampe, formerly chief engineer of the Irrigation Department of the United Provinces.

Tring Museum

ABOUT the time of the recent meeting of the British Association in Nottingham, it was announced in the Press that the late Lord Rothschild had bequeathed the buildings and collections of his museum at Tring to the nation on condition that the trustees of the British Museum should undertake their custody and maintenance. The president of the Association, Sir Edward Poulton, expressed in his address the hope that this condition would be accepted, and the committee of Section D (Zoology) forwarded a resolution to the Council, recording its opinion "that the continuance of the Tring Museum as an active centre of scientific research is a matter of the utmost importance from a national, and indeed from an international, point of view. For many years", the resolution continues, "the collections preserved there, more particularly the vast and unequalled collection of Lepidoptera, have attracted research workers from all over the world and have been the means of adding largely to our understanding of the problems of geographical variation. The Sectional Committee earnestly desire that the permanent conservation of these collections and the continuance of the facilities for their study provided by the munificence of the late Lord Rothschild will be ensured by their being placed in the custody of the Trustees of the British Museum." The Council of the Association has now adopted this resolution.

Royal Institute of International Affairs

THE report of the Council of the Royal Institute of International Affairs submitted to the eighteenth annual general meeting on November 2 refers to the establishment of a chair of international economics at the Institute, Chatham House, London, S.W.1, as a result of a gift of £20,000 from Sir Henry Price. Prof. Allan G. B. Fisher, of the University of Western Australia, has been appointed as the first holder of this chair and will assume his duties in January 1938. It is hoped that this is the first of what will become a group of research chairs devoted to the study of international affairs, and the council contemplates the establishment of research chairs in British Commonwealth relations, international law and institutions and Far Eastern affairs as soon as provision can be made for them. In addition to these important developments, which were largely inspired by the work of Prof. Arnold Toynbee, holder of the Stevenson research chair in international history, the council has been able to maintain its programme of research by individual scholars and by study groups through the support of the trustees of the Rockefeller

Foundation, who in January 1937 renewed for further five years their grant of £8,000 a year. For reports in the Study Group Series were completed during the year, covering "The British Empire", "The Problem of International Investment", "The Colonial Problem" and "The Republics of South America: a Political, Economic and Cultural Survey". Particulars of these, and of other publications of the Institute, are included in an appendix. The Rockefeller Foundation has also made a special grant for a investigation of the refugee problem. The report includes particulars of a number of other research projects which are in progress as well as meetings held and study groups in being. It is expected that the African Research Survey will be completed and published early in 1938, the preliminary survey having been extended to cover administrative economics, scientific research and social relations.

Tyneside Geographical Society

THE Tyneside Geographical Society celebrated its fiftieth year of existence at Newcastle-upon-Tyne on November 4-6. On November 4 a jubilee meeting was held with the president of the Society, the Duke of Northumberland, in the chair. The chief speaker at this meeting was Sir William Goodenough, who was one of the two representatives of the Royal Geographical Society at the celebrations. After the meeting, a dinner was held at the Royal Station Hotel, when Lord Polwarth, president of the Royal Scottish Geographical Society, proposed the health of the Tyneside Geographical Society. Sir Thomas Oliver acknowledged the toast and included in his response references to the past activities of the Society over the last fifty years. The health of the guests was proposed by Mr. Herbert Shaw, who held the office of secretary of the Society for nearly forty years. He expressed the gratitude of the Society to the Royal Geographical Society, the Royal Scottish Geographical Society, the Geographical Association and the Manchester Geographical Society for sending representatives to the celebrations. The toast was acknowledged by Lord Eustace Percy, rector of King's College, and by Prof. E. G. R. Taylor, Birkbeck College, University of London. On November 5 the Herbertson Memorial Lecture of the Geographical Association was delivered in King's College by Prof. A. G. Ogilvie, of the University of Edinburgh. The subject of the lecture was "Mineral Land Forms and Life". On November 6 an exhibition of geographical materials, publications and appliances was held, the official opening ceremony being performed by Lord Eustace Percy.

County Library at Ruislip

THAT a timbered barn, reputed to be of medieval age, used in olden days for the storage of corn and later for haybinders' work and general farm produce might be saved by its own appeal through adaptation for the needs of a public county library is a consideration which might well enter the minds of educational authorities in those rapidly expanding rural areas where sites are valued at exorbitant rates.

of purchase. On November 2, Prof. J. H. Clapham, vice-provost of King's College, Cambridge, performed the ceremony of opening at Ruislip, Middlesex, the "Little Barn" (so called for generations) appertaining to the ancient Manor of Ruislip, and now being used as a county library. The homestead of the farm, it should be said, originally constituted, with the acres around, but a fraction indeed of the extensive tracts owned formerly at Ruislip by King's College, Cambridge, the gift of its founder, Henry VI. Not long ago, the College conveyed the farm and surrounds to the people of Ruislip as a gift. Hence the presence of Prof. Clapham was specially opportune and relevant to the occasion. The requisite funds for the adaptation and library furnishing equipment of the barn for its new purposes were provided by the Middlesex County Council, supported by the unwearied efforts of the Middlesex Education Committee. It is of interest to record that Mr. T. E. James, formerly clerk to the Royal Society, who lives at Ruislip, has been appointed by the Middlesex County Council as a representative on the Ruislip-Northwood Local Library Committee.

Oils from Irish Grown Plants

CORK UNIVERSITY PRESS has issued an Agricultural Bulletin, No. 4, with this title. It contains the record of some small-scale experiments, carried out at Cork and elsewhere in the Irish Free State, on the possibility of producing supplies of oil seeds upon Irish soils. Crops of hemp, linseed, poppy, sunflower, rape, mustard and *Mercurialis annua* have been raised with varying success, and the yield of oils determined, as also the main physical chemical characteristics of the extracted oils. The work has been under the direction of Prof. J. Reilly and Mr. Denis F. Kelly, of the Department of Chemistry, University College, Cork. Very indifferent success was met with in these preliminary trials with the annual sunflower and *Mercurialis*, and the authors seem most impressed with the possibilities of native-grown poppy seed oil displacing cotton seed oil in the edible fat and soap industries in Ireland. These trials are, however, of a very preliminary nature; they throw very little light upon the possibility or otherwise of large-scale cultivation of these crops under Irish conditions, but they do establish the yields and main characteristics of the oils to be expected from such oil seeds grown under such conditions.

Horticultural Research in Australia

THE opening in September of a new laboratory under the Commonwealth Council for Scientific and Industrial Research at Merbein, Victoria, is an indication of the store now set by viticulturists on the provision of scientific services for their guidance. Merbein is in the Mildura district on the River Murray, where the first irrigation settlements were established some fifty years ago. Marked changes have taken place of late in horticultural practices in these areas, following particularly upon studies of soils with consequent modification of quantity and frequency of watering, and upon introduction

of communal drainage schemes. The former danger of ruin of blocks by 'salting', or bringing sodium sulphate and chloride and other salts to the surface by excessive watering and insufficient drainage, is almost a thing of the past. The Council is now preparing plans for a further new laboratory at its citricultural research station at Griffith, N.S.W., in an area watered from the Burrinjuck Dam on the Murrumbidgee River.

National Institute of Agricultural Botany

ON the occasion of the annual general meeting of fellows of the National Institute of Agricultural Botany at Cambridge, the chairman of the council, Captain D. M. Wills, directed attention to the value of the Institute's system of substations. By means of this organization the Institute is able to make recommendations to farmers which are applicable to all districts (with two exceptions) south of a line drawn between Lancaster and Scarborough. There are at present two defective links in the Institute's chain of substations—the Fens and Wales—and the Institute hopes that these defects will shortly be remedied. At present there are substations at Sprowston, Norfolk; Long Sutton, Hants; Cannington, Somerset; Newport, Shropshire; and Askham Bryan, Yorks; on soils ranging from blowing sand to heavy clay. In every case these substations are attached to an agricultural college, institute or station, and the trials are carried out under the supervision of a crop recorder who is responsible to the N.I.A.B. Although the primary purpose of a substation is the provision of trials upon which recommendations can be based, Captain Wills stressed the importance of another aspect of their work. It is possible for a farmer to visit any of these to see, under conditions which may be very similar to his own, trials of the latest introductions of plant breeders both at home and abroad, growing side by side with established varieties. This should enable him to form an opinion as to the suitability—or otherwise—of new varieties to his particular conditions. Finally, Captain Wills expressed the hope that the establishment of a substation in Wales would lead to the discovery of varieties particularly suited to the poorer soils, both in England and Wales.

Mass Observations of Social Problems

"MASS-OBSERVATION" by C. Madge and T. Harrison, with a foreword by Dr. Julian Huxley, the first of a series of projected pamphlets, outlines the technique of a study of social environment and its effects on lines comparable with much bird-watching and observation of natural history, since, largely because of its empiricism, it has, like them, room for the untrained amateur as well as for the trained man of science (London: Frederick Muller, Ltd., 1937. 1s. net). The three sciences most immediately relevant to mass-observation are psychology, anthropology and sociology, and a fundamental plan for research will be evolved by the central organization as a result of suggestions from observers and scientific experts. In the first place, it is intended to mobilize

a numerous and representative corps of observers and to equip and maintain an efficient central organization in touch with all other relevant research associations, however different their methods. The observers will collect their data, which cover as wide a field as possible in order to provide sufficient cross-references to indicate the probable nature of the bias in any individual report. The scientific expert will be required not only as an observer himself but also in drawing up the plan of work, framing well-constructed hypotheses to be tested by mass-observation methods and in suggesting subjects for detailed inquiry, as well as in the interpretation of the data collected and in securing a more rigorous objectivity. The presentation of the results involves further problems, as not only must facts be collected over the widest possible field, but also they must be made known to the widest possible field. As soon as possible, pamphlets at present projected will deal with such questions as popular superstitions, reasons for watching birds, the meaning given to freedom, and will be based on the work of the observers. They will be followed by cheap editions of relevant scientific books, and a monthly bulletin designed for wide circulation is also contemplated. The central office and filing system is at 6 Grote's Building, Blackheath, London, S.E.3.

Mould and Bacteria Killed by New Lamp

In the *International Merchant*, a monthly pamphlet published by the Westinghouse Electric International Company at New York, a description is given of the 'Sterilamp', a gaseous conductor tube which produces very decided germicidal radiation at low temperature and low cost. It has taken nine years to develop. It is claimed that it prevents the growth of mould and bacteria on the surface of meat aged at high temperature and high humidity. It also retards the growth of mould on bakery products. Tests have shown that the lamp is useful in pasteurizing milk and beer. It is particularly useful in sterilizing conditioned air. The lamp generates radiant energy of a particular wave-length of which 90 per cent is in a region of the radiant spectrum which has been found to be strongly germicidal. It is made in lengths of 10, 20 and 30 inches, and the 20-inch size requires only 7 watts. Of great importance when making applications to food is the fact that the unit operates at a temperature only about 5° F. above that of the room. The lamp and auxiliary equipment is now on the market.

W. Watson and Sons, Ltd.

MESSRS. W. WATSON AND SONS, LTD., of 313 High Holborn, London, W.C.1, have issued a booklet detailing the history of the firm in celebration of its centenary. Founded in 1837 for the manufacture of optical instruments by William Watson at 71 City Road, the business continued at this address until 1861, when it moved to 313 High Holborn, where it has since remained, and has been continuously carried on by members of the Watson family. The microscope was becoming a feature of the Watson firm in the 'seventies of last century, together with

cameras and lenses, since when telescopes, X-ray equipment, cinematographs, projection lanterns and other optical instruments and apparatus have been manufactured. A pleasing portrait of William Watson, the founder, forms a frontispiece to the booklet, which concludes with a series of plates illustrating the products of the firm during the hundred years of its existence.

Gift to the Royal Cancer Hospital

MR. A. CHESTER BEATTY, who has recently been elected vice-president and a member of the committee of the Royal Cancer Hospital, has purchased the Freemasons' Hospital, Fulham Road, with the intention of presenting the building for conversion into the Research Institute of the Hospital, and Mr. Chester Beatty is equipping the building for this purpose in addition to presenting it to the Hospital. It is well known that the Royal Cancer Hospital has maintained a research institute for many years under the direction of Prof. E. L. Kennaway. Mr. Chester Beatty is also generously entirely re-equipping the Radio-therapeutic Department of the Royal Cancer Hospital, at a cost of some £13,000, with the latest modern high-voltage X-ray therapy apparatus embodying many new features which will prove of inestimable value, not only in the treatment of cancer but also in affording full and adequate protection to both patients and operators during the carrying out of the treatment. The Royal Cancer Hospital is a school of the University of London and, in order to encourage the study of radiology, Mr. Chester Beatty has provided a travelling scholarship which has been accepted by the senate of the University of London. The scholarship will enable a student of radiology, after obtaining the academic diplomas in medical radiology, to spend a year in one of the great radiological clinics of the United States of America.

The National Health Campaign

LAST week, November 1-6, marked the beginning of the second month of the National Health Campaign, which was recently inaugurated by the Prime Minister, and this period has been devoted to the general aspects of the campaign and has aroused considerable public interest. During November and December special emphasis is being laid on the services available for mothers and infants, while in January next the child at a later stage, the school age, will be considered, together with the value of co-operation between home and school. The medium of the campaign varies; numerous posters and leaflets have been issued, public meetings and films have been arranged, and the support of the Press and of the wireless is expected.

Announcements

MISS JEAN BATTEN has been awarded the Gold Medal of the Royal Aero Club in recognition of her many Empire flights.

DR. A. G. FRANCIS has been appointed deputy Government chemist in succession to Mr. Andrew More, who retired on November 3.

THE following appointments have recently been made in the Colonial Service: M. Akenhead, agricultural superintendent, Gold Coast; W. E. T. Bond, agricultural officer, Nigeria; J. S. P. Beard, assistant conservator of forests, Trinidad; R. M. Harley, assistant conservator of forests, Gold Coast; C. A. Banister, dairy bacteriologist, Malta; D. R. Buxton, entomologist, Sleeping Sickness Service, Nigeria; J. Cherry, air survey draughtsman, Tanganyika; K. E. Cowan, inspector of plants and produce, Gold Coast; D. E. Davis, assistant analyst, Medical Department, Hong Kong; W. G. Evans, sleeping sickness control officer, Nigeria; R. K. J. Gascoigne, field officer, Tsetse Research Department, Tanganyika; E. G. Harmer, sleeping sickness control officer, Nigeria; H. Hirst, adviser in animal husbandry, Malta; R. E. Hunter, chief fruit inspector, Palestine; R. R. E. Jacobson, geologist, Nigeria; F. Jones, sleeping sickness control officer, Nigeria; E. M. Kidner, sleeping sickness control officer, Nigeria; R. B. Stonehouse, assistant meteorologist, West African Meteorological Service; I. P. Tamworth, assistant superintendent, Botanical and Forestry Department, Hong Kong; P. E. Trevor, sleeping sickness control officer, Nigeria; E. A. Walters (agricultural superintendent, St. Lucia), agricultural superintendent, Gold Coast; R. Daubney (chief veterinary research officer), director of Veterinary Services, Kenya; J. R. Hudson (veterinary research officer), deputy director of Veterinary Services (Laboratory Services), Kenya; R. W. M. Mettam (veterinary pathologist, Uganda), veterinary pathologist, Nigeria; E. J. Mulligan (senior veterinary officer), deputy director of Veterinary Services (Field Services), Kenya; H. Atkinson (deputy government analyst, Ceylon), government chemist, Cyprus; R. J. Johnston (assistant surveyor general), deputy surveyor general, Ceylon; I. F. Wilson (superintendent of surveys), assistant surveyor general, Ceylon; L. G. Woodhouse (deputy surveyor general), surveyor general, Ceylon.

THE trustees of a fund raised to commemorate Sir William Simpson, the well-known authority on tropical diseases, have offered the London School of Hygiene and Tropical Medicine the fund for the establishment of a prize to be awarded annually to a student obtaining the highest marks at Part I of the January examination for the diploma of tropical medicine and hygiene.

THE Huxley Memorial Lectures of the Imperial College of Science and Technology are now held biennially, and a new series of lectures, commemorating other distinguished men who have served on the staff of the College, was inaugurated in 1936. The second of these lectures will be given on May 4, 1938, in memory of Sir Warington W. Smyth. Prof. S. J. Truscott has agreed to deliver the lecture, the title of which will be "Metal Mining Enterprise".

THE Home Secretary has appointed the following committee to consider lighting in factories and workshops and to advise about standards of sufficient and

suitable lighting as prescribed in the Factories Act, 1937: Mr. D. R. Wilson, chief inspector of factories (chairman), Mr. J. S. Dow, Mr. John A. Gregorson, Miss Florence Hancock, Prof. H. Hartridge, Dr. C. S. Myers, Sir John Parsons, Mr. William Scholes, Mr. G. W. Thomson, Dr. J. W. T. Walsh, and Mr. H. C. Weston. The secretary of the committee is Mr. R. W. Daniel, to whom all communications should be addressed at the Home Office, Whitehall, S.W.1.

A COURSE of training in the inspection of milk pasteurizing plants will be held at the Royal Sanitary Institute on Thursday, November 25, and Saturday, November 27. Members and associates should apply to the Institute, 90 Buckingham Palace Road, London, S.W.1.

THE British Institute of Adult Education and the National Institute of Industrial Psychology jointly have arranged a conference to discuss the problems of leisure, to be held at Queen Mary Hall, Central Club Buildings, Great Russell Street, London, W.C.1, on Thursday, November 18, at 3 p.m. Invitations are being extended to representatives of organizations engaged in educational, recreative and social work and to selected individuals.

THE portraits of Sir Albert Seward and Dr. F. F. Blackman by Mr. Harold Knight and Mr. Henry Lamb respectively, which were subscribed for by Cambridge friends and British botanists, have been kindly presented to the Botany School, Cambridge. Prof. Brooks and the staff of the School will be "At Home" to subscribers on November 23 at 3.30-5 p.m., when Sir Albert Seward and Dr. Blackman hope to be present.

DR. BERNARD NOCHT, emeritus professor of tropical diseases and tropical hygiene at Hamburg, celebrated his eightieth birthday on November 4.

THE fifteenth International Congress of Ophthalmology will be held in the Semiramis Hotel, Cairo, on December 8-14. The subscription is 50 Swiss francs, and for ladies 25 francs. Further information can be obtained from the secretary, Dr. M. Tewfik, P.O.B. 2001, Cairo.

PROF. M. POLANYI writes further with reference to the paragraph in our News and Views columns of October 30, p. 766, relating to his article on the recent international science congress in Paris. In that note we printed a statement as received from him in his original typescript, together with a correction by him of the editorial modification of it as published in NATURE of October 23. The two statements are contradictory; and Prof. Polanyi now asks us to say that this "was due to my error in sending the editor a typescript in which two symbols (half of a parenthesis and a plural forming 's') were left out. Eliminating these typing errors the text clearly has the sense which I stated in NATURE, October 30, page 766".

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. 853.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Irregular Ionic Clouds in the E Layer of the Ionosphere

It has recently been found that momentary ionospheric echoes from irregular heights, occasionally as low as 60 km. but generally between 100 and 300 km., can be obtained, even on frequencies well above the critical frequency, if a sufficiently high-power transmitter is used.

A typical example is the (P, t) record shown in Fig. 1. This was taken over an interval of about 40 sec. on a wave-length of 32.35 m. (9,127 megacycles/sec.) at 0049 G.M.T. on the night of November 26, 1936. The transmitter was a high-power commercial station of the Cables and Wireless Co. situated at Ongar, Essex. It was of 40 kw. rating, and was modified to send out impulses of about 1/5 ms. duration at a repetition frequency of 50 per second. The receiver situated at Chelmsford, Essex, was 19.2 km. from the transmitter. The record shows that the echoes differ very considerably from the normal E and F echoes.

By using as a receiving array a pair of frames spaced 20 m. apart in the north-south direction, and determining the difference in phase induced by the signal E.M.F.s in the two aerials, the angle of the ray relative to the axis joining the two aerials can be determined.

The ordinary E and F echoes, presumably reflected from a more or less uniform layer, are vertical or nearly vertical, but this is far from the case for the weak echoes first described. Fig. 2 shows an example of the angular measurements made on January 27,

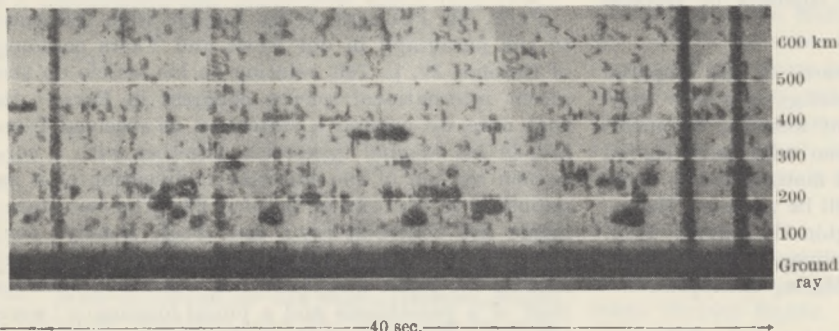


Fig. 1.

P, t RECORD FROM ONGAR (G.O.S. 32.35m.) AT 0049 G.M.T., November 26, 1936.

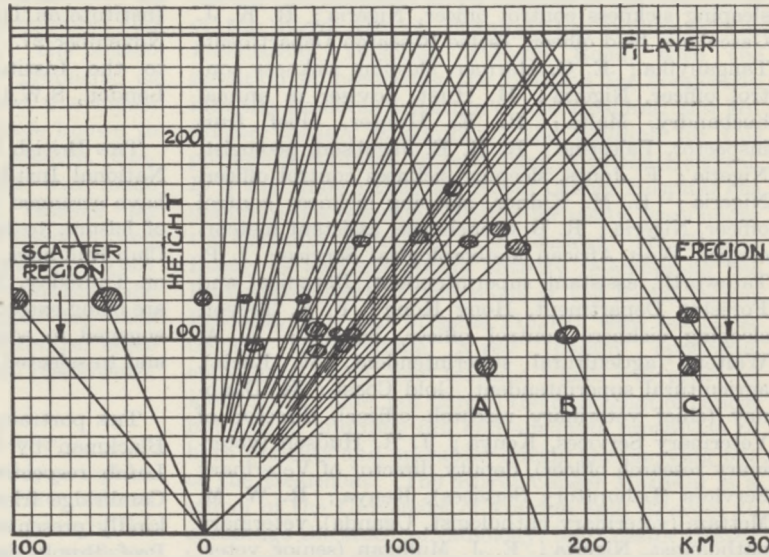


Fig. 2.

1937. The complement of the measured angle gives a lower limit to the angle of incidence, which reached 45° on occasions.

We can scarcely avoid the conclusion that the echo signals are not regularly refracted from a uniform layer in the ionosphere but are scattered from irregularities or clouds. By plotting the observed equivalent heights along the observed directions, we get an approximate determination of the position of the scatter clouds. The heights so determined are upper limits to the actual heights.

The positions of the clouds all come within or slightly above the E region, if we assume that the few echoes which apparently come from the F_2 region are really reflected at the F_1 layer from points such as A, B, C. The shower of echoes is practically continuous, in the sense that one or more echoes of this type are practically certain to occur in any interval of more than about 5 seconds duration.

This unceasing supply of scatter clouds, which if left to themselves would disappear in the course of a second or so, is a well-established fact, and only explainable on the assumption that there is some

nearly constant external source of ionization. Many of the disturbances in the outer atmosphere are caused by the emission of ultra-violet light or by charged or uncharged particles from the sun. The evidence, however, that the scatter cloud activity is practically equal day and night at high and low latitudes suggests that the sun is not the prime source of ionization.

Other possibilities include (a) small meteorites; (b) high-speed particles distributed more or less isotropically in space, or emanating from the stars in the galaxy. Disturbances (high-frequency noise) have been shown by Jansky to originate in the Milky Way.

There is some evidence that excessive scatter activity is associated with bright hydrogen eruptions from the sun, and if this is so, the possibility exists of a continuous ionizing supply caused by similar eruptions in the stars of the galaxy.

T. L. ECKERSLEY.

Research and Development Department,
Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford.
Sept. 28.

Ancestors of Some Groups of the Present-day Insects

WHILE studying fossil insects from the Middle Permian deposits of the Sylva River basin in the Urals, I have found among them a certain number of new forms that can be considered as predecessors and, in certain cases, as direct ancestors of some groups of modern insects. A few preliminary remarks on the results obtained are given here.

Up to the present time, the origin and geological age of the Embioptera are not exactly known, their fossil remains being found in deposits not older than the Tertiary. Dr. R. J. Tillyard, in 1918¹, pointed out their resemblance to the embiid *Megagnatha odonatiformis* Bolton found in the Carboniferous deposits of Commentry in France; in 1928, he gave a description of the new form *Permembia delicatula* Till., belonging to the special order of Embiopsocida from the Lower Permian of Kansas². In the present year³ he published a paper with a description of a new form, *Protembia permiana* Till., found in the same deposits in Kansas, that belongs, according to him, to the true Embioptera and to his new suborder Protembiarina.

Tillyardembia biarmica n.g. et sp., which is shown in Fig. 1, belongs to a genus that has been named by me in honour of the late Dr. R. J. Tillyard, and I refer it to the true Embioptera but of the independent suborder Epiembioidea. Among the fossils that I had occasion to study, I find, besides the species *Tillyardembia biarmica* n.g. et sp. with long and thin antennæ and a tetragonal prothorax, also the species *Tillyardembia antennæplana* n.g. et sp. with flat antennæ and the prothorax in the shape of an irregular rhomb. These forms differ from the modern Embioptera in the following features: (1) the males and females have homonomous wings; (2) the forelegs are of the grasping type without the inflated article of the tarsus with the spinning glands; (3) a large bivalve ovipositor; (4) long multi-articulated cerci. The length of the body of the *Tillyardembia* is 12-15 mm. This genus is very similar to *Protembia* described by Dr. R. J. Tillyard, but differs from it in its dimensions, the size of the ovipositor and other features.

I believe that the ancestors of the whole group of Embiid forms are the Protorthoptera belonging to the family of Spanioderidæ^{4,5}. From these must have issued directly the Permian suborder Epiembioidea, then the Protembiarina, and later the present type which, Dr. R. J. Tillyard has pointed out, belong to the special suborder Euembiarina.



Fig. 1.

Tillyardembia biarmica n.g. et sp. ENLARGED.
ACTUAL LENGTH, 12 MM.

Last year I recorded the existence of a new order of Hemipsocoptera⁶ phylogenetically connected with Psocoptera and Homoptera⁷. New discoveries induce me actually to modify, in a certain measure, ideas that we had about that group. The new species *Maueria pusillus* nov. sp. (length of the body 5 mm., of the wing 5.5 mm.) with a proboscis-shaped head and many other features shows that the mouth organs of that group were very similar to the sucking apparatus of the Homoptera; the shape of the body and its general appearance are of the type of Psocoptera.



Fig. 2.

Parapsocidium uralicum n.g. et sp. ENLARGED. ACTUAL LENGTH OF THE WING, 4 MM.

The newly found specimens of Psocoptera of the suborder Permopsocida lead me to suppose the existence of a sucking mouth apparatus in that group of insects. The new genus and species *Parapsocidium uralicum* n.g. et sp. (Fig. 2) is very close to the genus *Psocidium* described by Dr. R. J. Tillyard⁸, but the comparative study that I have made of the imprints of insects belonging to the order of Hemipsocoptera and the suborder of Permopsocida which I have in my possession induce me to doubt the correctness of the description by Dr. R. J. Tillyard of the chewing mouth organs of the *Psocidium*. The head of the insects of both groups is proboscis-shaped and carries, at the extremity, a sucking apparatus perfectly developed in the Hemipsocoptera and a little less developed in the Permopsocida.

The order Isoptera (termites) has always been found in deposits not older than the Tertiary. In 1935 Dr. A. B. Martynov, comparing the venation of their wings with that of the Protoblattoidea in his report to

the Russian Entomological Society, suggested that the termites are much more ancient.

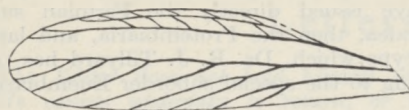


Fig. 3.

Uralotermes permianum n.g. et sp. ENLARGED. ACTUAL LENGTH OF THE WING, 18 MM.

I have found a wing imprint of 18 mm. length and 5 mm. width (see Fig. 3) which is much more perfect and more like (in its venation) the wings of some present termites than those of many mesozoic termites. I have called that form *Uralotermes permianum* n.g. et sp. and consider it to belong to the true termites (order Isoptera). I believe that the above-mentioned conclusion supports the theory of Dr. A. B. Martynov about the ancient origin of the termites.

GEORGE ZALESSKY.

Laboratory of Palaeontology,
University,
Moscow.
Sept. 19.

¹ Tillyard, R. J., "On the Affinities of two Interesting Fossil Insects from the Upper Carboniferous of Commeny, France", *Proc. Linn. Soc. New South Wales*, 43, pt. 1 (March 1918).

² Tillyard, R. J., "Kansas Permian Insects. Part 12. The Family Delopteriidae, with a Discussion of its Ordinal Position", *Amer. J. Sci.*, [v] 16, No. 96 (December 1928).

³ Tillyard, R. J., "Kansas Permian Insects. Part 18. The Order Embiaria", *Amer. J. Sci.*, [v] 33, No. 196 (April 1937).

⁴ Handlirsch, A., "Die fossilen Insekten und die Phylogenie der rezenten Formen" (Leipzig, 1906-8).

⁵ Handlirsch, A., Palaeontologie in "Schröder's Handbuch der Entomologie", 3 (Jena, 1925).

⁶ Zalesky, G. M., "Sur un représentant d'un nouvel ordre d'insectes permien", *Ann. Soc. Géol. Nord.*, 60 (February 1936).

⁷ Tillyard, R. J., "Kansas Permian Insects. Part 9. The Order Hemiptera", *Amer. J. Sci.*, [v] 11, No. 65 (May 1936).

⁸ Tillyard, R. J., "Kansas Permian Insects. Part 8. The Order Copeognatha", *Amer. J. Sci.*, [v] 11, No. 64 (April 1926).

Analytical Measurements of Ultracentrifugal Sedimentation

SEDIMENTATION in the ultracentrifuge has so far been followed quantitatively only by optical methods, depending upon the absorption or refraction of light by the substances studied. Even though they have been worked out to a high degree of accuracy, these methods for many important problems need to be supplemented by some procedure allowing chemical tests to be performed in the same run. For example, in a mixture of an enzyme or an antibody with its accompanying impurities, we do not know *a priori* the relationship between optical properties and the amount of active substance, and we cannot therefore definitely state which of the optically observed components in the mixture, if any, carries the activity. As the amount of substances of this kind in most cases can be defined only by an action measured by analytical methods, their sedimentation should be computed from analysis of samples taken out of the ultracentrifugal cell. In this laboratory^{1,2} and elsewhere³, several attempts have been made to take out samples of the ultracentrifuged solutions after concluding an experiment, but the arrangements have not been sufficiently perfect to allow quantitative application.

If we know the amount of substance above and below a certain level in the cell before and after centrifugation, the difference will give us the sedimentation velocity in much the same way as the migration velocity of an ion is calculated from the Hittorf transference experiment. In either case it is a necessary condition that the concentration gradients occurring at the ends of the column of solution do not reach the level which separates the layers to be analysed. As the cells used in the Uppsala laboratory hold comparatively long columns of solution, this condition can easily be fulfilled. The simple deduction gives the following equation for the calculation of the sedimentation constant, s :

$$s = -\frac{1}{2\omega^2 t} \ln \left(1 - \frac{2\Delta}{qxc_0} \right),$$

where ω is the angular velocity, t the time, Δ the change in amount of substance above or below the level at which the separation is made, x the distance of this level from the centre of rotation, q the cross-section area of the cell at this level, and c_0 the original concentration of the solution.

To avoid mixing the layers of the centrifuged solution when stopping the rotor, and especially when pipetting out the samples, we have divided the contents of the cell into two parts (of about equal volume in the present construction) separated by a thin wall of bakelite with a large number of fine holes, supporting a piece of hardened filter paper. The sieve plate is made in one piece with the bakelite centre part of the cell. This arrangement effectively prevents mixing for a time sufficient to remove the cell and to pipette out the contents of the upper compartment and rinse it quantitatively. On the other hand, as optical observations indicate, an arrangement including such a highly permeable membrane does not obstruct the free sedimentation. This is probably due to local convection at the membrane rapidly equalizing any small difference in density which would tend to occur as a consequence of an accumulation of material just above or dilution just below the wall. One must remember that the density differences are multiplied enormously by the centrifugal force.

The arrangement may, of course, be modified in several ways according to the purpose of study; one may use several compartments and differently placed walls. The cell described here allows optical observations to be made in the same experiment, which is a great advantage.

The method should be of much value not only for the study of substances of specific activity, as mentioned above, but also for a number of other important problems. The sedimentation of substances of low molecular weight is difficult to observe optically, as the rapid diffusion prevents the boundary from leaving the meniscus completely, a circumstance without influence in the analytical procedure described. Interesting possibilities are offered in the field of mixtures of substances of different chemical nature like carbohydrates and proteins. Separations for preparative purposes, guided by optical observation should be possible with small quantities of material.

We have made some preliminary experiments to demonstrate the possibilities of the method. A run with carbon monoxide-haemoglobin of $c_0 = 3.4$ per cent concentration gave $s = 3.6 \times 10^{-13}$ by the method described, whereas optical observation of the boundary migration (light absorption method) gave $s = 3.56 \times 10^{-13}$. (Both values uncorrected

for the concentration influence of the carbon monoxide-haemoglobin itself.) A few experiments were made with a type I antipneumococcus horse serum. In the first run, the heaviest globulin component observed was completely centrifuged out of the top compartment, as judged by optical observation. Analytical measurements according to the method of Heidelberger, Sia and Kendall⁴ showed that less than 1 per cent of the antibody originally present was left in the top compartment, whereas 92 per cent was found in the bottom. (We are indebted to Dr. E. A. Kabat for making these analyses.) Centrifuge runs of shorter duration, still leaving the fastest globulin boundary above the membrane, showed a corresponding increase in the analytically determined amount of antibody in the top layer. This indicates that the antibody function is mainly connected with this heavy globulin component, in agreement with earlier findings^{2,5}.

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ARNE TISELIUS.
KAI O. PEDERSEN.
THE SVEDBERG.

¹ Eriksson-Quensel, I.-B., and Svedberg, T., *Biol. Bull.*, **71**, 498 (1936).

² Heidelberger, M., Pedersen, K. O., and Tiselius, A., *NATURE*, **138**, 165 (1936).

³ Wyckoff, R. W. G., *Science*, **84**, 291 (1936).

⁴ Heidelberger, M., Sia, R. H. P., and Kendall, F. E., *J. Exp. Med.*, **52**, 477 (1930).

⁵ Blasco, J., Heröik, F., and Wyckoff, R. W. G., *Science*, **83**, 602 (1936).

Absorption of Tri-brom Ethanol through the Skin

IN connexion with a study on absorption of various drugs and chemicals through the intact skin of different animals, an interesting observation was made in this laboratory. It was found that tri-brom ethanol readily penetrates the intact skin of such small animals as rats and mice and produces its characteristic narcotic effects.

A solution of tri-brom ethanol crystals (Winthrop's) was made in 95 per cent ethyl alcohol. When a sufficient amount of this solution was applied to the fur of white mice, it was rapidly absorbed and the animals were anaesthetized within 15-30 minutes. The anaesthesia lasted 2-3 hours, after which the animals recovered. When larger doses were applied, anaesthesia was followed by coma and death. The minimal quantity of a 10 per cent solution of tri-brom ethanol in 95 per cent ethyl alcohol required to anaesthetize a mouse weighing 24 grams was 0.85 c.c. In control experiments with ethyl alcohol alone, no narcotic effect was produced, nor was the anaesthesia described above due to absorption through the mouth.

Inasmuch as tri-brom ethanol intended for clinical use is combined with amylene hydrate, experiments were also made with a 10 per cent solution of tri-brom ethanol together with 5 per cent of amylene hydrate in 95 per cent ethyl alcohol. The minimal dose of this mixture required to produce general anaesthesia, when applied to the skin of mice averaging 24 grams in weight, was 0.75 c.c. The effectiveness of this dose, which is smaller than that required of tri-brom ethanol solution in alcohol alone, is obviously due to the synergism produced by combination of amylene hydrate with the drug.

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Oct. 1.

Production of Artificial Respiration by Rhythmic Stimulation of the Phrenic Nerves

IN a study of the effects of drugs on respiration, the various methods used for the production of artificial respiration were found to be unsatisfactory. In an attempt to work out a suitable method for the work, it was found that the phrenic nerves when stimulated rhythmically would carry on respiration for hours and at the same time keep the animal in exceptionally good condition.

The primary currents of two induction coils, in addition to being made and broken by their interrupter operated by the iron core, were closed and opened by a rotary contact. By means of an electric motor and rheostat, this contact was rotated slightly above the normal respiratory rate of the animal. Anaesthetized rabbits were used. The phrenic nerve on each side of the neck was isolated just above its point of entrance into the chest and placed in a small shielded electrode. Each electrode was connected with the secondary of one of the induction coils. By placing a sledge key in each of the primary circuits, the action of either the right or the left diaphragm could easily be demonstrated, while changes in the rate of the motor changed the respiratory rate.

The method was found especially useful in experiments where hyperventilation was desired. It obviates the changes in circulation which result when the increased tracheal pressure method of artificial respiration is used. As conductivity in nervous tissue is poor immediately following decapitation, it was found necessary in this preparation to use another method of artificial respiration until the phrenics had sufficiently recovered.

A further study of the method with the view of extending its applications and improving the technique is being carried out.

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A Coloured Intermediate on Reduction of Vitamin B₁

A VERY distinct green yellowish colour appears when vitamin B₁ (synthetic, I. G. Farben.), in a 0.5-1 per cent solution, is reduced with hydrosulphite in the manner described in a previous note¹. The intensity of the colour is highest at the beginning, declines with the declining rate of reaction and disappears at the end. The same transient green colour is observed when the vitamin is reduced with zinc dust in normal hydrochloric acid.

Similar coloured intermediates have been observed on reduction of cozymase² and of nicotinic acidamide methyl iodide³. These compounds are considered as half-reduced pyridines corresponding to the semi-quinones of Michaelis⁴. Therefore, it is suggestive to consider the coloured reduction product of vitamin B₁ as a half-reduced thiazole.⁵

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Sept. 30.

¹ Lipmann, *NATURE*, **138**, 1097 (1936).

² Adler, Hellström and v. Euler, *Z. physiol. Chem.*, **242**, 225 (1936).

³ Karrer and Benz, *Helv. chim. Acta*, **19**, 1028 (1936).

⁴ Michaelis, *J. Biol. Chem.*, **92**, 211 (1931).

⁵ See also Erlenmeyer, Epprecht and v. Meyenburg, *Helv. chim. Acta*, **31**, 661 (1937).

Constitution of the Poly-acids

THE work of Keggin¹ has placed the constitution of the 12-heteropoly-acids, metatungstates and metamolybdates—for example, $R_3H[SiW_{12}O_{40}]_n.aq.$, $R_6[H_2Mo_{12}O_{40}]_n.aq.$ —on a sure basis, and has indicated that the poly-acid anions may be regarded as co-ordination structures, built up of polyhedra of oxygen ions in the manner first envisaged by Pauling². The constitution of other groups of poly-acids, for example, those with 9 or 11 MoO_3 or WO_3 for each molecule of hetero-acid, is still quite unknown, as also is that of the second main series of poly-acids—the 6-poly-acids, such as the 6-molybdo-periodates.

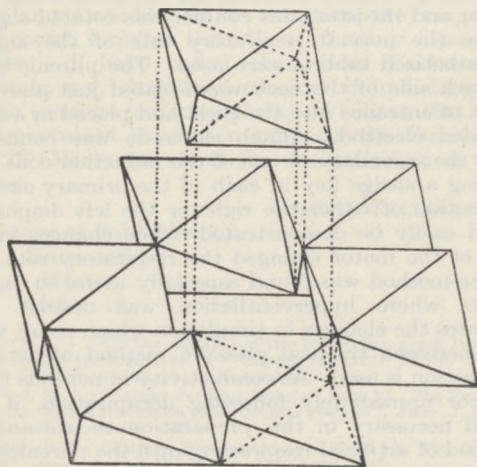


Fig. 1.

These have hitherto been regarded as satisfactorily expressed by the Rosenheim formula, $R_{12-n}[M^n(XO_4)_6]$, and there is good evidence that the central atom is, as shown, in 6-fold co-ordination. It may be predicted, however, from Goldschmidt's table of ionic radii, that the Mo^{6+} and W^{6+} ions must normally be found in 6-fold co-ordination with oxygen, as they are in known oxide structures, such as the 12-poly-acid anions. This conception leads to a new structure for the 6-heteropoly-acids and the related paramolybdates and paratungstates. It may readily be seen that six MoO_6 octahedra may be so arranged, by sharing corners with each of two neighbouring octahedra, that a hexagonal Mo_6O_{24} annulus is built up. The central cavity of this structure is then the same size and shape as one of the MoO_6 octahedra, and can therefore accommodate another cation in the same 6-fold co-ordination (see Fig. 1).

It is suggested that this is the structure of the 6-poly-acid anions. The similarity between the paramolybdates (and paratungstates) and the 6-heteropoly-acids led to their formulation by Rosenheim as $R_3H_6[H_2(MoO_4)_6].aq.$ Sturtevant³ has recently shown that ammonium paramolybdate is correctly represented by the older formula $3(NH_4)_2O \cdot 7MoO_3 \cdot 4H_2O$, or $(NH_4)_6[Mo_7O_{24}] \cdot 4H_2O$. The relation of this to the 6-heteropoly-acids, for example, to $R_6[I(Mo_6O_{24})]$, is at once made clear if the paramolybdate is regarded as $R_6[Mo(Mo_6O_{24})]$, with the Mo_6O_{24} structure built around a central MoO_6 octahedron in place of the IO_6 octahedron in the 6-molybdo-periodate.

Moreover, if some hydrolytic process, such as $[Mo(Mo_6O_{24})]^{6-} + H_2O \rightleftharpoons [Mo_7O_{21}]^{6-} + H_2MoO_4$, $[I(Mo_6O_{24})]^{2-} + 3H_2O \rightleftharpoons [Mo_7O_{21}]^{2-} + H_5IO_6 + H^+$ may be postulated in solution, it is possible that

the grave discrepancies between the X-ray evidence and the considerable bulk of physico-chemical evidence as to the complexity of poly-acids in solution might be removed.

In the present state of the subject, a careful X-ray examination of the 6-poly-acids, including the paramolybdates and paratungstates, is urgently desirable.

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Sept. 28.

¹ Keggin, F. J., *Proc. Roy. Soc., A*, 144, 75 (1934).

² Pauling, L., *J. Amer. Chem. Soc.*, 51, 1010, 2868 (1929).

³ Sturtevant, J. H., *J. Amer. Chem. Soc.*, 59, 630 (1937).

Determination of the Relaxation Time for the Vibrational Energy of Carbon Dioxide

DURING the past year, we have made a series of measurements¹ on the absorption of sound in gases at ordinary and low temperatures. As is well known, such experiments are of great interest in connexion with the collision mechanism between molecules. These phenomena can also be studied by means of measurements on the dispersion of the velocity of sound. This method is followed by Eucken and his collaborators².

We investigated especially oxygen, carbon monoxide, hydrogen and nitrogen. On the other hand Eucken has studied carbon dioxide and nitrous oxide for the reason that for such gases the vibrational energy is great, so that dispersion measurements are easily made. Hence there was hitherto no immediate relationship between our measurements and those of Eucken.

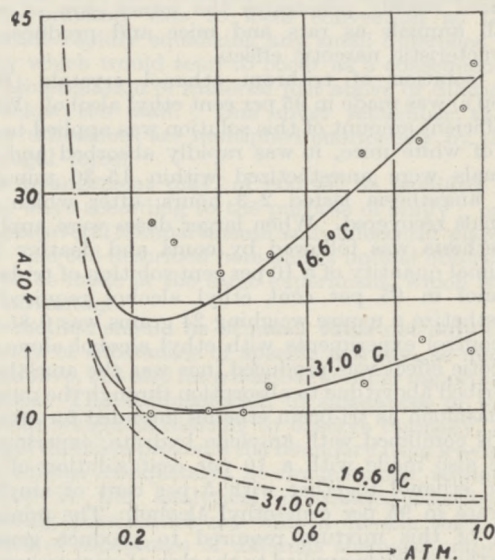


Fig. 1.

Recently we have made absorption measurements on well purified carbon dioxide, so that a direct comparison is possible with the dispersion measurements of Eucken. We have made measurements at 16.6° and -31.0° C., and have studied at each of the temperatures how the absorption of sound depends on pressure (frequency used, 304.4 kc.).

The results of our measurements are represented in Fig. 1. From these experimental results the following conclusions may be drawn:

(1) When we calculate the relaxation time at one atmosphere from the absorption coefficient A cm. (Kneserotation) at 16.6°C . and -31.0°C ., we find respectively $(8.3) \times 10^{-6}$ and $(13.3) \times 10^{-6}$ sec. These values agree very well with the values obtained by Eucken. He finds from his recent measurements $(8.27) \times 10^{-6}$ sec. at 19.5°C .

(2) The full lines of Fig. 1 represent the theoretical curves which are calculated for the relaxation times $(8.3) \times 10^{-6}$ and $(13.3) \times 10^{-6}$ and by supposing that the relaxation time for the transversal oscillation is the same as for the longitudinal vibration. We see that at -31.0°C . and at 16.6°C . (here only for a portion of the curve) the experimental values are on the theoretical curves.

The dotted curves of Fig. 1 correspond to the classical absorption.

(3) As under (2), the experimental values at 16.6°C . deviate from the theoretical curve in the region of small pressures. From the discussion of these deviations we have come to the conclusion that the experimental curve may be described by means of two relaxation times. An estimation of the second relaxation time gives as result $(1.7) \times 10^{-9}$ sec. A possible explanation for this very small relaxation time is an influence of the rotations. On the other hand, a serious objection to such an explanation is that at -31.0° no deviation is found.

(4) Finally, it is necessary to direct attention, as was done by Eucken, to the fact that impurities of the order of a few parts per thousand have an excessive influence on this kind of phenomenon. We believe that such facts must have a great importance relative to chemical kinetics.

The results of these experiments together with others will be published in a more complete form in *Physica*.

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Oct. 4.

¹ van Iterbeek, A., and Mariëns, P., *Physica*, 4, 207 (1937): 4, 609 (1937).

² Eucken, A., and Becker, R., *Z. phys. Chem.*, 27, 219 (1934); 27, 235 (1934). Eucken, A., and Jaacks, H., *Z. phys. Chem.*, 30, 85 (1935). Eucken, A., and Nümann, E., *Z. phys. Chem.*, 38, 163 (1937).

Infra-red Absorption of Carbon Disulphide

Two points of considerable interest in this spectrum have just come to light. With the view of instituting a comparison between the corresponding infra-red frequencies of gaseous and liquid carbon disulphide, the two spectra have been carefully re-examined in this laboratory. Using a prism spectrometer, we have found that the band of gaseous carbon disulphide at 11.4μ , previously supposed¹ to be a doublet with a maximal separation of 13 cm.^{-1} , is really a triplet with maxima at 884, 878, and 870 cm.^{-1} , having the appearance of a band with a medium intensity Q branch. Up to the present this band has been assigned to $\nu_2 - \nu_1$, but it is difficult to see how the triplet structure can arise from such a combination.

For information on the second point I am indebted to the kindness of the Government Chemist, Dr. J. J. Fox, and his collaborator, Dr. A. E. Martin. Some time ago, Dr. Cassie and I² explored certain of the bands with a grating spectrometer, and

resolved the 4.61μ band into a doublet with maxima at 2175.3 and 2162.0 cm.^{-1} . Doubt was thrown upon the accuracy of our results by Sanderson³, who repeated the work and found maxima at 2191.2 and 2177.9 cm.^{-1} . The two observations are reconciled by the observations of Fox and Martin, who find all three peaks at 2190.2 , 2177.1 , and 2165.4 cm.^{-1} , and also obtain the rotational structure. The band has generally been assigned to the combination tone $\nu_3 + \nu_1$, but may arise in part from excited levels. It is remarkable that no evidence seems to have been found for the existence of the double doublets which are such a characteristic feature of the spectrum of carbon dioxide.

With regard to the change of spectroscopic frequencies with change in state, Dr. Angus and I have found somewhat unexpectedly that in spite of the non-polar nature of the substance, there are marked shifts of the order of 30 cm.^{-1} in many of the bands in the passage from the gaseous to the liquid state.

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Oct. 8.

¹ *Proc. Roy. Soc., A*, 132, 236 (1931).

² *Proc. Roy. Soc., A*, 140, 605 (1933).

³ *Phys. Rev.*, 50, 209 (1936).

Colour Changes in *Hippolyte varians*

THE demonstration by Perkins¹ that colour changes in *Palæmonetes vulgaris* were controlled by a hormone that originated in the eye-stalks has since been confirmed and extended by a number of investigators (see Hånström's² review). Gamble and Keeble³ in their classic study of colour changes in *Hippolyte* were the first to describe a diurnal rhythm which persisted under constant environmental conditions. Within the past five years, several papers on persisting diurnal rhythms in the pigmentary system of crustaceans have appeared. The two English investigators interpreted the phenomena of crustacean metachrosis, according to the view of chromatophoral activity prevalent at that time, as being dependent upon the nervous system. We reinvestigated the colour changes of *Hippolyte* to see whether the endocrinal control similar to that found in other crustaceans was present.

It was found that extracts of crustacean eye-stalks (prepared from *Leander serratus* and from *Hippolyte varians*) when injected into test *Hippolyte* were effective in causing concentration of the chromatophores, accompanied by the diffusion of blue pigment into the surrounding tissues. Normal individuals, when kept under normal day and night conditions, exhibit the diurnal rhythm of colour change described by Gamble and Keeble, becoming "nocturnes" at night (the dark chromatophores concentrating to the punctate or stellate condition and the diffuse blue colour appearing in the tissues) and reverting to their original colours during the day. Individuals in which the retinas had been destroyed showed identical diurnal behaviour. Inasmuch as the presence of the crustacean eye-stalk hormone has been found necessary for concentration of the chromatophore pigments, we thought it might be possible to abolish the nocturnal colour phase by amputating both eye-stalks at their bases and thereby removing the source of the hormone. Gamble and Keeble had attempted to

render the eyes functionless by crushing the optic ganglia and by cutting off the eyes. We are able to confirm their results; individuals from which both eye-stalks had been removed were able to pass into the nocturnal colour phase.

The persistence of the diurnal rhythm in such preparations has been cited as proof of the existence elsewhere than in the eye-stalks of additional glandular tissue capable of liberating the chromatophoretic hormone. We believe this behaviour can be explained differently. Gamble and Keeble reported that the diurnal rhythm persisted under constant external conditions. Thus, normal as well as eyeless *Hippolyte*, regardless of whether they were maintained in constant illumination or in constant darkness, went into the nocturnal colour phase with approaching nightfall and reverted to their "diurnal" phase in the daytime. We have not been able to confirm these observations. Normal *Hippolyte*, individuals with the retinas ablated, and animals from which the eye-stalks had been removed always passed into the nocturnal phase when placed in darkness during the day. Microscopic examination of such individuals revealed the concentrated condition of the red chromatophore pigment. Within ten minutes after removal to light (on a white background) the nocturnal condition began to pass, the diffuse blue coloration having completely faded and the red chromatophores showing signs of pigment dispersion. Twenty to thirty minutes later the chromatophores had become dispersed and the animals were completely dark.

The chromatophores of *Hippolyte* can respond directly to light and to darkness, and the persistence of a diurnal rhythm under constant conditions is negated by the results obtained from observations made during day and night on individuals maintained in darkness.

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¹ *J. Exp. Zool.*, 50 (1928).

² *Ergeb. Biol.*, 14 (1937).

³ *Quart. J. Micro. Sci.*, 43 (1900).

The γ -Rays of Polonium

In a recent note, Champion and Barber¹ have suggested that the γ -rays of radium E may arise from the production of electron-pairs by internal absorption of β -rays, the γ -rays being thus recombination radiation. It seems possible that the γ -rays of polonium² may be due similarly to the production of electron-pairs by internal absorption of α -rays. My analysis³ of the absorption curve of this radiation suggested quantum energies of (1.0 ± 0.1) and (0.4 ± 0.1) million electron volts, equal numbers of the two types (about 12 per million α -particles) being emitted. This is consistent with identification as recombination radiation, and the process is consistent with conservation of momentum and energy.

If this interpretation is correct, all members of the radioactive series that emit α -particles should also emit γ -rays of quantum energies 0.5 and 1.0 million electron volts, the intensity corresponding to a few quanta per million α -particles, since the initial energy of all α -particles is sufficient to produce pairs. Slater⁴

found, in the case of radon, that a weak γ -radiation was emitted whatever the lining of the vessel containing the gas. In the case of most of the other elements the detection of this relatively weak radiation would be difficult on account of the presence of other, more intense, γ -rays.

It is conceivable that the radiation Slater found to be emitted when lead and tin are bombarded with radon α -particles is connected with the production of electron-pairs, the absorption coefficients being consistent with this interpretation, and the effective cross-section, 10^{-24} cm.² (upper limit), being inconsistent with the value 10^{-22} cm.² found by Champion and Barber in the case of mercury bombarded with radium E β -particles. This interpretation does not, however, offer any reasonable explanation of the absence of a similar effect when lead and tin are bombarded with polonium α -particles.

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Sept. 28.

¹ *NATURE*, 140, 105 (1937).

² Bothe, W., and Becker, H., *Naturwiss.*, 18, 894 (1930).

³ *Proc. Roy. Soc., A.*, 136, 428 (1932).

⁴ *Phil. Mag.*, 42, 904 (1921).

The Function of Experiment

IN continuing to maintain that stringent experimental test of a theory of Nature is pedantic, Mr. Whitrow would appear to be more extreme in views than are most of the contributors to this symposium on physical science and philosophy. Prof. Milne, for example, states that "the relevance of the theorems to Nature would require to be established by observation"². When Mr. Whitrow persists in claiming the support of Galileo³ on the grounds of his (Galileo's) profession of readiness to accept his own theories⁴, he displays an imperfect understanding of the nature of experimental demonstration.

A complete and self-contained experiment must do two things. It must provide a measure of so much quantity for comparison with a theoretically predicted value, and it must provide data from which we may calculate the likelihood that any observed discrepancy might be exceeded by chance. When the level of significance of the results is thus calculable from the experiment itself, we are each of us in a position to interpret the experiment without appeal to authority, to reject it or to accept it according as we are difficult or easy to satisfy. Other things being equal, a great number of experiments affords a more sensitive test of a theory than does a few; that is, it is possible to discern smaller 'real' discrepancies against the background of chance variation. It is clear that without experiment, or without only one experiment, it is impossible to estimate 'experimental error'.

Now, it may be that a series of experiments is too meagre to provide within itself an acceptable test of theory, and yet the experimenter may accept it in the light of past experience. He is then, in effect, calling upon past experience to furnish him with a rough estimate of variance⁵. He might even, upon rare occasions, justify himself in accepting the theory without test on no better grounds than that he has customarily right ninety-five or ninety-nine times out of a hundred. The general acceptance of t

assertion of his authority must depend upon the extent of his experience and his unquestionable integrity, of which he himself is the only competent judge. He must therefore aim at providing a high level of significance, even though he may upon occasion be justified in not requiring it for his own satisfaction.

It is not obvious why we should suppose that Galileo meant anything more profound than this. He merely expressed confidence in his own judgment, yet he made no assertion of authority but carried out the experiments which he would undoubtedly have demanded of others. It may be pointed out, in conclusion, that to accept one's own theories without adequate test and without a long record of sound judgment is to plead guilty of a very human weakness.

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¹ NATURE, 139, 1008 (1937).

² NATURE, 139, 997 (1937).

³ NATURE, 140, 646 (1937).

⁴ Fahle, W. C., NATURE, 140, 646 (1937).

⁵ Fisher, R. A., "The Design of Experiments", p. 39 (Oliver and Boyd).

Relation between Body Size and Metabolism

SINCE 1935, work has been proceeding on the respiration of different genotypes of *Drosophila melanogaster* during the first hours of the puparial period. The work has now been completed, and a

full account will shortly be ready for publication. For the moment, however, it may be said that differences in oxygen uptake per mgm. body weight originally found between the sexes and between the *wild-type* and its mutant *vestigial* were later shown to be due to slight differences in the sizes of these animals; when these were eliminated by alteration of the culture conditions the metabolic differences also disappeared. By actual measurement of the surface area of puparia it was further shown that the surface area per mgm. decreased, with increasing body size, at the same rate as did the oxygen consumption per mgm., and that the oxygen consumption was therefore related to the surface area.

Further work is in preparation which will indicate whether this relationship can be extended to other groups of animals, and will also help, it is hoped, to establish the causal nature of the connexion between body size and metabolism. Results already obtained clearly show the necessity, in metabolism experiments on cold-blooded animals, of paying much more attention to body size than hitherto; it is possible that the latter may prove to have considerable importance in problems of an ecological nature.

Using surface area as a standard, it is intended to investigate possible metabolic differences between the various species and races of *Drosophila*.

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Points from Foregoing Letters

IRREGULAR echoes of radio waves reflected from heights between 100 km. and 300 km. indicate, according to T. L. Eckersley, the presence of ionic clouds or irregularities in the ionosphere. Since the effect is noticeable both day and night, the sun cannot be responsible for this ionization, and it is suggested that the responsible agents might be small meteorites or high-speed particles from the stars.

A. Tiselius, K. O. Pedersen and Prof. T. Svedberg describe a new procedure for the quantitative study of ultracentrifugal sedimentation. With a specially modified cell, the centrifuged solution is separated into two portions, each of which can be readily pipetted out and analysed. From the change in the amount of the sedimenting component in one of the layers the sedimentation constant can be calculated. The method is of special importance in the study of substances like enzymes and antibodies, and may also be useful for measurements on very slow sedimenting molecules.

Dr. D. I. Macht finds that tri-brom ethanol in ethyl alcohol solution is rapidly absorbed when applied to the skin of mice, and produces its characteristic anaesthetic effect. The presence of amylene hydrate in the solution helps to produce the narcosis more rapidly.

Prof. R. A. Waud reports that he has been able to carry on artificial respiration in the rabbit by rhythmic stimulation of the phrenic nerves.

The appearance of a transient greenish-yellow colour on reduction of vitamin B₁ has been observed by F. Lipmann, who assumes that it is due to the formation of a semiquinone-like product.

From considerations of atomic radii, Dr. J. S. Anderson arrives at a possible structure for 6-poly-acids (such as the 6-molybdo-periodates). To account for discrepancies between the evidence obtained from X-ray investigations and from physico-chemical evidence he suggests that the 6-poly-acids may be hydrolysed in solution.

The absorption of sound in purified carbon dioxide gas at various pressures up to 1 atmosphere, and at temperatures of 16.6° and -31° C., has been determined by Prof. A. van Itterbeek and P. Mariëns. The authors calculate the relaxation time for the vibrational energy (of importance in connexion with the collision mechanism between molecules) and compare the values obtained with those calculated from measurements of sound dispersion. Small amounts of impurities exert considerable influence.

C. R. Bailey reports that the infra-red absorption bands of carbon disulphide at 11.4 and 4.6 μ have three components. Although carbon disulphide is a non-polar substance, shifts in some of the absorption bands have been observed on passing from the gaseous to the liquid state.

Drs. L. H. Kleinholz and J. H. Welsh confirm the fact that extracts of eye-stalks from the Crustacean *Hyppolyte varians* when injected into living specimens (which show diurnal change of colour) produce darkening due to diffusion of blue pigment. They find, however, that specimens which had their eye-stalks removed and were kept in darkness, responded to light at all hours; hence they consider that light acts directly upon the colour-producing mechanism and not necessarily by a hormone.

Research Items

The Marriage of Osiris

IN a study of the origins and character of the Osirian ritual in Egyptian religion, Mr. G. D. Hornblower (*Man*, Oct. 1937) figures a sculptured scene from the inner chamber attached to the Hall of Sukkur (Sokkaris) in the temple of Seti I at Abydos, which depicts the culminating scene of the great rite of the latter half of the month of Hathor, which in the Egyptian calendar is the last of the four months of the Nile flood. In the process of synthesizing the various local cults of Egypt, Osiris came to be identified with the Nile flood (but not with the river), while Isis became Mother-Earth, the flood appearing as a kind of hierogamy or sacred marriage. The sculptured relief at Abydos puts Seti, the king, in special relation with the god at the supreme moment of the adventures in the myth of Osiris. Osiris is here seen lying as a mummy in the "House of Sukkur", that is, the tomb. At his head is his sister-wife Isis, the Great Lady of Magic, who is engaged in calling her dead husband back to life, temporarily, for the purpose here revealed. For Isis, in accordance with the principle of early art, which depicts succeeding events in the same plane, is also shown in the form of a falcon, with her name inscribed by her, hovering over the body of Osiris, who, now resuscitated, is seen in the act of fecundating her. The rite is thus revealed as the solemnization of a sacred marriage. At the feet of Osiris, Horus, the falcon-god, stands protectively, and a falcon also shelters the head of Osiris. This is undoubtedly the outstanding rite of the Egyptian year. Other sacred marriages are known—of Amūn-re at Thebes, in the "Festival of Opet", and of Horus and Hathor at Edfou. It appears that a sacred marriage was a very early general institution which was adapted to Osiris on the establishment of his cult, the festival being observed concurrently in various Egyptian towns.

Early Indian Sites in Virginia, U.S.A.

AN examination has been made of a number of ancient Indian sites in the State of Virginia, U.S.A., by Mr. David I. Bushnell, jun. (*Smithsonian Miscell. Collect.*, 96, 4). These sites have been discovered on the banks of the Rappahannock, beginning at Leedstown, an early colonial settlement some forty miles below the falls, and continuing up the valley. The finds—stone implements, potsherds, beads and clay pipes—are from the surface, and probably represent the midden material from village sites, which have been scattered by the plough. Further research by excavation is eminently desirable. When the English first explored the Rappahannock, they found many Algonquian (Nandtaughtacund) villages in this district, extending up to the large island below the falls near the present city of Fredericksburg. From this point, the territory extending westward belonged to the Manahoac, a Siouan group constantly at enmity with the Algonquians. The finds of the present investigation vary in form and material, and obviously belong to several distinct periods of occupation. They prove that the tribes encountered by the settlers were not the first to

inhabit the country; and indeed it is evident not only that this area was occupied and re-occupied for centuries, but also that a part of the valley below the falls had been abandoned by the Algonquian tribes in 1608 when it was first visited by the English. The occurrence of a beautiful Folsom point of the eastern type near the Millbank creek on the left bank represents an interesting problem, which requires further investigation in order that the evidence of stratification may be made available for the consideration of the antiquity of man in the eastern States. Next in importance to the Folsom point are two axes found above Lamb Creek, which resemble a specimen found some years ago on the Rapidan. These may be earlier than the Algonquian occupation. Argillite points and scrapers resemble those from the Delaware Valley, and may also be pre-Algonquian.

Breeding of Oysters in Tanks

MR. H. A. COLE has gone a long way towards solving the problem of oyster breeding in captivity for the improvement of the oyster industry ("Experiments in the Breeding of Oysters (*Ostrea edulis*) in Tanks, with special reference to the Food of the Larva and Spat. Min. Agric. Fish. Invest. Series 15, No. 4; 1936). His own experiments during 1936 are particularly described, but these are a continuation of the work of Dodgson and Sherwood from 1919 onwards. It was found in 1918 that a large amount of spat from oysters which had remained in the tanks following some purification experiments had settled. The same occurred during the next two years, and in 1921 an attempt was made to repeat the spat collection on a much larger scale with the view of possibly re-stocking the natural beds. The results showed that food for the young oysters, especially in the free-swimming stage, was all important, and laboratory experiments were specially made to find a good micro-organism which the free-swimming larva could be fed. The experiments show that the only food which the oyster in its free-swimming existence is able to utilize is the naked flagellate, and that only the settled spat can feed on green cells surrounded by a cellulose or hemi-cellulose cell wall. The explanation put forward is that the slow penetration of enzymes through such a cell wall during the passage of food through the gut is possible in the spat, but in the larva where the passage is very rapid the cells pass through undigested. In the large-scale experiments where two tanks were used, one was provided with finely divided organic material and the second was used as a control, the result showing a much larger number of larvæ which settled in the tank so manured whilst the flagellates were also much more numerous. It is now possible to anticipate with some confidence a spat-fall of commercial value in the tanks, the rapid growth of such spat transferred to cages in the open water showing that the methods employed are effective. Good results are anticipated from further experiments in culturing on a large scale the naked flagellates for the food of the larvæ.

Climatic Cycles and Tree Growth

PUBLICATION No. 486 (1937) by the Carnegie Institution of Washington contains a description by W. S. Glock of the principles and methods of tree-ring analysis developed by Dr. A. E. Douglass, which enters very fully into the methods of sampling trees and of reading and correlating the numbers and breadths of the annual rings. A survey of ring breadths at different heights on the trunk of *Pinus ponderosa*, which extended even to observations on branches and roots, supplies convincing evidence of the validity of these ring measurements, and the analysis of the correlation between these observations and examination of their value as climatic indicators show how carefully and conservatively the new technique is being developed. Mr. G. A. Pearson, senior silviculturist in the United States Forest Service, discusses the factors influencing the growth of trees, but these have received more adequate treatment in many forestry publications; this volume will rather be consulted for its very full account of the technique developed in reading the ring breadths of trees and in applying such data to the discovery and analysis of climatic cycles.

Fjord Formation

THE coastal mountain belt of North-East Greenland affords ample evidence of a former considerable ice-cover, and the extensive system of fjords in that region provides scope for the study of the origin and development of fjords in relation to erosion processes. Mr. N. E. Odell discusses this problem in a paper on the Franz Josef fjord region of North-East Greenland in the *Geographical Journal* of August and September. J. H. Bretz, in a former study of these fjords, considered them to be stream-eroded valleys modified and deepened by ice action, which would, he believes, be accentuated, during ice submergence, on a previously eroded valley. This was also the view of F. Nansen. Mr. Odell, on the other hand, considering in detail the possibilities of subglacial plucking, doubts the ability of the ice to do the work suggested. An ice-sheet covering a steep preglacial valley might possibly have the motion necessary for abrading, but would be unlikely to acquire moraine matter, without which the scouring action would not occur. Mr. Odell also shows that the disintegrating effects of basal freeze and thaw would probably be absent. On this and other evidence he inclines to the belief that the greater part of the fjord formation of North-East Greenland must be attributed to a period of partial and complete emergence of the land surface rather than to a time of entire submergence by continental ice.

Basalts from the Carlsberg Ridge

AN important contribution to the petrology of the floor of the Indian Ocean has appeared (*Sci. Rep. John Murray Exped., 1933-34, 3, No. 1, 1-30, British Museum, 1937*). Dr. J. D. H. Wiseman gives petrographic descriptions and chemical analyses of four Carlsberg Ridge rocks dredged from a depth of 3,385 metres. While mostly angular, some of the specimens are rounded and have a coating of manganese nodule material. Three of the analysed rocks are oligoclase-basalts; the other is hornblende-augite-dolerite. Chemically, all are characterized by low total iron, relatively high soda and very low potash, and thus show spilitic affinities. The possibility that the unique alkali relations may depend

on the action of sea-water is discussed, but it is concluded that they are much more probably an index to the nature of the parental magma. The rocks are chemically different from the Deccan traps and other Gondwanaland basalts, and there is strong evidence that they are of submarine origin and do not represent sunken remnants of any former land area. Apart from the very low potash contents, the Carlsberg Ridge specimens are comparable with average basalts from the Atlantic and Pacific Oceans, all of which differ from the Plateau basaltic types of the world in their lower iron contents. Dr. J. H. J. Poole has determined radium in the described specimens and finds the amounts present to be uniformly low, in which respect the rocks also differ systematically from the Deccan basalts.

Deep-Focus Earthquakes in the South-West Pacific

MR. R. C. HAYES has recently made an interesting study of the distribution of normal and deep-focus earthquakes in the south-west Pacific (*Bull. N.Z. Dom. Obs. Wellington, No. 109, 691-701; 1937*). The area considered is bounded by the parallels 0° and 50° S. and the meridians 140° E. and 160° W., and, during the years 1918-34, contains the epicentres of 87 deep-focus earthquakes, of which Mr. Hayes gives a valuable catalogue. These form 11 per cent of the total number of earthquakes recorded in the district. As a rule, the focal depths lie between 100 km. and 200 km.; but, in an area of which the centre is in lat. 25° S., long. 176° E., depths of 500 km. or more were common, while normal earthquakes were almost absent. In the zone between 10° and 30° S., in which the deep-focus earthquakes were most numerous, the maximum monthly number occurred in August.

Atmospheric Pressure at Mauritius

PUBLICATION No. 18 of the Royal Alfred Observatory, Mauritius, by M. Herchenroder, is entitled "The Atmospheric Pressure at Mauritius". It is a discussion of fifty-six years' continuous record of that variable at the observatory at Pamplemousses made with a Kew barograph recording photographically. Mean yearly values for each year from 1875 until 1930 range from 1,008.70 mb. in 1916 to 1,010.82 mb. in 1880, the mean for the whole period being 1,009.69 mb., and show a secular drift. If this drift is a cyclical variation, the period of 56 years is too short to determine its value directly, but it is held to be connected if not identical with a long-period rainfall oscillation that seems to have completed one cycle between 1872 and 1928. Short-period oscillations are superposed on the long-period oscillation, notably periods of nine and seventeen years. The annual variation is shown by plotting the means for each day of each month, and is composed mainly of a very well marked annual wave of 10 mb. amplitude with a minimum on February 9-10, which falls very nearly at the time of the maximum of the annual temperature wave. The diurnal variation is studied by means of harmonic analysis, and this shows that by far the largest component is the 12-hour cycle, the phase of which shifts slightly in the course of the year; that the next in importance is the 24-hour term (mean amplitude 0.394 mb. compared with 0.953 mb. for the 12 hour); that the 8-hour term, although its amplitude is not more than a quarter of that of the 12-hour term even at the seasonal maximum of the 8-hour term in July, shows a large and remarkably systematic double annual

variation both of amplitude and of phase; and lastly, that the small 6-hour term also shows a double seasonal variation but with phase reversed. The lunar daily variation is not determined here, having already been investigated for the forty years 1876-1915 by Chapman.

Synthesis of Vitamin B₁

THE structure previously proposed for vitamin B₁, based on the identification and synthesis of several disintegration products (notably 4-methyl-5-beta-hydroxyethylthiazole, 2,5-dimethyl-6-aminopyrimidine, 2-methyl-6-oxypyrimidine-5-methylene sulphonic acid) and the establishment of the mode of linkage of the two nuclei indicated by the presence of quaternary nitrogen in the molecule, has been completed by J. K. Cline, R. R. Williams and J. Finkelstein (*J. Amer. Chem. Soc.*, **59**, 1052; 1937) by a synthesis of the vitamin by a method depending on the conversion of a 5-ethoxy-methyl-pyrimidine into the corresponding 5-halo-methyl derivative. Difficulties in obtaining crystalline material were encountered. Ethyl sodioformyl-β-ethoxypropionate was condensed with acetamide hydrochloride in alcohol with sodium, and the resulting 2-methyl-5-ethoxymethyl-6-oxypyrimidine liberated and sublimed in high vacuum. This was converted into the corresponding chloropyrimidine with phosphorus oxychloride, and this into the corresponding aminopyrimidine by heating under pressure with alcoholic ammonia. By heating this with a solution of hydrobromic acid in glacial acetic acid, 2-methyl-5-bromomethyl-6-aminopyrimidine hydrobromide was obtained, and by heating this with 4-methyl-5-β-hydroxyethylthiazole in butanol and diluting with boiling ethanol, needles of vitamin B₁ bromide hydrobromide were obtained. The physiological activity of this compound, C₁₁H₁₇ON₄SBr.HBr. 0.5 H₂O, was found to be equal to that of the natural vitamin. The corresponding chloride hydrochloride was prepared, and its physiological activity established.

Structure of Carbon Suboxide

ABOUT four years ago the structure of carbon suboxide (C₃O₂) was shown by the methods of electron diffraction to be most probably linear and symmetrical. Evidence supporting this view was also derived from investigation of its ultra-violet spectrum and, more recently, from its Raman spectrum. For a molecule possessing a centre of symmetry, spectroscopic selection rules forbid the appearance of Raman-active fundamental frequencies in the infra-red spectrum and vice versa. A paper of Drs. R. C. Lord and A. Wright (*J. Chem. Phys.*, **5**, 642; 1937) on the infra-red spectrum is therefore full of interest. They find that Raman-active frequencies are not present in their spectrum and the linearity and symmetry of the molecule are now convincingly proved. The modes of vibration of such a model consist of 4 non-degenerate (2 Raman-active, 2 infra-red active) and 3 doubly degenerate (only one of which is Raman-active) frequencies. By assuming the type of molecular force field, values of the frequencies can be calculated, and it is found that one of the infra-red active degenerate fundamental frequencies lies beyond the limits of their spectrograph at about 50 μ (200 cm.⁻¹). The other degenerate infra-red fundamental (ν₆) cannot at present be assigned with certainty. From a consideration of the allowed binary and ternary com-

bination tones, there is strong indication that its value is 550 cm.⁻¹, although another possible value at 900 cm.⁻¹ cannot be completely excluded. It is interesting to note that all the observed bands can be satisfactorily interpreted on the basis of ν₆ = 550 cm.⁻¹, but further and more detailed experimental data on the infra-red spectrum, especially between 2 μ and 7 μ, between 11 μ and 18 μ, and around 50 μ, must be forthcoming before the final assignments can be made.

Atomic Weight of Phosphorus

ASTON has shown that phosphorus is a pure element, in the sense that it is composed of one type of atom only, of mass number 31. It has a negative packing-fraction amounting to -5×10^{-4} . Hence the atomic weight of phosphorus should be less than 31, especially as the factor for converting physical atomic weights to chemical atomic weights on the scale O = 16 (1.00022) also acts in the same direction. Yet the internationally accepted value for the atomic weight of phosphorus is 31.02 (O = 16). The value calculated by Aston from mass-spectrographic data is 30.978. Hönigschmid (*Naturwiss.*, **25**, 670) 1937) has recently carried out a careful chemical determination of the atomic weight of phosphorus using phosphorus oxychloride, POCl₃. The ratio POCl₃:3Ag was determined by a nephelometric method, and the value obtained for the atomic weight was 30.978, in exact agreement with Aston's result.

Effect of Surface Treatment on Magnetic Permeability

IN a letter in NATURE of May 29, Dr. T. F. Wall gave particulars of results obtained in an investigation on the permeability of nickel wire as affected by a coating of 0.003 inch of electro-deposited copper. These showed that, as compared with the bare wire, a value about 60 per cent higher could be obtained under the conditions described. The results of further tests on similar lines are now available (*Engineer*, Aug. 13), and bear out the idea which gave rise to the experiments. The dissymmetry of the molecular forces at and near the surface of the bare wire suggested to Dr. Wall a corresponding dissymmetry of the magnetic forces, and his idea was that by coating the surface with a thin skin of non-magnetic metal this condition might, to some extent, be eliminated and that interesting information might be forthcoming as to changes in magnetic properties. The later tests have been made on wire of bright drawn Armeo iron with coatings of copper, nickel, and aluminium. While the uncoated wire gave a maximum permeability of 3,500, the figures reached with the coated wires were: copper coating 3,600, nickel 4,050, and aluminium 4,300. The effects are thus not as striking as in the first tests, but from the very marked increase obtained when nickel is coated with copper—two metals standing next to each other in the atomic number series—it is inferred that iron with a coating of manganese—two similarly placed metals—may be expected to show an equally pronounced increase. This is now under investigation by the methods described and with the aid of X-ray spectrograms of the boundary surface of the wire and the applied skin, and it is anticipated that in the results some light may be thrown on the behaviour of manganese in the Heusler series of alloys and its influence in Hadfield's non-magnetic manganese steel.

Origin of Oil

THE United States Geological Survey and the American Petroleum Institute have, during the course of studies of source beds, amassed a wealth of data which may prove invaluable in the elucidation of the vexed problem of the origin of petroleum. Dr. P. D. Trask has made full use of this data, and in a recent paper (U.S. Department of the Interior, Prof. Paper 186—H) he explains inferences he has drawn, and suggests that they are worthy of the consideration of geologists interested in the problem.

Geological conditions under which petroleum is found point to its derivation chiefly from the organic matter of fine-grained marine sediments. The source of this organic matter is directly traceable to planktonic organisms in the overlying water. During their life, prior to burial in sediments, these plankton undergo successive chemical changes, and a study of these provides a valuable clue as to the constitution of the organic matter of sediments.

The main source of original organic matter is floating plant life which serves as food to the animal life of the sea. On being taken in as food, part of the plankton is assimilated in the tissues of the consuming organism, part is excreted as waste, and the rest is used to generate energy. That part which generates energy is destroyed during the process. The part which is excreted may again serve as food to some organisms, but it becomes successively less and less digestible. Ultimately there remains a complex residue of substances resistant to decomposition, and, broadly speaking, this forms the organic constituents of sediments. After burial, this residue is associated with little if any free oxygen and, therefore, is unlikely to undergo much further alteration.

The average composition of marine plankton is approximately 24 per cent protein, 3 per cent fat, 73 per cent carbohydrates and other non-nitrogenous substances. The composition of the organic constituents of recent sediments is of the order of 40 per cent protein, 1 per cent fat and less than 60 per cent carbohydrates and other compounds. In ancient consolidated sediments, proportions are about 27

per cent protein, 1 per cent fat, and more than 60 per cent other compounds.

It is improbable that any substance present in organic constituents of sediments only in quantities of 1 per cent or less is a major source of oil. Cellulose is discredited on this count, since it is ordinarily found in recent sediments in amounts of 1 per cent or less. Other carbohydrates such as hemicellulose, starches and sugars, are found in equally small quantities and are accordingly discounted.

Proteins, since they form approximately 40 per cent of the organic matter of recent sediments and 27 per cent of that of lithified sediments, are possible sources of oil. The proteins in sediments, however, differ considerably from proteins of the original plankton whence they are derived. Simple proteins are present in recent sediments in such small quantities as to preclude their consideration as source materials.

Fats, though believed by many to be the chief sources of petroleum, are possibly not so, partly because they are present in insufficient quantity, and partly because they are unsaturated in character while the fats of petroleum are saturated.

In any event, cellulose, carbohydrates, simple proteins and fats together only form about 5 per cent of the organic constituents of sediments, and it is more probable that the remaining 95 per cent, or part of it, is responsible for the formation of petroleum. This is in point of fact an unassimilable residue composed of complex compounds deficient in oxygen. The tendency of buried organic constituents to come to chemical equilibrium might cause the generation of liquid hydrocarbons. These in turn might dissolve organic substances, and the resulting organic constituents in solution might react upon one another in order to reach a state of equilibrium. Repeated readjustments of this character might possibly result in the formation of petroleum.

To substantiate this hypothesis, however, detailed investigations of the chemical nature of the organic constituents of sediments are essential. Conclusions may then be reached as to the particular type of organic material likely to be transformed into oil by chemical reactions of the type envisaged.

Studies of Metals and Alloys

OF the papers read or taken as read at the Autumn Meeting of the Institute of Metals at Sheffield on September 6-9, the following short abstracts of some of the more generally interesting will give an indication of the widely varying fields of research considered.

In view of the engineering importance of alloys, both ferrous and non-ferrous, which consist of two phases of appreciably different hardnesses and of inclusions in metals generally, a paper by Hermann Unkel, on the deformation of the macrostructure of some two-phase alloys by cold-rolling, is welcome. Although this is but the first stage in the con-

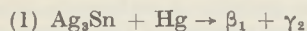
sideration of the subject, the paper gives much interesting data, and cannot fail to arouse the interest of metallographers generally.

Inverse segregation, that is, the segregation of components in an alloy in the reverse direction to that which would normally be expected, is a matter of both academic and practical importance. N. B. Vaughan contributes a general review of the present position, together with an extensive bibliography which will be widely appreciated.

The transformation which occurs at a temperature of about 470° C. in the β -brass and which has been known now for some forty years, is dealt with

in a paper by C. Sykes and H. Wilkinson. The work of Bragg and Williams which attributed the transformation to a change from disorder to order in the lattice is now generally accepted. The present paper provides data which confirm this view, and represents a most valuable contribution to our knowledge of this and similar changes in other metallic alloys.

The academic interest and the practical importance of the volume changes which occur during the hardening of a dental amalgam provide ample justification for two papers by Dr. Marie L. V. Gayler on the constitution of the alloys of silver, tin and mercury and on dental amalgams. The author concludes that the changes taking place on the setting of such an amalgam are to be attributed to complex reactions which probably do not proceed to completion and which may be briefly summed up as:



No explanation for the marked contraction or expansion which occurs is obtainable from X-ray analysis, but the former is ascribed to the formation of a solid solution of mercury in Ag_3Sn .

In view of the enormous amount of galvanized iron and steel now being used, a critical paper by L. Kenworthy on the methods of testing zinc coatings will arouse wide interest. The value of such protective coatings on iron and steel depends on the average weight, the uniformity, structure and porosity, and under these four headings the various methods which are actually in use, or which have been proposed, are described, together with their respective advan-

tages and limitations, and, in certain cases, with suggested modifications.

The determination of alumina in metallic aluminium is a matter of very great difficulty, and a paper by G. B. Brooke and A. G. Waddington makes a substantial contribution in this difficult field of metallurgical analysis. A method is described which has proved superior to any yet proposed for determining alumina in granulated aluminium dross. The complete separation of the metal by volatilization as the chloride in pure hydrogen chloride and subsequent conversion to oxide allows the metallic content to be accurately determined.

It was observed by Hopkinson in 1905 that stresses greatly exceeding the normally accepted values of the tensile strength could be applied to iron and copper wire for very short intervals of time without rupture, and this is now generally believed to hold for all the more common engineering materials. D. W. Ginns describes apparatus in which samples of metals have been broken in 0.005 sec., the yield point being attained in 0.001 sec. It is shown that when compared with ordinary tensile test values the yield point is increased very considerably, a times by more than 100 per cent, that the maximum stress is raised, but to a smaller extent, while the ductility remains more or less unchanged. It is a curious feature of many of these ultra-rapid tests that the yield point and maximum stress coincided even in metals of high ductility. As a sample of the type of results obtained, the following may be quoted for a steel containing 0.15 per cent carbon. The tensile strength broken at ordinary rates was about 32 tons per square inch, which was raised to 37 tons in the high-speed tests. The corresponding values for the yield point were 22.3 tons per square inch and 37 tons per square inch. F. C. T.

The California Sardine and its Fishery

THE California sardine (*Sardinops caerulea*) is caught by small motor-boats using purse-seines and round-haul nets with large bunts, called 'lamparas'. The fishery takes place in autumn and winter. The California State Fisheries Laboratory has recently added two more papers to the series of studies of this fishery.

The first paper ("Interseasonal and Intra-seasonal Changes in the Size of the California Sardine (*Sardinops caerulea*)"). By Frances N. Clark. Contribution No. 150 from the California State Fisheries Laboratory) deals with the results of the biometrical investigations which have been carried on by the staff of the State Fisheries Laboratory during the last sixteen years. The autumn fishery is of adolescent fish which will spawn for the first time in the following spring, and of the three preceding year groups. In the winter fishery these young fishes continue to be caught, but the bulk of the catch is made up of fishes in their fifth to tenth spawning seasons.

Unusually successful year classes occur at irregular intervals: the study of their effect upon the length frequency polygons of the autumn fishery indicates that the adolescent fishes form a higher proportion of the catches in the southern part of the area (San

Pedro-San Diego) than farther north off Monterey and San Francisco. These large year classes may be detected in the winter fisheries for six or more seasons. The author points out that the autumn fishery draws upon three or four year groups only, as against the eight or ten year groups present during the winter fishery. From the fact that the large year groups of 1929-30 and 1933-34 lost their dominance in the catches more rapidly than the year groups of 1919-20, 1922-23 and 1925-26, the conclusion is drawn that there is considerable over-fishing of the young fish, and that a serious reduction of the sardine population must be the result.

The seasonal changes in size which occur suggest that the young fishes are to be found off the southern coast of California, and that as they grow older they tend to move farther north after each spring spawning, so that the oldest fishes inhabit the more northerly part of the range. These old fishes move southward to the spawning grounds.

The fishing grounds of the Californian sardine boats are briefly reviewed in a separate paper ("Fishing Localities for the California Sardine, *Sardinops caerulea*, 1928-1936"). By Frances N. Clark. Contribution No. 158 from the California State Fisheries

Laboratory). In Central California practically no catches are made outside the 100-fathom line. Off Monterey, where the continental shelf is narrow, 81 per cent of the catch of sardines is taken within five miles of the coast. The shelf is wider off San Francisco,

and correspondingly more catches are made at greater distances from the shore. In southern California, where the 100-fathom line is close to the shore, the fish appear to be concentrated along the steep slope, which drops rapidly to 500 fathoms.

Lubrication and Lubricants*

INDUSTRIAL APPLICATIONS

The third group of papers is concerned with industrial applications of lubricants. Catterall and Maitland survey the use of grease in a number of diverse applications, and several papers reveal the extent to which this form of lubricant is being used. Although, as mentioned by Cooper, lubrication by an oil mist would be ideal for ball, roller and needle bearings, they are most commonly lubricated with grease, because grease remains in the housing and affords protection against dust and moisture, which would lead to abrasion and pitting of the accurate surfaces. Cooper, Richardson and Kjerrman all emphasize the undesirability of overfilling the housings, on account of churning, and the care required in choosing greases, advocating an actual running test. Hanocq deals with the friction of ball and roller bearings.

Water-grease emulsions are used in drawing steel tubes (Catterall and Maitland). In the similar operation of cold pressing sheet steel, high pressures are encountered, and Arrowsmith reviews the desirable qualities of the lubricant, film strength, appropriate friction, ease of spreading and of removal, etc.; a fatty oil emulsion containing chalk powder is generally used. High pressures also occur in wire-drawing, and Goodacre states that the lubricant used in dry drawing is a dry sodium soap, in conjunction with some calcium hydroxide remaining after neutralizing the acid used in cleaning. In wet drawing one of the essentials is the formation of a very thin coat of copper or tin on the surface of the metal; the bath usually contains a fatty lubricant and soap, and must contain sulphuric acid. Thompson considers that the friction in the die is of the boundary type, and investigates a number of soaps and liquid lubricants at various temperatures.

Miller contributes a useful review of extreme pressure lubricants as regards composition and the behaviour in various testing machines, and the problems presented by the need for stability, absence of corrosion, etc.; he refers to future trends and the need for more research, emphasizing the important effect this work on additions to lubricants is having on lubrication generally. Evans gives results of tests in the Almen machine on various oils and greases, and of a number of pure organic compounds in small proportion in mineral oil. Clayton describes the superior behaviour of extreme pressure oils over other gear oils in the 4-ball apparatus, not only in breakdown load and wear, but also in the time to recovery from seizure.

Parker writes on the lubrication of bearings of light mechanisms in which the oils sometimes cannot be renewed during the life of the mechanism. High 'oiliness' has thus been regarded as important, and dolphin and porpoise jaw oils have been used; on

account of the oxidation and gumming of these oils, however, mineral oils are now being tried. Stott and Shotter agree that the pivot and cupped-jewel bearing can run well for a time without lubricant, but that oil is necessary for prolonged running at low friction, one of the important functions of the oil being to carry in suspension the iron oxide formed at the contact under the extremely high local pressures.

Hogan, also Nixon and Jackson, describe the difficult problem of lubricating wire ropes; two functions are required of the lubricant: (1) to prevent corrosion; (2) to reduce the friction and prevent seizure of the wires, which make contact with each other at high pressure. Merritt gives much useful information on gear tooth failures and on factors governing the choice of lubricants for gears; Tuplin describes the different methods of applying the lubricant. Blok, in a notable paper, shows, by Bowden's method, the high temperatures reached by gear tooth surfaces under high-pressure running conditions.

PROPERTIES AND TESTING

The fourth group of papers concerns properties and testing and is of especial interest. In connexion with boundary lubrication, Adam and Kyropoulos review surface phenomena and the function of the adsorbed boundary layer in protecting the metals from cohesive contact. Kyropoulos favours internal molecular mobility rather than elasticity as the explanation of the efficacy of long molecules; also he reasons that the lattice forces of the adsorbing surface ultimately control the lateral packing of the molecules of the boundary layer, thus accounting for the surviving influence of the surface at distances exceeding the range of the original surface forces.

Finch and Zahoorbux describe their work on electron diffraction to show orientation of surface films. Trillat studies adsorption by measuring the rate of change of oil-water interfacial tension by a modification of du Nouy's method. Using oleic acid-B.P. paraffin mixtures to provide a scale, the activity of commercial oils can be expressed in equivalent oleic acid content. Examination of an oil before and after passing it over metal balls, through filter paper, etc., shows the adsorption of active molecules at the surfaces. Miss Nottage reports results of static friction tests with fatty acid and wax additions to oils, revealing the effect of atmosphere and adsorbing surface. Fogg describes kinetic friction tests with an oscillating bearing machine; he considers that true boundary friction is obtained below 3 cycles per minute.

Surface finish in relation to the boundary layer is mentioned in a number of papers. Bowden refers to the high temperatures found at sliding contacts; with Leben he shows that sliding is a discontinuous

*Continued from page 816.

process, and that when slip occurs there is a momentary jump in temperature. Blok works out the temperature rise for sliding contacts for a number of ideal cases. Neely describes simultaneous friction and wear measurements and shows that the wear-reducing value of addition agents may be quite different in degree and sometimes in direction from the friction-reducing value. Brownsdon, Southcombe, Wells and Waters, Clayton and van der Minne report breakdown loads and wear under relatively severe conditions, and provide a fund of information relating to 'oiliness' and extreme pressure effects which can only be partially co-ordinated; it appears that the good qualities of extreme pressure oils can only be brought out at high pressure and speed, leading to high temperature.

In the papers dealing with viscosity, that by Groff explains the use of a chart for the graphical solution of a number of viscosity-temperature problems. Geniesse describes the kinematic viscosity measuring equipment which has been adopted by the American Society for Testing Materials, and the new viscosity-temperature chart. Barr describes viscometer bath arrangements for high temperatures, and suggests a new empirical formula for expressing viscosity-temperature relationship. Suge gives an account of his methods and results of measurement of viscosity up to high temperature and pressure; he finds that the product of surface tension and coefficient of compressibility is a constant, and measures the thermal conductivity of oils. Bradford and Vandegrift quote Dow's results on the effect of pressure on the viscosity of mineral oils.

Coming now to papers dealing with oxidation tests of oils, Andrews finds that the rate of separation of water-in-oil emulsion is a good guide to the condition of a turbine oil in service. Moerbeek is critical of the

many oxidation tests for internal combustion engine oils on account of the disagreement between the results and the lack of correlation with engine behaviour; he is pessimistic as to their ultimate capability of predicting the behaviour of oils in engines. Mardles and Ramsbottom provide extensive results on the oxidation of oils with varying temperatures, time and method of oxidation. Hans and Egerton, finding that gumming increases with engine knocking occurs and that nitrogen oxides formed particularly under these conditions, have investigated the connexion between the two; they find that nitrogen oxides, even in small proportions, have a marked catalytic effect on oxidation, and suggest that this may be one of the factors leading to lack of correlation between laboratory and engine tests. Moutte, Dixmier and Lion find that they improved correlation by first oxidizing the oil at low temperature and then subjecting it to high temperature. Evans and Kelman have found that some such as tin oleate can inhibit the catalytic effect of iron on oxidation, and by engine tests have chosen optimum proportions of tin and chromium oleates for an engine oil.

The time has certainly not yet arrived when the principles of lubrication can be said to be satisfactorily established on a scientific basis: clearly much additional and carefully co-ordinated research of a really critical nature must be carried out. Nevertheless, progress has been made and certain underlying physico-chemical concepts are emerging. The papers contributed to this general discussion form an admirable review of the present position and their detailed study is recommended to those interested in the theory and practice of lubrication and lubricants.

H. J. G.

Recent Advances in Horticulture

MANY useful reviews are contained within the pages of vol. 5 of the Horticultural Education Association's yearbook for 1937 "Scientific Horticulture" (Pp. 196 + xxxii, 3s. 6d. net, from the Hon. Editor, S. E. Agric. Coll., Wye, Kent), which constitute a welcome channel for the distribution of knowledge from the research worker to the teacher of horticulture. "Some Recent American Work on the Copper Fungicides" is described by Mr. R. W. Marsh; Prof. Stoughton contributes "A Review of the Problem of Bud Dormancy". Dr. O. N. Purvis discusses recent Dutch research on the temperature requirements of hyacinths, and Dr. Meirion Thomas has a paper on "Plant Hormones and Their Possible Importance in Horticulture". Dr. F. Kidd and Dr. G. West show that apples destined for long-period gas storage should be picked within a fortnight of the 'climacteric phase'. This is the time when growth in size of the apple ceases in autumn, and is indicated in practice when the fruit can just be detached by gently twisting it on its stalk. The late Dr. W. Maldwyn Davies describes the results of his experiments on factors which affect the distribution of virus-transmitting aphids, particularly *Myzus persicae*. Winged individuals of this species fly readily when the temperature reaches 65° F. Increasing humidity deters the movement of winged aphids, and flight ceases

completely when the wind velocity rises above 10 miles per hour. Dr. T. Whitehead has correlated knowledge with a survey of districts in North Wales which are suitable for the growth of virus-free potatoes.

Messrs. B. S. Furneaux and W. G. Kent have investigated a malady of fruit trees known as 'death'. This is due to the suffocation of roots by the rise of the water-table after planting in a dry period whilst wind-rocking of newly planted trees is often contributory cause. Research work in progress at John Innes Horticultural Institution is reviewed by Mr. W. J. C. Lawrence, and at the St. Ives Research Station by Mr. R. B. Dawson, who also contributes a paper on the routine management of lawns. W. G. Ogg discusses the reclamation of peat land, the utilization of peat as a mulch, as a potting medium, and as a source of organic matter for garden soils. Prof. G. W. Robinson discusses more general problems of horticultural soils.

Papers dealing with practical topics also appear in the volume.

CHESHUNT RESEARCH STATION

The twenty-second annual report, for 1936, of the Experimental and Research Station sponsored by the Nursery and Market Garden Industries' Development

Society, Limited, at Turner's Hill, Cheshunt, Herts, shows that much work is being directed towards the improvement in quality of tomatoes. The director, Dr. W. F. Bewley, and Mr. J. Harnett, have investigated the condition of tomatoes upon arrival at the wholesale markets in many parts of England, and much information has been made available for growers. Manurial and crop-management trials have been continued, and a method for restricting the root systems of tomato plants within clay pots gives earlier ripening and enhanced quality. Soil heating, applied after the two bottom trusses have set, gives a greater yield than the use of continuous ground warmth from planting time.

The Station now possesses a mushroom house, where an attempt is being made to understand the cultural requirements of this plant, and where the incidence of pests, and the appearance of undesired fungi, can be studied and controlled. A truffle fungus, *Pseudobalsamia microspora*, has been described as a new invader of mushroom beds. Several new fungal diseases of flowering plants have been described.

An interesting method of testing for the presence of spotted wilt virus in chrysanthemum plants has been evolved. This virus is scarcely tolerant of oxidation, and it is difficult to inoculate such hosts as tobacco or tomato with it. A dilute solution of sodium sulphite, acting as a reducing agent, allows such inoculations to be performed with ease. The occurrence of the eelworm *Anquillulina dipsaci* upon the tomato has been recorded, and the marking of tomato fruits with circular rings is shown to be the result of drops of water containing *Botrytis* spores.

LONG ASHTON RESEARCH STATION

The annual report of the Agricultural and Horticultural Research Station at Long Ashton, Bristol, for 1936, sets forth the results of a number of investigations which are especially practical in their outlook. A new section deals with soil surveys; Dr. T. Wallace has described the soils in the Vale of Evesham, in their relation to fruit and vegetable crops, and Dr. D. A. Osmond has studied the more intensive problem of the Station's pedology. Mr. G. T. Spinks reports work in progress on apple breeding, and variability of apple trees on seedling and on clone rootstocks.

Drs. T. Swarbrick and W. E. Berry have carried out yield trials with various black currant varieties in relation to the system of pruning adopted. They give the interesting result that hard pruning reduces the crop significantly in every case. The same two workers have also inquired into the incidence and spread of the virus disease of black currants known as 'reversion'. They indicate a correlation between the appearance of big bud, caused by a gall mite, and the virus, though big buds have never been observed before the symptoms of reversion, on the same bush. This raises the possibility that the gall mites may be present upon a bush for some time, in numbers sufficient to transmit reversion, but insufficient to produce a gall.

Dr. H. G. H. Kearns, Mr. R. W. Marsh, Dr. H. Martin, and Mr. E. Umpleby have a number of papers upon the control of pests and diseases by spraying. A third progress report on the use of combined washes is given, and sulphite lye has been used as an emulsifier. Dr. C. L. Walton shows that a type of parsnip canker is caused by the eelworm *Anquillulina dipsaci*, which can also induce similar

symptoms on onions, and in collaboration with Messrs. L. Ogilvie and C. J. Hickman, a study of the effect of nitrogenous fertilizers on potato 'sickness' has been made. The eelworm, *Heterodera Schachtii*, which causes the trouble, evidently interferes with the nitrogenous metabolism of the potato, and the yield of tubers on 'sick' land can be increased by the application of nitrogenous manures.

Mr. P. T. H. Pickford reviews the cider-making trials during the year, and Mr. Vernon L. S. Charley contributes two papers upon principles involved in the manufacture of fruit juice syrups. This work is of importance in providing a new and steady market for various fruits, and should help materially in the economic management of the extremely variable yield of home-produced fruit. A study of the dormant buds of the cricket-bat willow, as they affect the wood, has been made by Mr. H. P. Hutchinson, who also inquires into the effect of lateral branches upon the production of sets in this species of willow.

CULTURE OF AMARYLLIDS

The American Amaryllis Society has decided upon the title *Herbertia* for its third, and all subsequent year-books. This is to honour the pioneer work of William Herbert, whose published work on the Amaryllidaceæ appeared in 1837. Vol. 3 (Pp. 151, from the editor, Dr. Hamilton P. Traub, Mira Flores, Orlando, Florida, U.S.A., 1936) is dedicated to Arthington Worsley, whose contributions to the culture of amaryllids are acknowledged in a short appreciation by Lord Aberconway, president of the Royal Horticultural Society of England. The botanist will find much of interest in the volume, particularly in the sections dealing with the physiology of reproduction and with genetics and breeding. Little is yet known about causes which influence the balance between flowering and vegetative propagation in bulbs. A paper on "The Propagation of *Zephyranthes rosea* by Under- and Over-Feeding" by Dr. Hamilton P. Traub and A. E. Hughes, provides a welcome introduction to the effect of soil nutrients upon propagation by bulbils. I. W. Heaton describes the propagation of amaryllids by destruction of the terminal bud, and Wyndham Hayward gives a method for propagating *Lycoris* by basal incisions. Dr. Traub has a further paper on "Growth Responses Following Stem Cuttage of Amaryllids".

The most widely interesting contributions in the section on genetics and breeding are, perhaps, those which relate to the storage of pollen. It has only been possible in the past to cross-pollinate such varieties as overlapped each other in their times of flowering. It is now possible to store pollen of many species for a considerable time. Miss Norma E. Pfeiffer has shown that the best conditions for storage are provided by a temperature of 10° C. with a relative humidity of 35-50 per cent. Dr. Traub shows how such a humidity can be preserved in an enclosed space by means of saturated solutions of various salts. Dr. A. B. Stout has an article on the evaluation of horticultural clones of day lilies, and there are also papers upon specific genetic problems relating to the Amaryllidaceæ by S. P. Lancaster, G. W. Gibson, R. T. van Tress, and Wyndham Hayward.

The section on colour description includes three papers on colour photography, and the colour charts of Fischer and the Royal Horticultural Society are discussed.

Science News a Century Ago

Captain Back's Voyage in H.M.S. *Terror*

AT the opening meeting of the session of the Royal Geographical Society on November 13, 1837, many interested in Arctic exploration assembled to hear Captain (afterwards Admiral Sir) George Back (1796-1878) give an account of his voyage in the *Terror*, made at the instance of the Society with the object of furthering knowledge of the North-West. Leaving England in June 1836, he passed through the Hudson Strait and shortly afterwards in exceptional circumstances was beset in the ice off Southampton Island. Speaking of his experiences off the Island he said: "The frost-smoke that allured us vanished as we drew near, and the dark lanes of water from which it originated closed firmly, to the utter impossibility of proceeding one yard farther. Left, therefore, to the influence of events, we were borne backwards and forwards, according to the eccentric movements of the ice, crowding sail when the least crack showed a probability of an opening, or with the aid of saws, axes and ice anchors, working a few paces, until the most closely packed ice finally arrested our progress twelve miles from Cape Bylot, when only fifteen more would have ensured a safe wintering place in Duke of York's Bay."

The ship remained fixed in the ice from September 1836 until June 1837, when owing to the damage done to her it was necessary to return home. On the way home she leaked so much as to need incessant pumping, and to secure the ship, said Back, "we were obliged to strap her together with the stream chain cable. . . ." The *Terror* arrived back in Lough Swilly on September 3, 1837.

The Royal Society's New Barometer

ON November 16, 1837, Francis Baily read a communication to the Royal Society, entitled "Description of a new Barometer recently fixed up in the Apartments of the Royal Society; with remarks on the mode hitherto pursued at various periods, and an account of that which is now adopted, for correcting the observed height of the mercury in the Society's Barometers". In the course of his paper, Baily referred to the height of the Society's barometer above the mean level of the sea, about which there appears to have been some uncertainty. Thus prior to 1823 the cistern of the barometer is said to have been 81 ft. above the level of low-water spring tides at Somerset House, but without any information how this was connected with the sea. From 1823 until 1825 inclusive, it was said to have been 100 ft. above the same level, and from 1826 until 1836 inclusive the height is said to have been 83 ft. 2½ in. above a *fixed mark* on Waterloo Bridge or above the mean level of the sea (presumed about 95 ft.). The discordance between the 81 ft. and the 100 ft. was accounted for in as much as the old barometer prior to 1823 was fixed in the Council room while the Daniell barometer of 1822 was fixed in the closet adjoining the library on the floor above the Council room. With respect to the mark on Waterloo Bridge, the reference level was the surface of the granite pedestal at the base of the columns at the north abutment of the bridge and on the eastern side, a reference point "more durable, and more convenient than any mark that could have been inscribed by hands".

Taylor's Scientific Memoirs

ON November 18, 1837, the *Mechanics Magazine* under the above heading said: "The first volume of this collection of translations from the foreign scientific periodicals is now completed, and we are sorry to find the editor and proprietor has still to complain of a want of adequate patronage. He has suspended the continuation of the work for the present, to give an opportunity for men of science to come forward in its support, before he commits himself by commencing the second volume. As the great utility of such a publication is too manifest to admit a doubt . . . it is to be hoped that Mr. Taylor's appeal will not be in vain. Richard Taylor (1781-1858) was a printer and naturalist and a member of various scientific societies. He was the publisher of the *Annals of Philosophy* founded in 1813, which was incorporated in 1827 with Tilloch's *Philosophical Magazine* founded in 1797.

Cholera in Africa

THE *Lancet* of November 18, 1837, contains the following information: "The cholera has just broken out in the *Dey's Hospital* at Algiers. On the 14th of October seventeen cases and nine deaths were reported. At Bona, where the epidemic has been prevailing for some time, the number of cases on the 17th of October had amounted to 318, the deaths to 180. One of the most curious points in the history of the Asiatic Cholera is, perhaps, the steady proportion of deaths to cases which may be observed to have occurred in all parts of the world and in all climates. This fact proves how very little as yet has been done in the treatment of the disease!"

University Events

CAMBRIDGE.—The Vice-Chancellor has announced that the University has received from Mr. J. W. O. Hamilton, of Chesterfield House, 98 Great Tower Street, London, E.C.3, an album entitled "The Commercial Development of Radio-telegraphy, Telephony and Broadcasting", and a cheque for £500 to found a prize for the encouragement of radio research in the University. Mr. Hamilton wishes the prize to be associated with the names of James Clerk Maxwell and Sir Ambrose Fleming.

It is proposed that Prof. F. Dobenham and J. A. Steers, of St. Catharine's College, be appointed to represent the University at the International Congress of Geography in Amsterdam on July 18-28, 1938.

LONDON.—The degree of Doctor of Literature *honoris causa* was conferred on H.M. the Queen in the presence of H.M. the King on November 10.

The following doctorates have recently been conferred: D.Sc. in chemistry on Mr. A. N. Dey (Imperial College—Royal College of Science); D.Sc. in statistics on Mr. M. S. Bartlett.

OXFORD.—The honorary degree of D.Litt. will be conferred on November 20 on Dr. R. R. Marett, rector of Exeter College since 1928 and reader in social anthropology since 1910.

K. A. H. Murray, of the Agricultural Economics Research Institute, has been elected fellow and bursar of Lincoln College.

Societies and Academies

Edinburgh

Royal Society, October 25.

J. W. S. MARR: Antarctic surveys: The work of the "Discovery" investigations (Bruce Memorial Prize lecture, 1936). The Discovery Committee, in spite of the heavy commitments of a comprehensive oceanographical programme, has not overlooked the urgent need for reliable charts of the little-known Antarctic lands, and of the widely scattered, remote and frequently inaccessible island groups that are the dependencies of the Falkland Islands. Among other things it was this aspect of the Committee's researches that Dr. W. S. Bruce himself had so strongly supported in an interview at the Colonial Office nearly twenty years ago. In the twelve years the Discovery investigations have been in existence, much has been done to further existing knowledge of these distant coasts. The cartography of this region is emerging slowly from a state of uncertainty and confusion, and will, it is hoped, in time reach one which may prove useful to future scientific or commercial enterprise.

Paris

Academy of Sciences, September 27 (*C.R.*, 205, 529-548).

CHARLES JACOB: Obituary notice of Albert Heim.
LOUIS LAPICQUE: Isochronism as a condition of intercellular transmission of stimulation.

PAUL LÉVY: New contribution to the arithmetic of products of Poisson's law.

RODOLPHE HENRI GERMAÏ: The existence of functions associated with the solutions of completely integrable systems of total differential equations with linear coefficients.

SANTIAGO ANTUNEZ DE MAYOLO: The composition of the electron and the energy of fixation.

PIERRE DUPIN and LOUIS SACRÉ: The measurement at a distance of the electrical state of the surface of insulating bodies.

MLLE. SUZANNE VEIL: The presence of iodine dissolved in aqueous solutions of potassium iodide, and the electrical properties of the medium.

HENRI MOUREU, MICHEL MAGAT and GEORGES WETROFF: The stereochemical structure of phosphorus pentachloride. In an earlier paper, the authors have suggested that phosphorus pentachloride exists in two forms, the solid state possessing an unsymmetrical structure, the liquid form a symmetrical structure. These considerations are applied to explain anomalies of electrical conductivity and dielectric constant described by various authors, and also certain differences in chemical reactivity.

Amsterdam

Royal Academy (*Proc.*, 40, No. 7, Sept. 1937).

J. CLAY: The energy and penetrating power of cosmic rays. A survey of the evidence for the energy and corpuscular nature of cosmic rays.

F. M. JAEGER, J. TER BERG and P. TERPSTRA: Optical rotation and rotatory dispersion in solution and in the crystalline state.

P. E. VERKADE, J. VAN DER LEE, MISS J. C. DE QUANT and E. DE ROY VAN ZUYDEWIJN: New methods for the synthesis of glycerides (2).

MISS W. A. LUB: The optical spectrum of actinium. New lines due to actinium.

MISS J. G. EYMERS and H. P. BOTTELIER: Proto-plasmic movement in the oat coleoptile as related to oxygen pressure and age.

A. KAWAGUCHI: The relation between a metric, linear connexion and a non-metric one in a general metric space.

P. TERPSTRA and J. TER BERG: The crystal form of some complex salts of triaminopropane with trivalent cobalt and rhodium.

A. W. H. VAN HERK: The chemical processes in the spadix of *Sauromatum*.

G. C. HIRSCH: Outlines of a theory of the Golgi bodies. (1) The Golgi bodies in space.

L. H. BRETSCHNEIDER and J. J. DUYVENÉ DE WIT: The hormone chain: active urine substance \rightarrow ovary \rightarrow ovipositor in *Rhodeus amarus*.

P. JULIEN: (1) Distribution of the blood groups in some peoples of Liberia and Sierra Leone. (2) Studies in blood group correlations in some peoples of Liberia and Sierra Leone.

Cracow

Polish Academy of Science and Letters, July 1.

W. JACYNA: The thermodynamic scale below 1° K. Data concerning the thermodynamic scale below 1° K. are doubtful for two reasons, the inexactitude of the thermomagnetic equation and the irreversibility of the adiabatic demagnetization.

T. BANACHIEWICZ: The numerical solution of a system of linear equations.

B. KAMIENSKI: Thermodynamical considerations on dielectric potential and surface tension.

B. NIKLEWSKI and MLLE. J. WOLNICKA: The morphological phenomena produced as the result of chemotropic irritation of the roots.

H. GROSSFELD: Osmotic pressure and intravital coloration.

H. GROSSFELD: A method applied in researches on the permeability of animal tissue cells.

Rome

National Academy of the Lincei (*Atti*, 25, 353-412; 1937).

A. DE MIRA FERNANDES: Expressions for the curvature of a surface.

G. PALAMÁ: The transformation of Gauss and the Hermite polynomials.

T. TURRI: An observation on the classification of curves of the second kind.

G. COLONNETTI: The elastic equilibrium of systems in which non-elastic deformations also occur (1).

G. PERETTI: Plastic sources.

C. TOLOTTI: Generalization of Dirac's equations for the space of general relativity.

L. CAVALLARO: Absorption bands in polar substances at very high radio frequencies (1).

A. MANGINI: Aromatic nitroderivatives (13). Some substituted α -naphthylamines.

G. DAL PIAZ: Geological structure of the Austrides (5). Some further work on the Austrian alpine system of the Eastern Alps.

A. CAVINATO: Morenosite from Val Malenco.

G. BORZINI: Observations on the parasitism of *Sclerotinia libertiana sclerotiorum* Fuck associated with other fungi.

A. SALVATORI: Further contribution to the study of post-operation hypochloræmia.

Forthcoming Events

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

Monday, November 15

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—H. St. J. B. Philby: "The Land of Sheba" (Asia Lecture).

Tuesday, November 16

CHADWICK PUBLIC LECTURE (at Manson House, 26 Portland Place, W.1), at 5.15.—Dr. Bernard Myers: "The Promotion of Health in the Empire Citizen".*

GRESHAM COLLEGE, BASINGHALL STREET, E.C.2, at 6.—A. R. Hinks, F.R.S.: "Nebulae as External Galaxies" (succeeding lectures on November 17, 18 and 19).*

Wednesday, November 17

ROYAL MICROSCOPICAL SOCIETY, at 5.30.—J. E. Barnards, F.R.S., and F. V. Welch: "The Principles of Fluorescence Microscopy".

Thursday, November 18

LONDON MATHEMATICAL SOCIETY, at 5 (at the Royal Astronomical Society, Burlington House, W.1).—Annual General Meeting.

Prof. G. B. Jeffery, F.R.S.: "Mathematical Studies in the Modern Universities".

CHEMICAL SOCIETY, at 8.—Dr. J. M. Robertson: "Bond Character and Interatomic Distance".

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS—(at Manson House, 26 Portland Place, W.1), at 8.—Annual General Meeting.

Dr. Marie Stopes: "The Year's Work, and Behind the Scenes in the Present Crisis".

Friday, November 19

ROYAL INSTITUTION, at 9.—Sir William Bragg, O.M., F.R.S.: "Clay".

Appointments Vacant

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

LECTURER IN ELECTRICAL ENGINEERING in the Wolverhampton and Staffordshire Technical College—The Director of Education, North Street, Wolverhampton (November 13).

LECTURER IN ENGINEERING in South-East Essex Technical College, Dagenham—The Clerk to the Governors (November 15).

ASSISTANT ENGINEER in the Roads Department of the Ministry of Transport—The Establishment Officer, Ministry of Transport, Metropolitan Buildings, Northumberland Avenue, W.C.2 (November 17).

SCIENTIFIC OFFICER in the Air Ministry Scientific Research Pool—The Secretary, Air Ministry (S.2.d. Room 405), Adastral House, Kingsway, W.C.2 (November 20).

TECHNICAL OFFICER in the Directorate of Armament Development of the Air Ministry—The Secretary, Air Ministry (S.2.d. Room 406), Adastral House, Kingsway, W.C.2 (November 20).

JUNIOR SCIENTIFIC OFFICERS in the Electricity, Radio and Aerodynamics Departments of the National Physical Laboratory, Teddington, Middlesex—The Director (November 22).

PHYSICIST at the Liverpool Radium Institute, 1 Myrtle Street, Liverpool—The Secretary (November 30).

PROFESSOR OF PHYSICS in University College, Aberystwyth—The Principal (November 30).

PROFESSOR OF CHEMISTRY in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (December 15).

DEWAR RESEARCH FELLOW IN CRYSTALLOGRAPHY in the University of Edinburgh—The Secretary (December 15).

GENETICIST to the Rubber Research Scheme (Ceylon)—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, S.W.7 (December 31).

JUTE SPECIALIST to the Indian Central Jute Committee—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (December 31).

STRUCTURAL ENGINEERING ASSISTANTS in the Directorate of Fortifications and Works of the War Office—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (Quote Appts./56).

SENIOR AND JUNIOR RESEARCH ASSISTANTS in the Courtauld Institute of Biochemistry, Middlesex Hospital, W.1—(The Secretary).

SENIOR LECTURER IN GENERAL AND INORGANIC CHEMISTRY in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, W.C.1.

SENIOR LECTURER IN ANATOMY in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, W.C.1.

Official Publications Received

Great Britain and Ireland

Forestry Commission. Leaflet No. 22: Pruning in Young Plantations. Pp. 12. (London: Forestry Commission.) [2610]

Technical Publications of the International Tin Research and Development Council. Series A, No. 63: The Corrosion of Tin in nearly Neutral Solutions. By Dr. T. P. Hoar. Pp. 16. Free. Series A, No. 64: Surface Tension and Viscosity Phenomena in Tinplate Manufacture. By Dr. Bruce Chalmers. Pp. 10. Free. (London: International Tin Research and Development Council.) [2810]

Rothamsted Experimental Station, Harpenden: Lawes Agricultural Trust. Report for 1936. Pp. 294. (Harpenden: Rothamsted Experimental Station.) 2s. 6d. [2810]

Institution of Gas Engineers. Publication No. 162: The Low-Temperature Carbonization of Scottish Cannel. By Dr. J. G. King and James Jamieson. Pp. 16. Publication No. 165: Third Report of the Research Executive Committee, 1936-37. Pp. 24. Publication No. 167: Forty-first Report of the Joint Research Committee of the Institution and Leeds University—The Investigation of the Use of Oxygen and High Pressure in Gasification, Part 2: Synthesis of Gaseous Hydrocarbons at High Pressure. Pp. 48. (London: Institution of Gas Engineers.) [2810]

Hull Museum Publications. No. 191: The *Sirius*, the first Steamer to Cross the Atlantic. By Thomas Sheppard. Pp. 15. No. 193: A Roman and Saxon Site at Elmswell, East Yorks., 1935-1936. By Anthony L. Congreve. Pp. 28. No. 194: Excavations at the Roman Town at Brough, E. Yorkshire, 1936. By Philip Corder and the Rev. Thomas Romans. Pp. 69+3 plates. (Hull: Hull Museum.) [2910]

Decennial Index of *The Analyst*, the Journal of the Society of Public Analysts and Other Analytical Chemists. Vols. 51-60 (1926-1935). Compiled by M. B. Elliott. Pp. 467. (Cambridge: W. Heffer and Sons, Ltd.) 25s. net. [2910]

ULAWS Monographs and Reports, No. 4E: Instructions for dealing with Rabbits. Compiled by Capt. C. W. Hume. Second edition (revised). Pp. 16. (London: University of London Animal Welfare Society.) [3010]

Other Countries

Instituto Nacional de Tecnologia. Copias do Brasil: Resinas de Jatobá, Tapocá e Jutahycica. Pelos José Luiz Rangel e Haya S. Schneider. Pp. 42+2 plates. Nota sobre os Fosfatos de Trauhira (Bauxita e laterita fosforosa). Por S. Fróes Abreu. Pp. 38+4 plates. Rochas oleígenas do Brasil e seu aproveitamento. Pelo S. Fróes Abreu. Pp. 162+10 plates. (Rio de Janeiro: Instituto Nacional de Tecnologia.) [2510]

Memoirs of the Geological Survey of India. Palaeontologia Indica New Series, Vol. 22, Memoir No. 5: Cambrian Trilobites from Iran (Persia). By W. B. R. King. Pp. iv+22+2 plates. (Calcutta: Geological Survey of India.) 1.14 rupees; 3s. 3d. [2510]

Zweihundsechzigster Jahresbericht über die Tätigkeit der Deutschen Seewarte, 1936. Pp. 40. (Hamburg: Deutsche Seewarte.) [2510]

Forestry Pamphlet No. 5: Forestry and the Oil Industry. Pp. 4 (Port-of-Spain: Government Printing Office.) 12 cents. [2510]

Report of the Aeronautical Research Institute, Tôkyô Imperia University. No. 165: Some Effects of Ignition Timing and Rate of Burning on the Thermodynamical Performances of High-Speed Compression-ignition Engines. By Seichi Awano. Pp. 20. (Tôkyô: Kôgyô Toshô Kabushiki Kaisha.) 55 sen. [2510]

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1936. Pp. 24. (Zomba: Government Printer.) 2s. 6d. [2610]

N.Z. Department of Scientific and Industrial Research. Apia Observatory, Apia, Western Samoa: Annual Report for 1934. Pp. 121. (Wellington: Government Printer.) 5s. [2710]

Osiris, Vol. 4: Incunabula Scientifica et Medica. By Arnold C. Klebs. Pp. 359. (Bruges: St. Catherine Press, Ltd.) [2710]

Smithsonian Institution: Bureau of American Ethnology. Bulletin 116: Ancient Caves of the Great Salt Lake Region. By Julian H. Steward. Pp. xiv+131+9 plates. (Washington, D.C.: Government Printing Office.) [2710]

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