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CIVIL SERVICE RECRUITMENT DURING THE RECONSTRUCTION PERIOD

THE report of the Committee of the Civil Service National Whitley Council on the staffing of the Civil Service during the reconstruction period, appointed in accordance with the Government's request as announced by the Chancellor of the Exchequer in the House of Commons on February 17, 1944, and containing proposals agreed between the official side and the staff side of the Council, has now been published*, under cover of a statement by the Government. The report proceeds on the basis envisaged in the Chancellor's statement that recruitment to the permanent service should begin at the earliest possible moment after the end of hostilities in Europe, continuing steadily throughout the reconstruction period, to provide for the required intake by departments of appropriately qualified men and women, and for the smooth transfer into permanent employment of those selected, whether from the Fighting Forces or otherwise.

In the covering statement the Government expresses its belief that public opinion will endorse the conclusion that, at the end of a war during which we have had total mobilization of man-power, a proposal to reserve all vacancies in the Civil Service exclusively for ex-Service candidates would be unfair to the rest of the community. The Government, however, is satisfied that the Committee's recommendation that, of the vacancies available for the reconstruction competitions, not less than 75 per cent in the administrative class, 66⅔ per cent in the executive class, and 50 per cent in the clerical class should be filled by suitably qualified ex-service men, additional vacancies being reserved for ex-service women, constitutes the generous treatment that is essential, and the proposals in the report are commended to Parliament and to the public.

Like the Assheton Report on the training of Civil Servants, the recommendations of which have been accepted in principle by the Government, the present report is written almost entirely around the administrative, executive and clerical classes of the Civil Service. The importance of recruitment of well-qualified men and women to the professional, scientific and technical classes of the Civil Service is also recognized, and the Government states that departments employing these staffs are now engaged in formulating proposals for them which will, so far as possible, incorporate the principles already recommended for the general classes. It is expected that the matter will shortly be sufficiently advanced for discussion with the Civil Service staff representatives through the National Whitley Council. Meanwhile, the Government has decided to retain a central body of economists and statisticians, such as has been set up during the War in the Cabinet Offices. It is

* Recruitment to Established Posts in the Civil Service during the Reconstruction Period: Statement of Government Policy and Civil Service National Whitley Council Report. (Cmd. 6567.) Pp. 24. (London: H.M. Stationery Office, 1944.) 4*d.* net.

also stated that discussions are taking place in the National Whitley Council on problems that will arise on redundancy as the work of departments contracts, and on the question of any changes required in the main structure of the Service, such as the grades and classes, the methods of passing from one class to another, and the general arrangements to secure that the best use is made of all members of the staff. The flexibility of existing superannuation arrangements, the position of unestablished staff, and the effect of the new scheme of social insurance on the pensions of the public services have already received preliminary consideration.

The recommendations of the present report fall into two parts: those relating to "reconstruction competitions" and those relating to "normal competitions". The former are recommended primarily for those who have lost opportunities of competing for the Civil Service owing to the War, and the latter for those who reach the normal ages of entry as recruitment is re-opened.

The reconstruction competitions should extend over a period, so that the last man released from the Forces or other war service has as good a chance of competing as the first, and arrangements should be made to ensure that the late entrants suffer no disadvantage in pay. For vacancies accrued during the War by wastage and permanent expansion, the main source of recruits should be those who have missed their opportunity of competing for the Civil Service because of the interruption, that is, those within normal age limits plus the period of the War. Some of these vacancies should, however, be reserved for those above these limits but not older than thirty. In the administrative class there should be a common field of recruitment up to thirty years of age; in the executive, clerical and sub-clerical classes, one vacancy should be reserved for the older group of candidates for every four allotted to the younger group.

The reconstruction examinations should consist of written examinations in general subjects, plus an interview for the administrative and executive classes. Candidates should be required to possess certain minimum educational qualifications, namely, a university degree of at least second-class honours standard, or a year's continuous full-time university attendance and expectation of such a degree, for the administrative class; full-time education up to seventeen, or higher school certificate for the executive class; full-time education to sixteen or school certificate for the clerical class; full-time education up to fifteen for the sub-clerical class. Temporary Civil Servants should be subject to the same conditions as other candidates, with certain exceptions such as provision for the retention of specially selected senior temporary officers as principal, or analogous executive or departmental grades, or above, who are more than age thirty, and allotment of 15 per cent of the accrued vacancies in the basic executive and clerical grades to the best of the temporary officers in junior grades, above the age of thirty, who have at least two years of service (including any period of service with the Forces).

Established Civil Servants should be eligible for the reconstruction competitions, by which they may obtain promotion to a higher class. Very few of them will be able to comply with the minimum educational qualifications for the executive and administrative reconstruction competitions, and limited competitions should be provided against fixed quotas of vacancies in these classes, so as to restore their pre-war opportunities of sitting for the open competitions. All acting assistant principals promoted since the outbreak of war should be required to succeed in the limited competition before their promotions are confirmed.

Resumption of normal competitions is recommended concurrently with these reconstruction competitions, and candidates coming forward straight from school or university should be required to sit for a normal competition. These are proposed on the same lines as before the War, subject to the introduction of an interview for the executive class, a common examination for clerical assistants, typists and shorthand-typists, and, on an experimental basis, of a system of selection of a limited number of candidates for the administrative class mainly by interview by the Civil Service Commission. This last experiment is to be closely watched and reviewed after, say, ten years. Admission by this method should be confined to those who possess at least a good second-class honours degree.

These proposals, taken as a whole, seem eminently fair, in that they make provision for the entry into the Civil Service of those whose education has been interrupted by direction either to national service or the Fighting Services, and for the retention of those who have proved themselves, as temporary Civil Servants, to be exceptionally suited to their posts. The difficulties likely to arise through the necessity for spreading demobilization over a lengthy period are also foreseen. No guidance is given, however, on the precise methods of selection which are desirable, though no doubt the matter is under consideration; indeed, there is a hint to this effect in the suggestion that a certain number of candidates in normal competitions for the administrative class will be chosen mainly by interview.

The Civil Service Commissioners are facing a difficult task. Selection, in the main, will be by examination; but it does not follow that examinations of the stereotyped form will be adequate. There has been much criticism in the past few years of the methods and the personnel of the Civil Service: in particular, their devotion to precedence and the general lack, and even discouragement of, initiative, have been pilloried. To what extent the type of examination used to select candidates was responsible for the selection or development of this type of mind is difficult to assess, but there can be no question that the British Civil Servant of the future will need, in addition to the virtues which have been envied and admired by the corresponding services of other countries, a whole range of other abilities. As has been said repeatedly in these columns, he must be able to keep in touch with the feeling of the people

at large, he must have initiative, and, particularly in the administrative class, he must be able to interpret not only the letter but also the spirit of policy laid down by the Government. This, of course, raises the whole question of the status of the Civil Servant. The country will require for its administration the best brains available, and the Civil Service will have to attract, and hold, such ability in competition with industry and commerce. It is all to the good that this was so fully recognized in the House of Commons debate on December 14, when the report was warmly welcomed and endorsed.

THE TREE ROOT AND THE SOIL

Problems in Tree Nutrition

An Account of Researches concerned primarily with the Mycorrhizal Habit in relation to Forestry and with some Biological Aspects of Soil Fertility. By M. C. Rayner and W. Neilson-Jones. Pp. 184+27 plates. (London: Faber and Faber, Ltd., 1944.) 12*s*. 6*d*. net.

ONE of the most difficult problems, either in botany as a pure science, or in forestry as applied biology, has always been, and still is, to assess the relationships which exist between the root of a tree and its environment in the soil. The reason for this lies, of course, in the fundamental difficulty of observing the root under natural conditions without, at the same time, destroying its environment, or at least changing this in some radical manner. A secondary source of difficulty is also to be found in the need for a specialist's knowledge in making accurate observation of the micro-flora and -fauna of the soil, which form so important a part of the natural environment of the root. The consequence of this is to be seen in the relative neglect in general works on plant ecology of that part of plant associations which occurs below the ground, notwithstanding its admitted very great importance. The book under notice is concerned with the study of a special aspect of this relatively neglected subterranean field. Its topical interest lies herein, and especially in view of the wide interest aroused in the effect of composting on soil fertility—that is, on the value of the soil for root development—by Sir Albert Howard and others during recent years. The book consists of a collection of papers which have appeared at various times since 1934. They are here brought together with little or no alteration or editing and, with a short but excellent introduction, form the chapters of the book. A list of references, a glossary and an index are appended, and there is also a large number of plates illustrating the various papers.

The research work, the accounts of which are here collected together, will be well known to many foresters and botanists. It was begun in connexion with the afforestation of heathland near Wareham in Dorset. Much of this infertile tract of land had proved refractory for the growth of trees, principally pines, which had been sown or planted on it. In many parts growth was so disastrously inadequate that the condition of the trees was obviously pathological and a matter for much concern. Dr. Rayner, who initiated this research, put forward the hypothesis that the cause of this condition lay in the biotic relationships which occurred in the soil rather than in the admittedly low nutrient status as measured chemically; and that these relationships were expressed principally, so far as the trees were concerned, in the type of fungal association made by the root to form true or false mycorrhizas. Proceeding on this hypothesis, composts were prepared from materials such as hop waste and straw, and were added to the infertile Wareham soil. Conifer seedlings raised on such treated soil, whether in the forest or in the greenhouse, made normal vigorous growth and developed true mycorrhizas on their roots. Account had to be taken of the effect on growth of the nutrient salts added with the compost in order to distinguish between the effect of these and the organic matter. It was shown in a series of controlled experiments that the addition of equivalent amounts of nutrient salts by themselves to the heath soil failed to account in any adequate manner for the improvement in growth, both of shoot and root, obtained by composting. It was demonstrated that this improvement was related to the dominance in the soil of fungi such as *Boletus bovinus*, which form normal mycorrhizal associations; to a suppression of the fungi which form false mycorrhizal associations and to a marked increase in the number of short feeding roots. The differences between plants growing on treated and untreated soil and between normal and false mycorrhizas are well shown in the plates.

The biological aspects of soil fertility, in so far as they are illustrated by this work, are discussed in the interesting final paper. It is shown that the infertile heath soil contains a toxic substance, probably hydrogen sulphide, and that treatment which produces healthy growth results in the removal of this. The untreated soil is relatively inactive biotically, fungus activity being strongly depressed. Thus cellulose, such as filter paper, placed in it, shows very little tendency to decay. The reverse is true of soil treated with a suitable compost, in which fungi are very active. The toxic condition is worst in late winter: it is shown that this is correlated with high moisture content and not with low temperature.

This is a valuable and successful piece of work, the results of which are already being put to practical use. Its value is, perhaps, in no way greater than as a demonstration of the need of attempting to obtain a complete and unified view of the biotic association which is, in reality, being exploited in cultivation, and of which the crop plant is only a part, when trying to diagnose the factors responsible for any particular condition of growth. For fertility is the resultant of the interaction of all the factors of this association upon the crop plant. So far as forestry in particular is concerned, this work directs attention to the need for understanding the factors which determine the successful regeneration and maintenance of an adequate root system, especially during the first years after planting and also in the nursery. The rotation required to raise a utilizable forest crop may be lengthened very appreciably by slow unsatisfactory growth during early years. Technical measures for the alleviation of this state of affairs should be based on a knowledge of the adverse factors operating and not merely on guesswork, as has been too often the case in the past. Our knowledge of these matters at present is very slight, and it is highly desirable that further fundamental work should be encouraged. Much of this work will be concerned with the pathological rather than the normal development of plants, and not the least important aspect of the work under

review is the direction it must help to give to future studies of the pathology of the root system.

It remains to discuss the form and purpose of this publication. The book is an undoubted sign of the increasing interest being taken in land cultivation and especially in its scientific foundations. It is a present need of all who cultivate the soil that they shall understand adequately what they are trying to do, from a biological as well as from an economic aspect, for the two are indissolubly related. It is for these people rather than for the biological specialist that this book is, presumably, intended. If so, then it is doubtful whether in its present form it adequately fulfils the needs of the public it is desired to reach. The manner of compilation has resulted in a great deal of duplication of matter, which is rather tiring to the reader and by no means makes for clarity of exposition. The style of writing is also often difficult; this is partly because the papers were written for the instructed biologist with whom neither farmer, forester, nor horticulturalist is necessarily to be classed. No doubt the exigencies of the times made a re-writing of the work completely impossible; but it is to be hoped that at some future time the authors will be able to give a more connected and lucid account of the important relationships which exist between the root, the micro-flora of the soil and their physical environment. In the meantime, those who read through this series of papers will find much of interest and value. The many illustrations and the clear and well set out tables and text-figures are an undoubted help to their reading and understanding.

W. R. DAY.

ELLIPTIC FUNCTIONS

Jacobian Elliptic Functions

By Eric Harold Neville. Pp. xv+332. (Oxford: Clarendon Press; London: Oxford University Press, 1944.) 25*s*. net.

IN the preface to his "Elliptic Functions", written in 1892, Prof. A. G. Greenhill complained that, although the subject was then nearly seventy years old, it had not made its way into the ordinary curriculum of mathematical study in Great Britain. Fifty years later, in a lecture to the London Mathematical Society, Prof. E. H. Neville declared that, while his contemporaries at Cambridge thirty-five years ago would have regarded the elements of the theory of Jacobian elliptic functions as a subject which every undergraduate should study, the time had now come when the subject was largely neglected. He claimed that the study of Jacobian elliptic functions was being killed by the unnatural way in which the functions were introduced, and that every general principle was stifled by the lack of symmetry and the multitude of special formulæ. The book under review is his attempt to restore the Jacobian functions to their proper place in a university curriculum.

An elliptic function is a doubly-periodic meromorphic function of a complex variable z. The Argand plane is divided into a lattice of period-parallelograms, and the elliptic functions are functions defined on this lattice. The simplest elliptic functions are of order two; one type is the Weierstrass function $\mathfrak{p}(z)$, with a double pole in each cell; the other comprises the Jacobian functions with two simple poles per cell. While it is the case that $\mathfrak{p}(z)$ is defined directly on the lattice, the modern treatment of the Jacobian functions is not a direct one; the functions are introduced in an artificial way, undoubtedly the best way for the computer, by means of theta functions. In Prof. Neville's book, the Jacobian functions are defined directly by means of the Weierstrass function.

This is not entirely an innovation, but it is coupled with a new notation which exhibits the systematic and organic relations between the functions in a strikingly simple way. Writing $\omega_f, \omega_g, \omega_h$ for the half-periods ω_1, ω_2, ω_3 of Weierstrass, Prof. Neville introduces three primitive elliptic functions defined by

$$\mathrm{pj}\, z \equiv \sqrt{\{\mathfrak{p}(z) - e_p\}} \quad (p = f, g, h)$$

with the condition that the residue at O is unity; then $\mathrm{pj}\, z$ has periods $4\omega_p$, $2\omega_q$, $2\omega_r$, a simple pole at O and a simple zero at ω_p. To complete the notation, he uses a symbol ω_j to represent the origin, and denotes the function with a simple zero at ω_p, a simple pole at ω_q, by $\mathrm{pq}\, z$. There are twelve functions in the complete set, and they are connected by the simple relations

$$\mathrm{pq}\, z \cdot \mathrm{qr}\, z = \mathrm{pq}\, \omega_r \cdot \mathrm{pr}\, z$$
$$\mathrm{pq}\, z \cdot \mathrm{qp}\, z = \mathrm{pq}'\, \omega_q$$
$$\mathrm{pj}^2 z = \mathrm{qj}^2 z + \mathrm{p}_q{}^2$$

where p_q is the value of $\mathrm{pj}\, \omega_q$.

The Jacobian function $u = \mathrm{sn}\, x$ was originally defined by the elliptic integral

$$x = \int_0^u \frac{du}{\sqrt{\{(1-u^2)(1-k^2u^2)\}}}.$$

To link up the new theory with the old, it is next shown that the relation

$$z = \int_0^w \frac{dw}{\sqrt{\{(g^2 - w^2)(g_h{}^2 - w^2)\}}}$$

is equivalent to $w = -\mathrm{jg}\, z$. Comparing these integrals, we see that with $z = x$, the relations are identical if $g_f = 1$, $g_h = -k$, $w = ku$. The actual dimensions and orientation of the lattice on which the primitive functions $\mathrm{pj}\, z$ are defined is immaterial because of their homogeneity in z and the three periods. The condition $g = 1$ picks out of the whole family of similar lattices a special lattice called a Jacobian lattice. If the functions $\mathrm{pq}\, z$ are defined on a Jacobian lattice and are suitably normalized, they are simply the twelve Jacobian elliptic functions; in fact, $\mathrm{fj}\, z$, $\mathrm{gj}\, z$, $\mathrm{hj}\, z$ are the functions $\mathrm{cs}\, u$, $\mathrm{ns}\, u$ and $\mathrm{ds}\, u$ respectively.

Having now reached the customary notation, Prof. Neville again breaks with tradition. Instead of the usual quarter-periods K, iK', $K + iK'$, he writes K_c, K_n and $-K_d$, and uses K_s as a symbol for the origin. This notation is likely to prove valuable, as it simplifies the whole presentation of the theory. For example, in the discussion of the transformations of Landen and Jacobi, the reader sees at once why the transformations work, as well as how.

It remains to complete the link with the definition of $\mathrm{sn}\, u$ by the inversion of an elliptic integral. This part of the book is very well written. It emphasizes clearly the nature of the problem, and gives a solution on entirely new lines.

In this review it has been possible to mention only the salient points of an excellent book. We hope that it will have the success it deserves, and that it will revive interest in this fascinating branch of analysis.

E. T. COPSON.

The Navigator's Handbook on Modern Compass Adjusting

With particular reference to Wartime Conditions. By John Calder Gillie. Pp. 110. (London: George Allen and Unwin, Ltd., 1943.) 3*s*. 6*d*. net.

MR. GILLIE'S book contains within its small compass all the information necessary for those who wish to understand the factors on which the efficiency of the magnetic compass depends. Among its merits we may refer to its simplicity; it does not require a navigator to understand the nature of the problems. Although it cannot be considered a text-book for examination purposes, it will serve as an introduction to such books. Simple explanations are given regarding the effect of the steel of a ship on the compass, how the disturbing forces are divided into 'co-efficients', the means employed for making the necessary corrections, etc. The principle for degaussing installations—a matter of supreme importance in recent years—is simply explained and also their effect on the compass and the means adopted for overcoming their disturbance. Chapter 9 supplies some simple rules for dealing with compass troubles at sea, and a glossary and index are a useful addition to this highly commendable little book.

M. D.

Principles of Powder Metallurgy

By Franz Skaupy. Translated by Dr. Marion Lee Taylor. Pp. 80. (New York: Philosophical Library, Inc., 1944.) 3 dollars.

IN view of the extreme interest being taken throughout the industrial world in the production of articles made from sintered metallic powders, a survey of existing knowledge of the fundamental principles involved is very much to be desired. Much of this information has been revealed by research, and the time has come when it should be collected and critically discussed.

Although the book is written by an author who has a considerable amount of original work to his credit, this volume does not, in the reviewer's opinion, perform this function. The general treatment is inadequate in view of the importance of the subject, and the English throughout is so bad that even after careful re-reading there are some sentences the exact meaning of which is still in doubt. It would not, for example, be immediately obvious that by "steam" (p. 20) the author is, in reality, referring to a metallic vapour.

F. C. THOMPSON.

Science and Progress

By Dr. S. Lilley. (Story of Science Series.) Pp. iv+68. (London: Cobbett Publishing Co., Ltd., 1944.) 2*s*. 6*d*. net.

THIS book is one of a series projected by the Young Communist League. After directing attention to the ways in which science has changed the world's outlook, the author compares the progress of science under various forms of social structure—capitalism, Fascism and in the U.S.S.R. The last chapter deals with science and reconstruction after the War. Throughout the book the importance of organized scientific research is stressed. The author is convinced that this can only be adequately carried out under socialism, and he urges scientific men to fight for the best use of science "as a part of the organised Labour Movement". Half a crown seems a high price for such a propagandist pamphlet.

The Riddle of Cancer

By Dr. Charles Oberling. Translated by Dr. William H. Woglom. Pp. viii+196. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1944.) 20*s*. net.

IT is often said, and with some reason, that the education of medical men is so specialized that they are turned out incapable of intelligible literary expression. The average book on a medical subject is seldom read with æsthetic pleasure. In "The Riddle of Cancer" we find the exception. To have presented the problems of cancer research in such a form that the survey is complete, lucid, interesting and not only valuable to the medical profession but also instructive to the inquiring layman, is a task for which the author and his translator deserve the highest praise. If standard medical text-books were only written in such a style, the student's work would be made vastly pleasanter.

The subject-matter covers the most important points in the whole field of experimental cancer research in some detail, and with particular reference to the carcinogenic viruses. A description of the general nature of viruses is included. The author is an exponent of the virus hypothesis, but his presentation of the work in other fields has not been allowed to suffer by his beliefs. There are a comprehensive bibliography and an index.

No doctor or medical student could fail to be edified by this fascinating exposition of a subject which is generally portrayed either luridly and inaccurately for the layman or at sombre, ponderous length for the expert.

Chemical Industries

Edited by L. Ivanovszky. Nineteenth edition, enlarged and revised. Pp. xxviii+392. (London: Leonard Hill, Ltd., 1944.) 15*s*.

THIS edition of a useful publication has been enlarged in many sections. It includes a large number of detailed tables of physical data, properties of many kinds of materials, glossaries giving definitions of apparatus and products (with many clear diagrams), and ample sections on the most varied aspects of chemical engineering. The work is evidence of great skill in assembling and presenting valuable information in a concise form, and should prove of daily service in technical and other laboratories. The advertising material, which is quite separate from the text and takes up only a reasonable amount of the volume, is also instructive in character and likely to prove very useful.

A Concise Pharmacology and Therapeutics of the More Important Drugs, together with an Introduction to the Art of Prescribing

By F. G. Hobart and Dr. G. Melton. Second edition. Pp. xvi+168. (London: Leonard Hill, Ltd., 1944.) 12*s*. 6*d*.

THIS is a compact survey of applied pharmacology which can be recommended as a reference book for students in the wards and preparing for examinations. It suffers in places by being so condensed that misinterpretation is possible. The apothecaries system of dosage is used almost exclusively even for drugs, such as those of the arsphenamine series, which are never prescribed in any but metric doses. Proprietary names of some drugs are included, and the examples chosen do not always include the one in commonest use.

NOMENCLATURE PROBLEMS OF THE APPLIED BIOLOGIST

AT a meeting of the Association of Applied Biologists on November 10 a discussion took place on practical problems of botanical and zoological nomenclature. Dr. J. Ramsbottom (Department of Botany, British Museum (Natural History)), in opening the discussion, referred to the common but erroneous idea that systematists have as their main object the upsetting of established names. Paradoxical though it may seem, changes in scientific names are designed to achieve stability. The principle of priority is that the first validly published name for an organism is the one to be used. This principle is perfectly sound in theory, but its practical application is complicated by the fact that many names published in obscure journals are not rediscovered until years afterwards, when well-known names may have to be rejected in their favour.

The International Rules of Botanical Nomenclature permit of the conserving of well-established generic names under certain conditions; but proposals to conserve specific names have always been defeated in the past and are not likely to be accepted by any International Botanical Congress in the future. The conservation of a specific name would mean fixing the rank and genus of the plant concerned, regardless of subsequent research, which is incompatible with scientific taxonomy. On the other hand, a suggestion emanating from the Royal Horticultural Society to legalize the rejection of certain specified names may contain the germ of an idea which is workable and would achieve the same result in practice. The not unnatural desire of the economic botanist to have one name and one name only for any one plant is likewise incompatible with progress in taxonomy. A plant can have as many names as genera in which it has been placed. Genera may be split up into smaller genera or may be combined into larger genera; or a species may be reduced in rank to that of a variety. Homonyms provide another reason for change: sometimes it is found that the name of a well-known plant has previously been applied to some other species; a change must therefore be made.

To try to fix specific names it has often been proposed that standard lists of conserved names should be prepared. But it should be understood that no standard list can prevent changes of name caused by changes in classification.

Mr. G. R. Bisby (Imperial Mycological Institute) pointed out that mycologists have done little to deal with their special problems of nomenclature; the two articles of the International Rules applying particularly to fungi are still ambiguous and are variously interpreted, and no generic name of a fungus has yet been conserved. He suggested that there should be a permanent executive committee, with changing personnel, for the nomenclature of fungi; that this committee or some other should produce a shorter special code for mycological nomenclature, to apply under the International Rules; that users of names (including plant pathologists and various kinds of mycologists) should be given a chance to vote on proposals, such as the conservation of a few specific epithets, which affect them greatly; that specific epithets of fungi be decapitalized; and that the conservation of generic names be effected when necessary and desirable.

Mr. B. J. Rendle (Forest Products Research Laboratory) gave an account of what has been done in recent years towards stabilizing the names of timber trees. Workers in forestry and wood technology have suffered much inconvenience from changes in the names of common trees, most of them due to the application of the priority rule. Some bodies have found it expedient to fix certain well-known botanical names for their own use, in contravention of the International Rules. The reasons for doing so can be appreciated when it is remembered that trees are often cited by their botanical names in legislation, forest department regulations, contracts for timber concessions, specifications for timber and so on. A measure of stability has been achieved by the Empire Forestry Association and the British Standards Institution in drawing up a list of standard trade names of timbers with their correct botanical names. Over a period of about fifteen years this list has been repeatedly checked and revised, and is now as nearly correct as it can be.

It may not be generally known that the Sixth International Botanical Congress, in 1935, as a practical alternative to conserving specific names, adopted a motion "That an International Committee be appointed to draw up a list of names of economic plants according to the International Rules and that this list may remain in use for a period of ten years". It is understood that the work of this Committee was proceeding very satisfactorily until the outbreak of war; but since then it has been practically impossible to carry on, and much still remains to be done before the list is ready for publication.

Mr. A. Roebuck (Midland Agricultural College, Sutton Bonington) spoke feelingly from the point of view of an advisory agricultural entomologist. He deplored the frequent changes in the names of insects. To the field-worker it is the insect that matters; the name is of importance merely as a label or means of designation, so that one man can understand what another is talking or writing about. He quoted as an example a common insect pest which, in the course of a few years, has been placed in four different genera; much confusion has been caused to farmers in consequence. Genera are sometimes sub-divided on what appear to be insufficient grounds; for example, when three insects are difficult to separate into species, it seems unreasonable to place them in different genera. As a practical sugg stion for stabilizing the names of economic insects, Mr. Roebuck advocated the use of English names for British insects, and suggested the preparation of a standard list giving the common names and the corresponding scientific names, the latter to be revised from time to time to keep pace with changes in taxonomic entomology.

Dr. I. Thomas (School of Agriculture, University College of North Wales), while supporting the claim that stability in nomenclature is incompatible with progress in taxonomy, was in favour of a standard list of Latin names of insects for the convenience of economic entomologists, provided that such a list were brought up to date at intervals of ten or twenty years. Periodic revision would provide the opportunity of asking the International Commission on Zoological Nomenclature to suspend the rules in cases where greater confusion than uniformity would result from a change. As an example of the confusion which may be caused by strict application of the law of priority, Dr. Thomas described what has recently happened in the family Aphidæ.

According to Hille Ris Lambers[1] the potato aphis *Macrosiphum solanifolii* (Ashmead, 1882) should now be designated *M. euphorbiæ* (Thomas, 1878). Unfortunately, Theobald stated that the species *solanifolii* Ash. was identical with *gei* (Koch, 1855) and the latter name, as a result of the application by Theobald of the law of priority, became well known in the literature. In all, Ris Lambers gives a list of twenty-four synonyms for this aphis. If it were possible easily to have the rules of nomenclature suspended in this instance, probably all economic entomologists would like to see the name *solanifolii* established. As a result of a discussion on the law of priority the Royal Entomological Society set up a Committee on Generic Nomenclature, but its lists are sometimes not accepted even by the authors of the lists themselves.

Entomological literature is still suffering from the effects of inadequate descriptions of proposed new species. Some of the descriptions given even in present-day literature are totally inadequate. All such work has to be sifted by the bona fide systematist, and it would considerably lighten his labours if something could be done to establish a minimum standard for publications.

Mr. Francis Hemming (secretary to the International Commission on Zoological Nomenclature) described the working of the International Code of Zoological Nomenclature. This was drawn up primarily by workers in systematic zoology in order to meet the needs of workers in that field, and unanimity was only achieved by placing a greater stress on the law of priority than had previously been intended. The International Code won a rapid acceptance among systematic zoologists, but owing to the rigidity of Article 25 (Law of Priority) difficulties were soon encountered, since the application of that Article led to well-known and well-established generic names being replaced by older but less well-known names. Objection was taken to such changes not only by numerous systematic zoologists but also by workers in applied biology, who argued that; whatever rules of nomenclature systematists might adopt for their own purposes, those rules should be such as to secure a reasonable degree of stability for important names widely used in the applied field.

The International Congress tried to meet this criticism at a meeting held at Graz in 1910, in which it was agreed in principle to establish an Official List of Generic Names in Zoology, with their type species. It was hoped that in this way it would be demonstrated that the Berlin Code of 1901 would secure stability for a wide range of important names, and therefore that the area of disagreement would be greatly narrowed. In 1913 at Monaco, the International Congress again considered this problem and decided to settle it by the grant (subject to certain safeguards) of plenary powers to the International Commission on Zoological Nomenclature to suspend the rules as applied to any given case where, in the judgment of the Commission, the strict application of the rules would clearly result in greater confusion than uniformity. It will be seen, therefore, that, as regards zoological names of importance either to workers in the applied field or to workers in systematic zoology, two valuable and important instruments have been placed in the hands of the International Commission in order to assist in the stabilizing of zoological nomenclature.

The International Commission is anxious to extend the Official List so as to include the names of all the most important genera in the animal kingdom. Arrangements are now being made for the early publication of the Official List, giving full bibliographical particulars relating to the names (between six and seven hundred in number) which have so far been admitted. The International Commission is hopeful that the publication of the Official List in this way will demonstrate the value of securing the admission of generic names to the List, and will stimulate specialists in various fields to submit proposals for further additions to the List. Applied biologists can be assured that, where any group of workers notifies the International Commission regarding names which they would like to see stabilized by admission to the Official List, the Commission, for its part, will do everything possible to meet their wishes in this matter. Here and there cases will no doubt arise where it will be found impossible to place some well-known name on the Official List without the Commission first suspending the rules in order to validate that name by suppressing some earlier name, or by fixing as the type of the genus some species other than that which is the type under the International Code. Where there are such cases, the sooner they are brought out into the open and settled once and for all, the better for all concerned.

In the general discussion which followed the more formal contributions, several speakers returned to the suggestion that for certain purposes common names are more convenient and more easily stabilized than scientific names. Standard lists of trade or common names, or more compendious works of reference such as the British Pharmacopœia, must necessarily give the corresponding scientific names in order to fix the identity of the organisms concerned; the scientific nomenclature can be kept up to date by periodic revision without affecting the common names. It was pointed out that although it is impracticable permanently to stabilize scientific names, the risk of confusion can be minimized by following some standard work of reference. It is open to any author of a paper or text-book, for example, to say in his introduction that he is using the names in the *n*th edition of such and such a standard work.

The discussion served to clarify the distinction between name-changes due to advances in taxonomy and those due to conventions such as the law of priority. No responsible body of biologists would seriously propose to limit improvements in classification by permanently stabilizing scientific names, though many would wish to see more careful consideration on the part of taxonomists before upsetting established names by minor changes in the rank of important economic plants and animals. Admittedly, the herbarium worker, dealing with very large numbers of specimens and continually striving towards the ideal system of classification, does not always appreciate the trouble which name-changes may cause to economic botanists concerned with a limited number of species. At the other extreme, the applied biologist, and still more the farmer or timber merchant trying to take an intelligent interest in the scientific aspect of his work, often fails to realize that a name is something more than a label, and condemns the name-changers as being uncompromising, academic and out of touch with realities.

There is a strong case to be made against name-changes which do not signify any progress in taxonomy, as when the resurrection of a prior name invalidates a well-known and old-established name. Botanists and zoologists attending the meeting were able to compare the merits of the international codes of

nomenclature for the two sciences with respect to this problem. The Botanical Rules provide for the conservation of generic names to avoid disadvantageous changes in nomenclature which might result from strict application of the Rules, but they do not permit of conserving specific epithets. Zoologists are perhaps more fortunate in that their standing International Commission on Nomenclature has plenary powers to suspend the rules in cases where their strict application would result in greater confusion than uniformity. Several suggestions were put forward by botanists to restrict changes due to the principle of priority, either by introducing a time limit for the reviving of an old name or by amending the rules so as to allow of the rejection of names which are clearly undesirable. A formal proposal that the Council of the Association of Applied Biologists should examine the question was carried without dissent. B. J. RENDLE.

[1] Hille Ris Lambers, D., *Temminckia*, 4. 84 (1939).

GEOCHEMISTRY IN THE U.S.S.R.

By S. I. TOMKEIEFF

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THE term 'geochemistry', like many other scientific terms, has a variable connotation. If geochemistry means simply the chemical study of the earth or parts of the earth, then geochemistry must be as old as chemistry itself, and dates from the attempts of Babylonian and Egyptian metal-workers and potters to understand the nature and properties of their materials. If, on the other hand, geochemistry is not only that, but something more, namely, an attempt to understand the distribution of chemical elements in the different parts of the earth, the migration of chemical elements and the laws of their combinations in the process of mineral formation, then geochemistry is indeed a young science. This is why the Russian geochemists claim that geochemistry is the science of the twentieth century. In saying that, they imply that science does not consist of a mere collection of data, but involves also theories and hypotheses which link up the data to form an organized whole; that a real science involves a definite mental technique in handling problems, setting up new points of view, and, in general, marshalling the results of experience. According to the Russian men of science, geochemistry is now passing from the stage of the 'data of geochemistry' to the 'science of geochemistry'; and from being a mere handmaid of mineralogy, petrology and economic geology, it is emerging as an autonomous science with its own problems, scope and methods.

A determined attempt to establish an autonomous science of geochemistry was made by Vernadsky, Fersman, Goldschmidt and Niggli, to mention only the four most prominent workers in this field. It is in Russia that geochemistry has taken deepest root, no doubt because of the widespread search for economic minerals and the scientific renaissance during the last two decades. Unfortunately, the intellectual isolation of the U.S.S.R. and the language barrier has made it difficult for scientific workers in other countries to become really acquainted with this movement.

The old descriptive mineralogy and descriptive petrology, which made such great strides during the last century, were predominantly static sciences. Many attempts at a genetic approach were made before Vernadsky, but perhaps it is to him that we owe its most forcible expression. He began in 1890 to break new ground in his lectures at the University of Moscow, and developed this work in his book on descriptive mineralogy[1], which began to appear in parts in 1908 and is still unfinished; for the surge of new ideas in the mind of the author led him to embark in 1925 on yet another serial work, the history of minerals[2]. Unfortunately, these books are not only left unfinished, but also their subject-matter is presented in such an inchoate form that they are difficult to follow. However, the author has managed to present his ideas more coherently and in application to more restricted problems in a book published in Russian, German and French[3]. In it we see a definite attempt to build a new geochemistry on the basis of the old mineralogy—an attempt full of daring ideas and schemes. It is a book that may shock an orthodox mineralogist and leave him bewildered and dazed. In spite of this, however, the book is very vivid and stimulating, and it suggests many new problems which, if followed up, may lead to some new fields of science. Vernadsky's next book[4] is even more daring, for it deals with that still more complex realm, the biosphere, the sphere of life, full of complexities and change. By publishing this book, Vernadsky stimulated the study of what he called 'biogeochemistry'—the study of the chemical composition of the living matter in relation to the organically formed rocks. A biogeochemical laboratory was established in the U.S.S.R. and it soon became the thriving centre of a new research school.

Vernadsky's younger contemporary, Fersman, began his lectures on geochemistry in Moscow's People University in 1912. By that time he had already conceived the idea of a book which would not only include all the data of geochemistry, but also present a synoptic view of the whole subject. It is important to note here that Fersman, like Vernadsky, being a first-class mineralogist, made the approach to geochemistry from the side of mineralogy. His main interest at that time was concentrated on regional mineralogy, or as he called it 'topomineralogy', and in 1922 he published the first part of his ambitious work on the geochemistry of Russia[5], which was left unfinished under the stress of the new ideas which emerged from it. In this book he used regional mineralogy only as a basis for a superstructure of geochemistry. His mineral assemblages became genetic types, mineral provinces became geochemical provinces, and these in their turn were incorporated into geospheres, the whole being linked up into unending genetic cycles. In this way genetic mineralogy and genetic petrology became incorporated into the all-embracing geochemistry. Not satisfied with geospheres and the unknown centrosphere, Fersman overflowed into the cosmos, incorporating the sun, the stars and the meteorites, merging geochemistry into cosmochemistry. These ideas were fully developed by him in his next book, published in 1923[6].

Not only interested in the distribution of the chemical elements in the geospheres and in the cosmos, Fersman made an attempt to find the causes of such a distribution. Following up the guiding ideas of De Launay and Goldschmidt, he tried to connect up the distribution of the chemical elements and their atomic structure, first in a series of papers and later in a monumental work of more than 1,500 pages entitled "Geochemistry"[7]. The main body of this work is contained in the first three volumes; the

fourth volume provides reference tables and geochemical data for all the chemical elements. A fifth volume, which was announced, was replaced by a separate publication dealing with applied geochemistry[8].

Already in 1922 Fersman emphasized that the main purpose of geochemistry is not merely the chemical study of minerals and rocks, but also the study of the distribution and migration of chemical elements in the earth. In his book on geochemistry, Fersman defines the aim and the scope of this science even more precisely. "The purpose of geochemistry is the study of the element-atom in the conditions prevailing in the earth's crust (as well as in the parts of the cosmos accessible to our exact observations). Geochemistry studies: (*a*) the quantitative distribution of the chemical elements in the earth's crust and their dispersion and local concentration; (*b*) the combinations of different elements in the different parts of the earth's crust and their distribution in space and time under the influence of different chemical processes; (*c*) the migration of elements and the laws of such migration as determined by the different thermodynamic conditions of their environment; and (*d*) the behaviour of chemical elements either in the environment of the earth's crust or as compounds and particularly as crystals. This may be expressed even more simply: geochemistry studies the history of chemical elements in the earth's crust and their behaviour under different thermodynamic and physico-chemical natural conditions".

Taking the dictum of Lomonosov—"From observation follows theory, theory corrects observation"—as his motto, Fersman packs his book with data culled from all possible sources, and gives an imposing list of references to the literature in all languages. The observational or experimental data is used by him for the construction of far-reaching theories, or, as some may say, hypotheses. A host of new and daring ideas spring into existence and enmesh his array of facts. These new ideas often necessitate the invention of new terms, and an ordinary mineralogist or chemist may be greatly puzzled meeting terms such as *EK*, *VEK*, clarke, paragene, co-centre protectite, orthotectite, etc. Here is the explanation of some of his key-terms: clarke (in honour of F. W. Clarke, the author of "The Data of Geochemistry") is the average quantity of a given element in any geochemical system; *EK* (energy coefficient) is an index expressed in calories per gram-mol at 0° Abs., showing the amount of energy contributed to a heteropolar compound by the transfer of an ion from infinity to its present position in the crystalline lattice; *EK*'s are calculated from the energy of the crystal lattice, but an approximate formula gives $EK = Kw^2/2R$, in which K is a coefficient (almost equal to unity for anions), w is valency, R is ionic radius; *VEK* is *EK* divided by valency, or the energy per valency of an ion; paragene is a complex and as yet undetermined function depending on the crystal chemical constants and energy coefficients. It is suggested that the paragene, when properly determined, may fix the relative position of a compound (mineral) in the paragenetic succession.

The field covered by geochemistry as outlined by Fersman is most extensive. It includes all systematic mineralogy and petrology, the study of ore deposits, crystal-chemistry and physical chemistry as applied to natural processes. All these sciences are combined into a unified scheme following definite leading ideas. In his book on geochemistry, Fersman begins with the consideration of chemical elements and then passes to crystals, geospheres, migration of chemical elements, clarkes, geochemical processes and geochemical types. At a later stage a detailed examination of the periodic system is undertaken in the light of atomic structure and crystal-chemistry, and also a detailed treatment of energetics as applied to geochemistry, including the energy of the crystal lattice, energy coefficients (*EK* and *VEK*) and the principle of the paragene. Fersman's main idea is that the energy coefficients of ions provide the fundamental ground for the understanding of all geochemical processes: "The course of a natural process and the association of minerals and elements in space and time are determined by the law of the decrease of the space-lattice energy. The application of *EK*'s, for example, the energy of simple and complex ions forming the lattice, provides an important key for the solution of geochemical problems from the point of view of energetics".

This application of 'geoenergetic analysis' to all geochemical problems is most clearly marked in his treatment of pegmatites—coarse-grained rocks crystallized out of a water-rich rest magma during the later stages of magmatic consolidation. Fersman has been engaged in the study of pegmatites during the last thirty years, and has published a number of papers on this subject. In 1931 he published a large book on granite-pegmatites, a third, revised and enlarged edition of which appeared in 1940[9]. This is to be followed by another work dealing with syenite-pegmatites. The book on granite-pegmatites is packed with data culled from all parts of the world, including many new observations on pegmatites in the U.S.S.R. The factual data are interpreted according to a definite genetic scheme, and all types of pegmatites are considered as members of a continuous series corresponding to the stages of the cooling of granitic magma. The chronological sequence of these stages is as follows: (1) magmatic (900°–800° C.), (2) epimagmatic (800°~600°), (3) pneumatolytic (600°–400°), (4) hydrothermal (400°–50°), (5) hypogenic (50°-0°). Each stage is characterized by a more or less definite mineral assemblage in a given type of pegmatite. The main concern of Fersman is to find the cause or causes of this association and succession of minerals (paragenesis). A suggestion is made by him that minerals with a high lattice-energy crystallize out first, but this is complicated by other factors, such as the composition of the melt, the amount of volatiles, the nature of the ions present and many others. The book on granite-pegmatites is definitely a work on the geochemistry of these rocks, and it provides a test piece for his geochemical theories as applied to magmatic rocks. At the same time, a systematic description of pegmatites of the U.S.S.R. has been undertaken in a series of monographs, two of them already published[10]. Pegmatites contain a number of economically valuable minerals and such a survey is of great practical importance.

The new school of geochemistry has made and is making rapid progress in the U.S.S.R. It was fostered by the formation in 1931 of the Institute of Geochemistry, a research institute forming part of the Lomonosov Institute at the Academy of Sciences. The Lomonosov Institute (named in honour of the great Russian scientist, M. V. Lomonosov, 1711–65), occupies a large new building in Moscow and houses a great number of research workers, many of them

engaged on problems of economic importance. As an example of such work one may mention a recent publication on the geochemistry of gold by Zviaginzev[11]. In this book the author gives an account of the distribution and migration of gold in geospheres, and traces the history of gold from its concentration in hydrothermal veins to its renewed concentration in placers. Several interesting problems are discussed, such, for example, as the occurrence of gold in meteorites, in water, in plants and in coal. The concentration of gold in the hands of man (anthroposphere) is estimated to be of the order of 0·001 per cent of the total amount in the earth.

It is difficult to avoid the impression that geochemistry in the U.S.S.R. tends to the fanciful, and the criticism so implied is not altogether unjustified. It must, however, be noted that Russian geochemists have done and are doing much spadework, and that ideas and theories, which may have seemed extravagant, have proved valuable both in the co-ordination of knowledge already acquired and in the search for knowledge as yet unrevealed. In this branch of science, as in others, progress depends on daring thrusts into the unknown, on the blazing of new trails which must later be consolidated by patient experimental and observational work.

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[2] Vernadsky, V. I., "History of Minerals of the Earth's Crust" (Leningrad, 1925), 1, Part 1, 1933, 2, Part 1.
[3] Vérnadsky, W., "La geochimie" (Paris, 1924).
[4] Vernadsky, W., "La biosphere" (Paris, 1929).
[5] Fersman, A. E., "Geochemistry of Russia" (Petrograd, 1922), Part 1.
[6] Fersman, A. E., "Chemical Elements of the Earth and the Cosmos" (Peterburg, 1923).
[7] Fersman, A. E., "Geochemistry" (Leningrad), 1 (1933), 2, (1934). 3 (1937), 4 (1939).
[8] Fersman, A. E., "The Search for Mineral Deposits on the Basis of Geochemistry and Mineralogy" (Moscow, 1939).
[9] Fersman, A. E., "Pegmatites". 1, "Granite Pegmatites" (Leningrad), 1st edit. (1931); 2nd edit. (1932); 3rd edit. (1940).
[10] "Pegmatites of U.S.S.R.", Edited by A. E. Fersman and I. I. Ginsburg (Moscow), 1 (1936); 2 (1939).
[11] Zviaginzev, O. E., "The Geochemistry of Gold" (Moscow, 1941).
(With the exception of 3 and 4, all these publications are in Russian.)

CRYSTAL DYNAMICS

THE subject of crystal dynamics, which is concerned with the vibrational movement of atoms in the solid state, is now of respectable antiquity. The classic papers are perhaps those of Einstein[1], Debye[2] and Born and v. Kármán[3], which deduce the specific heat of metals from the vibrational energy of the crystal lattice. The whole subject has recently received a new interest and stimulus by the discovery that the thermal vibrations of the atoms of a crystal produce measurable effects in the background of X-ray diffraction patterns. The normal Bragg-Laue diffraction pattern of a crystal is characteristic of its geometry: the thermal motion of the atoms appears as a pattern in the background of the diffraction photographs. This is a subject which evidently has wide ramifications, and in fact must ultimately affect every branch of physics concerned with the solid state of matter. The experimental and theoretical development of the subject have been ably summarized by Lonsdale[4] and Born[5].

That ideas concerning the vibrations of so complex a system as a crystal lattice should depend to some extent on the mode of approach to the problem is perhaps to be expected, but the extent to which they diverge is surprising. Sir C. V. Raman approaches the matter, naturally, by a road leading from the optical characteristics of transparent crystals: such phenomena as the Raman effect, luminescence and absorption spectra should throw light on the nature of vibrations in the crystal lattice. Recently there has appeared "A Symposium of Papers on the Dynamics of Crystal Lattices"[6], in which Raman develops his ideas about the atomic vibrations in a crystal, while his collaborators extend his ideas in several directions.

The basic fact which the theory seeks to explain is that the Raman spectra and luminescent spectra of crystals consist of a number of discrete monochromatic lines. That these lines are superimposed on a continuous background of intensity is ignored. To provide an explanation for the discrete lines in the spectra Raman seeks to endow the crystal lattice with a limited number of discrete modes of vibration. The absorption of energy from the incident beam by one of these modes would give an absorption line, while the communication of energy from one of the modes would give an emission line in the emission spectrum.

Raman's argument seems to run as follows. Directing our attention to a particular atom in a particular crystal cell, we see that the restoring force which operates when it is displaced from its position of equilibrium is the same as that which acts on any crystallographically equivalent atom in any other cell of the crystal, because all these equivalent atoms have the same kind of neighbours arranged in the same pattern. This identity of the force constants suggests that the displacements of equivalent atoms in a normal mode of vibration are related in a simple way. Raman is then led to the result that equivalent atoms in the crystal have all the same amplitude of vibration, their phases being either the same or opposite in neighbouring cells along the three crystal axes. This means that the atomic vibrations repeat themselves in a space pattern of which the unit has twice the linear dimensions, and therefore eight times the volume, of the unit cell of the crystal lattice. If there are p atoms in the unit cell of the crystal, there are $8p$ atoms in the superlattice cell into which the vibrations divide the lattice. Each of these $8p$ atoms has three degrees of freedom, so the total number of normal modes is $24p$, three of which correspond to translations of the crystal as a whole and do not rank as modes of vibration of the lattice. The total number of frequencies so enumerated will also be reduced by the symmetry of the crystal structure.

The foregoing argument thus leads to the result that the vibrational spectrum of the crystal consists of a small number of discrete (monochromatic) frequencies. The result is founded on an arbitrary assumption and is quite at variance with all other work on the subject. Raman concludes his paper with some (unfortunate) remarks about Born's "postulate of the cyclic lattice", an idea which both Born and Lederman[7] have re-examined and found to be justifiable.

The remainder of the symposium consists, on the theoretical side, of four papers by E. V. Chelam on the enumeration of the normal modes of vibration of several types of cubic lattice, and two papers by G. N. Ramachandran on the vibrations of the fourteen Bravais lattices. The experimental background, which the theory is designed to explain, is reviewed by R. S. Krishnan, who deals with the Raman effect in crystals, and by D. O. Pant, who surveys the experimental data concerning the luminescent spectra of crystals. It is unfortunate that these

authors and their eminent leader have not given their careful attention to the X-ray evidence which has been so well described by Dr. Kathleen Lonsdale. This demands a nearly continuous spectrum of vibrational frequencies in the crystal quite contrary to Raman's theory. Krishnan, moreover, ignores the continuous background to the Raman spectrum of sodium chloride observed by Fermi and Rasetti[8] and stresses only the lines which are superimposed on the background. The lattice theory developed by Born (*loc. cit.*, p. 309) provides an explanation of the X-ray results and also of the small number of lines in the Raman and absorption spectra of crystals. There does not, therefore, seem to be any necessity for introducing arbitrary assumptions into the dynamical theory in order to reduce the number of normal modes of vibration to a few discrete frequencies. G. D. PRESTON.

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[2] Debye, *Ann. Phys.*, **39**, 789 (1912).
[3] Born and v. Kármán, *Phys. Z.*, **13**, 297 (1912).
[4] Lonsdale, Reports on Progress in Physics, **9**, 256 (1943).
[5] Born, Reports on Progress in Physics, **9**, 294 (1943).
[6] Raman and others, *Proc. Indian Acad. Sci. Bangalore*, 1–102 (1943).
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OBITUARIES

Sir Joseph Arkwright, F.R.S.

JOSEPH ARTHUR ARKWRIGHT, an honorary member of the staff of the Lister Institute of Preventive Medicine and a former member of the Medical Research Council and of the Agricultural Research Council, died on November 22 after a short illness, a few weeks after the death of his friend and colleague, Sir John Ledingham. He was the son of the late Arthur William Arkwright, of Broughton Astley, Leicestershire, and was born on March 22, 1864. He was educated at Wellington College, and Trinity College, Cambridge, and pursued his medical studies at St. Bartholomew's Hospital, London, qualifying in 1889 and graduating M.D. in 1895.

Arkwright had a many-sided and distinguished career. After postgraduate work at St. Bartholomew's, the Victoria Hospital for Children, Chelsea, and the West London Hospital, he engaged for some years in general practice, chiefly at Hales Owen, Worcestershire; but in 1905 he renounced this work to join the staff of the Lister Institute, first as a voluntary research worker and from 1909 onwards as assistant bacteriologist. He retired from active duty in 1927, but continued to work at Chelsea as an honorary member of the staff. He was elected a member of the governing body of the Institute in 1932 as the representative of the Royal Society and served until January 1 of this year, when the Board recorded its high appreciation of the value of his wise counsel during the period of his service.

Arkwright's work at Chelsea was interrupted by the War of 1914–18 when, after investigating an epidemic of cerebro-spinal meningitis among troops encamped on Salisbury Plain in 1915 and recording his observations on the grouping of meningococcus strains that were isolated, he served in the R.A.M.C. with the rank of major as pathologist at St. George's Hospital, Malta, where with Dr. E. A. Lepper he investigated the occurrence of blackwater fever in the Eastern Mediterranean area. In 1918 he was appointed a member of the War Office Committee on Trench Fever, and with his colleagues, Bacot and Duncan, demonstrated the constant association of the virus of trench fever with *Rickettsia quintana* in lice. In 1922 he accompanied Bacot to Egypt at the request of the Egyptian Government, to investigate the etiology of typhus fever. After two months work in Cairo, both contracted the disease, to which Bacot unfortunately succumbed; Arkwright recovered from a severe and hazardous illness. Previously, in 1920, he had carried out a series of investigations on foot-and-mouth disease under the auspices of a committee appointed by the Ministry of Agriculture and Fisheries and later became chairman of this committee, as also of the Agricultural Research Council's *Brucella abortus* Committee and the joint committee with the Medical Research Council on tuberculosis.

The subject, however, with which Arkwright's name will always be associated is that of bacterial variation, and his fundamental and luminous researches on the forms of bacteria that he named the "S" and "R" variants, embodied in an outstanding communication to the *Journal of Pathology and Bacteriology* in 1921, gave a new impetus to research in this direction. He was also deeply interested in the carrier problem, and his book, "The Carrier Problem in Disease", published in collaboration with the late Sir John Ledingham, was an important contribution to this subject. He also contributed freely to the Medical Research Council's "System of Bacteriology" and to numerous scientific journals.

Arkwright's active and versatile mind found many channels for its expression. He was appointed a member of the Medical Research Council in 1930 and of the Agricultural Research Council on its inception in 1931. His public-spirited and useful work in these directions only terminated in 1940, when in his seventy-sixth year he retired from the latter of these offices. He was made a fellow of the Royal College of Physicians in 1916 and served on the Council during 1929–31. He was elected a fellow of the Royal Society in 1926, and the honour of knighthood was bestowed on him in 1937 for his outstanding scientific achievements.

Arkwright had a charming personality and extended an ever-helping hand to the younger workers at the Lister Institute, to whom he was a source of encouragement and inspiration. Apart from his special studies he had a broad cultural and scientific background and was a field naturalist of no mean ability, possessing an exceptional knowledge of field botany and of horticulture, and a good working knowledge of other branches of natural science. He married in 1893 Ruth, daughter of the late Joseph W. Wilson, who, with their three daughters, survives him. R. ST. JOHN-BROOKS.

Dr. G. A. Tomlinson

WE regret to record the death of Dr. George Arthur Tomlinson, a principal scientific officer at the National Physical Laboratory, on December 1, after a short illness.

Tomlinson was born on January 7, 1885, and educated at Nottingham High School, passing on to University College, Nottingham, where he took the degree of B.Sc. (London) in engineering, with first-class honours. He then spent two years as a research student at St. John's College, Cambridge, on post-graduate research. He also gained honours in electrical engineering in the City and Guilds (London) exam-

ination. On leaving Cambridge he worked for a time with Messrs. Kelvin and James White, of Glasgow, on researches relating to electrical and magnetic problems. Later he held, in turn, lectureships in electrical engineering at the Rutherford Technical College, Newcastle-on-Tyne, and at the Borough Polytechnic, London.

In 1915 Tomlinson was appointed to a post at the National Physical Laboratory, where he was first engaged, during the War of 1914–18, on the verification of gauges. From this he turned his attention to devising apparatus for the measurement of gears and gear-cutting hobs, then almost a new field, with which he continued to be closely associated for the rest of his life, developing further methods and instruments for checking the accuracy of gears of all sizes, and of the hobbing machines used in their production. In this subject he became a recognized expert whose advice was sought both by government departments and by private firms.

Among other matters Tomlinson also devoted himself successfully to the study of molecular cohesion in relation to surface phenomena such as pressure corrosion and friction. Following this, he became interested in the geometrical properties of surfaces, and devised the now well-known surface-finish recorder which bears his name, and which is an excellent example of his direct attack on a problem, and his faculty for attaining results by the simplest means.

An altogether different line of work was in connexion with the improvement of time-keepers. He spent much time on the development of a new type of vibration clock, and in experiments on new methods for driving free pendulum clocks. Incidentally to this work, he designed a new type of chronograph for the comparison of time-signals to an accuracy of 0·1 millisecond.

Tomlinson had a flair for instrument design which amounted to genius. More often than not he would make the first model of a new instrument with his own hands, using the material nearest to hand. But though these first models might have a somewhat gimcrack appearance they were always usable tools and, being usually designed to meet some immediate need, were often put into practical service for considerable periods before, as happened in many cases, their proved utility made it desirable to re-design them in a form suitable for commercial production.

Tomlinson—"Tommy" to his friends—had a charming and lovable personality. Modest and unassuming, he was always ready with advice and help for others, and a source of inspiration to those who worked with him. He was a rare combination of man of science and practical engineer, and his death is a national loss. He leaves a widow and two sons.

J. E. SEARS.

Dr. J. N. Sugden

DR. JAMES N. SUGDEN, senior lecturer in inorganic chemistry in the Imperial College of Science and Technology, who was killed by a flying bomb on July 11, 1944, was born at Silsden, near Keighley, on March 27, 1894. As a pupil of the Trade and Grammar School, Keighley, he came under the influence of a former student of chemistry in the Royal College of Science, Mr. Harry Harper, and after a period of study at the Technical College, Huddersfield, he proceeded to South Kensington in 1913.

Having graduated as an associate with first-class honours, and having been awarded the Neil Arnott Studentship and a Royal Scholarship, Sugden devoted himself to investigations which naturally soon became closely related to war problems. He received a commission in the Army, and under the direction of the late Prof. H. Brereton Baker he took part in some of the early scientific work which arose out of the enemy's use of poison gas. Later he was much concerned with the technical development of methods and equipment for ensuring an adequate supply of safe drinking water for troops dependent on contaminated supplies, particularly in France and in Mesopotamia. Under his immediate supervision, large mobile and static chlorination plants with their control laboratories were designed, tested, dispatched, and operated. Returning in 1919 from a prolonged visit to Iraq, he was appointed a demonstrator in chemistry at the Royal College of Science (Imperial College of Science and Technology); he was promoted to be a lecturer in 1922, and senior lecturer in 1943. There he quickly established a reputation as a most conscientious and efficient teacher.

Sugden's methods were often ingenious, and sometimes unorthodox; for he was an individualist whose acidulated epigrams were a tonic to the laggard, but whose meticulous care and patient instruction were an inspiration to every diligent student. Prolonged ill-health restricted the scope of his physical activity, but his mind seemed the more acute. His principal contribution to chemical knowledge concerned the hydration of salts in aqueous solution. This study yielded most interesting results; but he placed his teaching duties before all other attractions, and never regained the physical strength to pursue the inquiry.

Sugden was not an easy man to know. His bachelor life was lonely, and his friends, deliberately few, scattered by the march of time. He was interested in British silver coins, and liked to try his hand at the more erudite literary competitions in periodicals, especially those involving a foreign language. He was a judge of burgundy, and his efforts as an amateur photographer disclosed an artistic perception. While few could phrase a rebuke more mordantly, few enjoyed more gloomily the humour of life or more often delighted their acquaintances with gleanings among the unusual, the comic, or the profound. By his colleagues, as well as by many of the students to whom he ministered for twenty-five years, he will be remembered with affection and with the respect due to one who, having well considered, possessed the courage of his convictions.

A. A. ELDRIDGE.

Prof. B. B. Ray

PROF. B. B. RAY, Khaira professor of physics in the University of Calcutta, died on July 29, 1944. He was a fellow of the National Institute of Sciences of India; and presided over the Physics Section of the twenty-ninth session of the Indian Science Congress, held at Baroda in 1942. Prof. Ray joined the University of Calcutta in 1921 as a lecturer in physics and was one of the early batch of students who carried out research work in physics under Sir C. V. Raman.

Prof. Ray visited Europe twice, once in 1923 and again in 1935. During his first visit he worked at Uppsala in the laboratory of Prof. M. Siegbahn and at Copenhagen under Prof. Niels Bohr. It was in Prof. Siegbahn's laboratory that Prof. Ray learned

the technique of research on X-ray spectra. On his return to India he devoted himself to founding an active school of research on X-rays.

In 1935, he was elected to the Khaira chair of physics in the University of Calcutta.

Immediately before his death, Prof. Ray was carrying out researches on the absorption and emission spectra in the soft X-ray region. He was also conducting investigations on the luminescence of solids under X-ray bombardment. Prof. Ray had a charming and lovable personality and was very popular with his students. Science in India has suffered a great loss by his untimely death at the early age of fifty.

WE regret to announce the following deaths :

Prof. Edward F. Berry, professor of civil engineering at Syracuse University, on August 28, aged fifty-four.

Prof. E. F. Gaines, professor of genetics in agronomy and cerealist in the Agricultural Experiment Station of the State College of Washington, known for his work on the inheritance of disease resistance in cereals, on August 17, aged fifty-eight.

Dr. Walter L. Jennings, formerly professor of chemistry and later director of the Worcester Polytechnic Institute, Massachusetts, on September 2, aged seventy-seven.

NEWS and VIEWS

Royal Institute of International Affairs

THE annual report of the Council of the Royal Institute of International Affairs for the year ended June 30, 1944, gives a brief review of the growth of the work since the Institute was established in 1919 for the scientific study of international affairs. A committee was appointed by the Council on April 19, 1944, to review the developments of a quarter of a century, "to re-examine the purposes for which the Institute was founded ; to inquire whether any change is desirable in the present activities of Chatham House, or any shift of emphasis in order to increase its influence and value". Researches into international problems published during these twenty-five years appearing in the growing list of volumes under the auspices of the Institute have already placed Chatham House on a footing comparable with the national institutions established in other fields. Strict adherence to the basic rule that the Institute should express no corporate opinion on any aspect of international affairs has contributed in no small measure to recognition of its integrity and to the attainment of its present position. Means of study have been provided for the serious student of international affairs. The Library is the most comprehensive collection of its kind in England, and has overflowed from its cramped quarters into more ample reading rooms. The Press archives are unique, and after the War, when these archives are returned to Chatham House by the Foreign Office Research Department and again become generally available, they will be a source of information that will attract scholars from all over the world.

With regard to the past year, the report refers to the opening on May 17, 1944, of the additional premises at 9 St. James's Square, London, the republication in January 1944 of *International Affairs* as a quarterly, by arranging for printing in Canada, and the opening in New York on February 1 of a Publications Office for distribution of the Institute's publications, and to the continuance of week-end courses on international affairs for officers and men of the Forces. A list of the fourteen courses arranged is appended, and the 300 available places at each were allocated among the Royal Navy, the British Army, Royal Air Force, Canadian Army and U.S. Army. The "British Year-Book of International Law", which was suspended at the outbreak of war, is to re-appear shortly as a Chatham House publication covering the period 1940–43. Reconstruction studies have continued, but only one report, "The International Secretariat of the Future", was published during the year. A preliminary report of the group dealing with economic and social problems will be published shortly under the title "The Economic Lessons of the Nineteen-Thirties", as well as a series of pamphlets under the title "Looking Forward" to assist members of the general public to form their opinions on some of the principal international problems of reconstruction. One of these, by Dr. C. H. Desch, deals with "Science and the Social Order". Lists of individual studies published during the year, in the press or in progress are included ; with notes on Far Eastern studies and the Institute of Pacific Relations, British Commonwealth relations, Allied research in London and on the work of the branches and of the institutes in the Dominions and in India.

Town and Country Planning in Britain

BULLETIN No. 4 of the Tory Reform Committee deals with "Government Policy for the Rebuilding of Urban Areas" as set forth in the Town and Country Planning Act, of which it gives a concise exposition. Development in Great Britain has hitherto been haphazard, uneconomical and unplanned for five reasons. The planning authorities have always been too small and there has been no central machinery co-ordinating local schemes in accordance with a national policy. Any planning authority inclined to take a less parochial view met financial difficulties resulting from its small size. Urban authorities were similarly penalized if they sought to make an enlightened dispersal of their population, because this meant handing rateable value to neighbouring authorities. Again, just where dispersal was most needed, land values rose sharply in proportion to the need for using the land. Compulsory acquisition by an authority was made slow, difficult and costly by the old piecemeal procedure.

The Tory Reform Committee holds that there can be no doubt that the elimination of all local inquiries, except in special cases, as was recommended by the Uthwatt Committee, would greatly expedite the compulsory acquisition of land, but it would be impossible to justify the compulsory purchase of the property of individuals without giving them an adequate opportunity of stating their objections. Again, it would be disastrous if post-war planning resulted merely in a tidier expansion of the existing industrial aggregations. What is really required is, first, the encouragement of industry into

industrial areas which are menaced with post-war unemployment, and when this need has been met, the dispersal of industry and populations into communities ten or fifteen miles outside existing towns, as contemplated, for example, in the Plymouth plan. The provisions of the Act, as in all legislation dealing with the ownership of land, are complicated and difficult, but the Committee believes it offers a more acceptable solution of the problems incidental to the public acquisition of land than has been proposed in various plans put forward since planning seized the public imagination.

Universities of Britain and the Future

A SPECIAL number of the *Political Quarterly* devoted to the future of the universities of Britain contains an article by Sir Lawrence Bragg, "Organisation and Finance of Science in Universities". Sir Lawrence urges the importance of further steps to ensure that the fullest use is made of scientific men and potential scientific workers of the highest quality; and he suggests that more care should be taken to see that the highest ability does not 'fall off the educational ladder' before reaching the university, and that young people possessing such qualities should be carefully guided as to the courses they pursue at the university and the careers they take up afterwards. Then he suggests that an attempt should be made to avoid distracting our best university men from their real work by loading upon them too many extraneous duties, and finally he directs attention to the way in which lack of sufficient money for aids to research reduces the efficiency of our best scientific investigators. Dr. C. P. Snow also examines the question of careers, and pleads for a standing Government committee to report at least once a year on trends in employment of graduates; the Appointments Department of the Ministry of Labour should act in close touch with such a standing committee and have as an essential task the diffusion of information to undergraduates; and the university appointments boards should be strengthened in the large universities on the Cambridge scale, and developed on tutorial lines in the smaller universities. Sir Ernest Simon discusses the number of university students, and Mr. G. D. H. Cole's article on "The Social Studies in the Universities" includes a suggestion for group research in place of individual research for the average postgraduate student, which may have potentialities elsewhere also. Bruce Truscot discusses the "University and its Region", indicating possible developments, and Prof. John Macmurray the functions of a university, stressing the importance of the cultural function, in which the universities of Great Britain are most conspicuously lacking.

Research and Development in Scotland

SOME further notes on "Scientific Research in Scotland" are contributed by Mr. R. H. S. Robertson to *Discovery* of October, to some extent amplifying those in Bulletin No. 3 of the Scottish Reconstruction Committee (see *Nature*, August 12, p. 205). Some reference is made to the research stations already established in Scotland such as the Macaulay Institute, the Rowett Institute and the Fisheries Research Station at Torry, but no fresh evidence is advanced in favour of the formation of a new Scottish research station or branch of the Department of Scientific and Industrial Research. What is required is rather more attention to local conditions and problems and more effective liaison with the research boards and stations of the Department, whether they are located in Scotland or elsewhere. Modification or adaptation of the Portal house may be as important to suit conditions in Devon or Cornwall as to suit those in Scotland. To duplicate the work of the Building Research Station when the first need is a large all-round expansion of research would be both wasteful and inefficient. The national research stations, wherever located, should be strengthened so as to be capable of dealing with the development of national resources, whether they are found in Cornwall or Durham, Glamorgan or Buchan. In regard to the location of industry, Mr. Robertson is on firmer ground, and his paper emphasizes the need for action on the lines of the Barlow Report and as foreshadowed in the White Paper on "Employment Policy".

Early Medical Books at Glasgow

To illustrate a current series of lectures on "The Evolution of Social Medicine", by Dr. Douglas Guthrie, there have been placed on view in the Hunterian Library of the University of Glasgow some interesting works from the Hunterian and the Ferguson Collections, and from the library of the Royal Faculty of Physicians and Surgeons. Dr. William Hunter, eminent in London as an obstetrician and an anatomist, though not so famous as his younger brother John, bequeathed his library and museum to the University of Glasgow, where it forms a rich mine of learning. Besides his own magnificent atlas, "The Anatomy of the Gravid Uterus" (1774), the books selected from Hunter's library include some of the earliest works on midwifery. Among the medical classics in the exhibition are the first edition of the works of Hippocrates, printed in Greek by Aldus of Venice in 1526, and another Aldine work, Celsus' "De Medicina", the oldest medical document after Hippocrates, of which the 1528 edition is shown, the Florentine edition of 1478 being still stored away for safety. From the Ferguson Collection come two of the finest works of Paracelsus, "Grosse Wundarztney", 1536, and "Paramirum" (1565), next to which may be seen David Laing's copy of one of the rarest of medical books, Michael Scot's "Liber phisionomie" (1477). Herbal literature is represented by "De historia stirpium" (1540), by Leonard Fuchs, Nehemiah Grew's "Anatomy of Plants" (1682), with many beautiful drawings, and the magnificent "Curious Herbal" of Elizabeth Blackwell (1737). Another rare work is "An Account of the Foxglove" (1785), in which William Withering of Birmingham, a friend of Erasmus Darwin, introduced the use of digitalis in heart disease, having learned of its use as a 'folk remedy' from his country patients. Although the valuable University manuscripts have been stored away for safety, it has been possible to show from the Faculty library a volume of letters of advice, or "consilia", written and signed by Herman Boerhaave of Leyden (1668–1738); the earliest minute book of Glasgow Medical Society (1815), and a manuscript diary of the Crimean War, written by George Buchanan, the first professor of clinical surgery at the University of Glasgow. The exhibition, which has been arranged with the co-operation of Dr. W. R. Cunningham, University librarian, and Dr. Snodgrass, librarian of the Royal Faculty of Physicians and Surgeons, will remain open until the end of January.

Sunspots and Associated Phenomena

WALTER G. BOWERMAN has an article entitled "Sunspots in Review" in *Sky and Telescope* of September, which, although containing nothing new on the subject, provides an excellent summary of research in this particular branch. Much still remains to be done on the effects of sunspots, and in some cases results obtained by different investigators are of a contradictory nature. Thus, while some have discovered that the sun radiates more heat to the earth with increase in the number of sunspots, others have found no such correlation, and additional material is necessary before any definite conclusion can be drawn. H. H. Clayton, writing in *World Weather*, has pointed out that proof of variation in the sun's radiation with sunspot periods is found in the variation of the polar caps of Mars. When the spots are numerous and at the same time a polar cap is turned towards the sun, it lessens in size. He also states that variations in the light reflected by Jupiter have been found to be associated with sunspot periods. Dr. Stetson, in a letter to Mr. Bowerman, states that evidence from ionospheric investigations reveals an output of solar radiation, especially in the extreme ultra-violet, which is 100–150 per cent greater at sunspot maximum than at minimum. Huntington, writing in "Earth and Sun", suggests that the planets have an influence on sunspots—akin to trigger action—the energy derived from them being like pressing a button to start an explosion. Once a little eddy is started, the slight movement so generated may be reinforced by stresses due to rapid cooling of the sun's outer layer, or to the sun's varying rate of rotation at different latitudes. Mr. Bowerman admits that there are many pitfalls for the student of solar-terrestrial relations, and one must avoid too hasty generalizations. In different parts of the world relationships to temperatures, pressure, and precipitation are not always the same. For example, the Nile shows a maximum height near sunspot maximum, whereas rivers in temperate regions, such as the Parana in the Argentine, show the reverse. Great care is necessary before formulating definite conclusions.

Industrial Electrical Maintenance

IN a paper read in London on December 14 before the Institution of Electrical Engineers, J. C. B. Nicol contends that industrial maintenance should be controlled through an organized system. From an analysis of the functions of a maintenance department, he derives the principles underlying good organization and illustrates some of these by examples. There are probably many types of equipment data records in use, and it is believed they are all fundamentally the same if different in detail. These differences must cause considerable trouble to manufacturers when supplying information to various customers, and if standard cards were agreed, manufacturers could easily supply them with their equipment. Manufacturers often supply maintenance instructions and connexion diagrams with their equipment, as well as lists of spare parts. If all such information were provided on standard-size pages, which could be bound into a strong loose-leaf book, it could then be given to workmen with a good chance of survival.

It would be advantageous if a standard code of practice for the maintenance of industrial electrical apparatus were compiled and issued by the British Standards Institution. Such a code could not make any comprehensive technical recommendations, but it could specify good administrative procedure, which would tend to standardize systems and facilitate the interchange of maintenance engineers. Some standardization on these lines would make the exchange of information between manufacturers and maintenance engineers easier, and would also help installation contractors and consultants to take an interest in maintenance work and its problems.

Plastics in Electrical Industry

AN article by A. J. Warner (*Elec. Comm.*, 22, No. 1; 1944), in reviewing the physical and electrical properties of plastics, discusses the various types of plastic materials available, paying particular attention to their electrical properties, and also examines their physical limitations, since there is no 'all-purpose' plastic available for the variety of conditions encountered. In all cases, a compromise must be made between the electrical properties and the mechanical limitations inherent in the material. In the summary which is provided, which of necessity is incomplete and rather fragmentary, such data are collected and collated as will facilitate an intelligent selection of materials. It cannot be too strongly emphasized, however, that, in the present state of the plastic art, a mere tabulation of physical and electrical properties will not necessarily enable one to choose the right material for any particular application. There still exists and will always exist the need for the exercise of judgment and the use of the accumulated knowledge of the particular engineer having the problem under consideration.

For the highest degree of electrical performance, where dielectric properties are of paramount importance, the pure hydrocarbons such as polystyrene and polyethylene are the best materials available. Where cheapness, availability, and good overall physical properties are required for low-frequency applications, and where only moderate electrical performance is required, the recent developments in the urea formaldehydes should be considered. For large sheets of various thicknesses for panel mounting strips, etc., and where high electric strength, reasonably low moisture absorption, and reasonable electrical properties are required, Grade *XXXP* laminated plastics are recommended.

Equilibrium Diagrams of Alloys

THREE more "Annotated Equilibrium Diagrams" have been published by the Institute of Metals. No. 2 deals with the copper-tin system, No. 3 with the copper-zinc alloys and No. 4 with the copper-aluminium. Prepared by Dr. G. V. Raynor, each sheet contains a large-scale diagram in its latest form, some notes upon it, and an extensive bibliography. At the almost nominal price of 6*d*. per sheet, they represent what is probably the best value attainable anywhere in metallurgical literature.

Mineral Deficiencies in Pastures

TECHNICAL COMMUNICATION No. 15, issued by the Imperial Bureau of Animal Health (Rowett Institute, Aberdeen, 1944. 5*s*.), entitled "Minerals in Pasture, Deficiencies and Excesses in Relation to Animal Health", by Miss F. C. Russell, is a valuable review of this complex subject. The literature surveyed deals with diseases attributed or attributable to

deficiencies of cobalt (bush sickness of New Zealand, pining in the United Kingdom, etc.); of copper (swayback in the United Kingdom and other countries, which is a disease of lambs with paralysis of the limbs, inco-ordination and demyelination of certain tracts of the spinal cord, which J. R. M. Innes (*Vet. Record*, 55, 369; 1943) has compared with certain rare diseases of man); of both copper and cobalt; and of potassium, sodium chlorine, iodine, phosphorus, calcium or magnesium (grass or lactation tetany). Other sections deal with diseases attributed or attributable to excesses of selenium, molybdenum, nitrate or manganese and with fluorosis and arsenical poisoning. A useful general summary completes the review, and the bibliographies of each section guide the reader to further study. The problems here discussed are difficult and are not for those who require circumscribed investigations which are certain to give results. Miss Russell has performed very well her difficult task of presenting the controversial literature about them, and everyone who is concerned with this kind of work will be grateful to her.

Mexico's Vital Statistics

DR. RICARDO GRANILLO, head of the Mexican Department of Statistics and Demography, states that his Department is a part of the Secretariat of National Economy (*Bol. Of. San. Panamericana*, 23, 419; 1944). It collects and publishes statistics, takes a national census, makes special studies, represents the country at international congresses, and has jurisdiction over population, public education, social welfare, industrial economy and vital statistics. The principal functions of the Vital Statistics Office of the Secretariat of Health and Welfare include keeping Federal and State health authorities informed of the general mortality and that from contagious disease and other important causes; reporting on epidemics in areas where there are no practitioners and regular reports of contagious diseases cannot be obtained; the study of the geographical and seasonal distribution of general, infant, endemic and epidemic disease mortality; reporting to the Panamerican Sanitary Bureau and other international offices and neighbouring health authorities on the general health conditions of Mexico; and keeping a record of public health activity throughout the Republic.

Nizamiah Observatory, Hyderabad

THE director of the Nizamiah Observatory has communicated a paper, "Occultations of Stars and Planets by the Moon observed at the Nizamiah Observatory, Hyderabad, during the Year 1943" (*Mon. Not. Roy. Astro. Soc.*, 104, 4; 1944), which gives the occultation results for 1943 from January 11 until December 31. Twenty-seven occultations of stars and one of Venus were observed by M. K. Bappu, using the 15-in. visual refractor. M. V. V. Sastry, assisted by S. Aravamudan, carried out the reductions. In the case of two stars, proper motions were applied to the co-ordinates given in the catalogue in computing the mean places for use in the reductions, and positions were taken from the "Nautical Almanac" for the others.

The Night Sky in January

NEW moon occurs on January 14d. 05h. 06m., U.T., and full moon on January 26d. 06h. 41m. The following conjunctions with the moon take place: Jan. 4d. 20h., Jupiter 4° S.; Jan. 12d. 08h., Mercury 0·2° S.; Jan. 12d. 21h., Mars 2° S.; Jan. 17d. 14h., Venus 4° N.; Jan. 25d. 18h., Saturn 0·5° N. Mercury is in conjunction with Mars on Jan. 26d. 15h., Mercury being 0·4° N. The following occultations of stars brighter than magnitude 6 take place: Jan. 1d. 20h. 56·5m., 8 Leon. (*R*); Jan. 18d. 17h. 52·8m., 33 Pisc. (*D*); Jan. 21d. 17h. 27·5m., μ Ceti (*D*); Jan. 24d. 2h. 15·2m., *i* Taur. (*D*); Jan. 25d. 2h. 21·7m., + 20° 1105*m* (*D*); Jan. 26d. 18h. 24·0m., 63 Gemi. (*D*). The times refer to the latitude of Greenwich, and *D* and *R* refer to disappearance and reappearance, respectively. Mercury rises 1½ hours before the sun at the beginning, and 36 minutes before the sun at the end, of the month. It is stationary on Jan. 2 and reaches its greatest westerly elongation on Jan. 13. Venus is conspicuous in the evening hours, setting at 19h. 51m., 20h. 29m. and 21h. 08m. at the beginning, middle and end of the month, respectively. Mars rises about three-quarters of an hour before the sun at the beginning of the month and is not well placed for observation. Jupiter, in the constellation of Virgo, is a conspicuous object in the morning hours and rises at 23h. and 21h. at the beginning and end of the month, respectively. Saturn, in the constellation of Gemini, can be seen throughout the night, setting at 6h. 52m. in the middle of the month.

Announcements

DR. W. A. WATERS, lecturer in chemistry in the University of Durham, has been elected to an official fellowship in organic chemistry at Balliol College, Oxford.

MR. A. W. LADNER retired from his position of principal of the Marconi Company's School of Wireless Communication at the end of the year, after thirty-two years service with the Company, and twenty-four years as superintendent of instruction. Mr. Ladner will continue to act in an advisory capacity. His place as principal of the School has been taken by Mr. N. C. Stamford, who was previously with the Company and has since been on the teaching staff of the Department of Electrical Engineering at the University of Manchester.

AT the annual meeting of the Genetical Society, the following officers were elected: *President*, Dr. C. D. Darlington; *Vice-Presidents*, Prof. T. J. Jenkin, Prof. R. A. Fisher and Mr. M. B. Crane; *Treasurer*, Miss E. R. Saunders; *Secretaries*, Mr. W. J. C. Lawrence, John Innes Horticultural Institution, Merton, S.W.19, and Mr. R. Race, Galton Laboratory Serum Unit, Department of Pathology, Cambridge.

THE following appointments have recently been made in the Colonial Agricultural Service: V. E. Gale, to be agricultural officer, Nigeria; D. H. Laycock, to be agricultural officer, Nyasaland; A. H. Strickland, to be entomologist, Gold Coast; J. W. D. Fisher, senior agricultural officer, Sierra Leone, to be principal agricultural officer, Sierra Leone; R. R. Glanville, principal agricultural officer, Nigeria, to be director of agriculture, Sierra Leone; and R. O. Williams, deputy director of agriculture, Trinidad, to be director of agriculture, Zanzibar.

ERRATUM.—In the article on the "Deciduous Cypress" in *Nature* of December 16, p. 775, for 12 ft. (line 8, col. 2) read 21 ft.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Method for Measuring Diffusion Constants of Biologically Active Substances

THE study of diffusion constants of proteins and other materials of high molecular weight has added much to our knowledge of the nature of these substances (Svedberg and Pederssen[1], Polson[2]). These studies were made on materials which were obtained in the pure state. Unfortunately, when dealing with substances comprising several components, the usual optical method of diffusion (Lamm[3]) cannot be applied except with great difficulty. In such cases recourse must be made to analytical methods. The method of Northrop and Anson[4], namely, diffusion through a porous plate, has been of great value, but this method too has its limitations. Bourdillon[5] has proposed a method for the analytical determination of diffusion constants. His method, although theoretically sound, is very difficult to apply, especially when dealing with viruses. (For a criticism of the above-mentioned methods, see Markham, Smith and Lea[6].)

An account is given below of a method which has been found suitable for the measurement of the diffusion constant of horse-sickness virus.

Theoretical: From the well-known law of Fick

$$ds = -AD\frac{dc}{dx}\cdot dt,$$

and its solution

$$\frac{dc}{dx} = \frac{C_0}{2\sqrt{\pi Dt}}\,e^{-x^2/4Dt},$$

the following equation has been deduced

$$D = \frac{S^2}{C_0^2 A^2}\cdot\frac{\pi}{t},$$

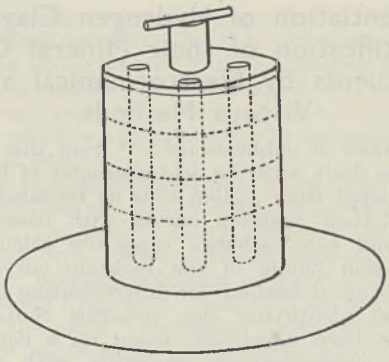
where S is the amount of substance which diffused through a cross-section A cm.^{2} at the original boundary $X = 0$ in t sec. D is the diffusion constant and C_0 is the original concentration.

This equation can be applied to all substances which do not sediment appreciably under the influence of gravitation, such as the proteins, enzymes and the small viruses. Its range does not include the larger viruses like vaccinia and psittacosis, as their sedimentation constants are too high.

Experimental: To measure the amount of substance which passed a given layer in a diffusion vessel, the apparatus shown in the accompanying diagram was made. Four circular metal sections 1 cm. thick and 4 cm. in diameter were cut and holes 0·5 cm. in diameter drilled through them, except the bottom section, into which the holes extend three-quarters of the thickness of the section. The flat faces of these sections were well ground. They turn on a central bolt which is fixed in a wooden base. In a certain position the holes coincide to form four cylindrical cavities 4 cm. long and 0·5 cm. in diameter. The surfaces between the sections were smeared with a thin layer of wool grease.

The diffusion experiment was run as follows.

The virus solution was placed in the four cavities formed by the bottom two sections, and the cavities in the top two sections filled with suspension medium of a slightly lower density than the fluid in the bottom



cavities. The apparatus was placed in a constant-temperature room and when temperature equilibrium had been reached the top two sections were turned slowly so that the cavities corresponded with those in the lower two sections. In this way sharp interfaces were formed at the contact of the top fluid with the bottom fluid. The apparatus was left in that position for definite periods of time, after which the top fluid was again isolated by rotating the segments. The fluid in the top sections was sucked out with a syringe, the volumes measured and tested for virus content.

The accompanying table gives the results obtained:

Exp. No.	Time (sec.)	A (cm.^{2})	C_0 in mid.* per c.c.	S in mid.*	$D \times 10^7$ cm.^{2}/sec.	
1	151,200	0·2	160,000	2232	1·01	Av. 0·80
2	151,200	0·2	440,000	6480	1·01	
3	237,600	0·2	226,000	3360	0·73	
4	331,200	0·2	200,000	2796	0·46	

* Determined by the Read and Münch method of 50 per cent end-points.

The diameter calculated from the Stokes-Einstein formula for the diffusion of a substance gave the value $d = 53{\cdot}2\ \mu\mu$. This value agrees very well with those determined by other means, namely, ultracentrifugation 45·4 $\mu\mu$, and ultrafiltration 40–60 $\mu\mu$ (Polson[7]).

From the sedimentation constant $S = 286 \times 10^{-13}$ Svedbergs, the specific volume $V = 0{\cdot}8$ and the diffusion constant $D = 0{\cdot}8 \times 10^{-7}$ cm.^{2}/sec., the molecular weight is calculated according to the formula of Svedberg[1],

$$M = \frac{RTS}{D(1-V\rho)} = 44{,}500{,}000,$$

where ρ is the density of the suspension medium.

This value for the molecular weight must be considered approximate, as the determination of D depends on the relationship $\frac{(S)^2}{(C_0)^2}$, the determination of which could only be done by biological means.

A more extensive article will be published in the *Onderstepoort Journal*.

ALFRED POLSON.

Veterinary Research Institute,
Onderstepoort.

[1] Svedberg and Pederssen, "The Ultracentrifuge" (Oxford University Press, 1940).
[2] Polson, *Koll. Z.*, **87**, 149, and **88**, 51 (1939).
[3] Lamm, *Nova Acta Reg. Soc. Scient. Upsal.*, **4**, 10, No. 6 (1937).
[4] Northrop and Anson, *J. Gen. Physiol.*, **12**, 543 (1928–29).
[5] Bourdillon, *J. Gen. Physiol.*, **24**, 459, and **25**, 263 (1941).
[6] Markham, Smith and Lea, *Parasitology*, **34**, 315 (1942).
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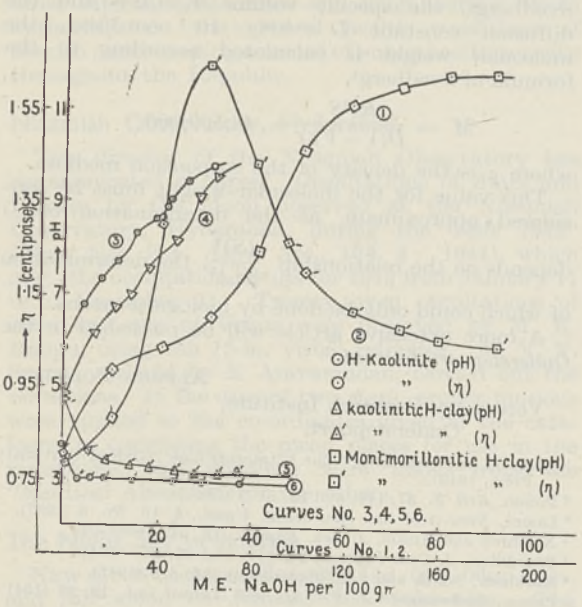
Differentiation of Hydrogen Clays and Identification of their Mineral Constituents by Electrochemical and Viscous Methods

A NUMBER of publications[1,2,3,4] from this Laboratory have dealt with the acid character of hydrogen clays isolated from Indian soils as revealed from a study of their titration curves with bases, buffer indices and base-exchange capacities calculated at the inflexion points of the titration curves. An 'electrochemical method' for differentiating hydrogen clays and identifying clay minerals contained in them has been developed, based on a comparison of their electrochemical properties with those of hydrogen colloids isolated from natural deposits of the clay minerals. Hydrogen kaolinites (prepared by repeatedly leaching entire clay fractions with 0·04 *N* hydrochloric acid and washing free from chlorides) from four different samples of kaolin and a number of hydrogen clays known, from X-ray and dehydration studies carried out by Mr. S. N. Bagchi, to contain kaolinitic minerals have a dibasic acid character within the range of *p*H 4–11·0[5,6]. The first inflexion usually occurs between *p*H 7·0 and 8·0 and the second between *p*H 8·0 and 9·5 (see diagram). The ratio of the base-exchange capacities at the two inflexion points is nearly 2·0, though the actual value of the base-exchange capacity varies in the case of different hydrogen clays and hydrogen kaolinites from 12·0 m.e. to 23·0 m.e. per 100 gm. at the first inflexion point; and from 20·0 to 45·0 m.e. per 100 gm. at the second inflexion.

Hydrogen clays containing only montmorillonitic minerals as judged from X-ray analysis show only one inflexion between *p*H 7·1 and 8·8 in their titration curve with caustic soda (see graph) and between *p*H 5·2 and 7·5 when titrated with barium hydroxide and calcium hydroxide[7,8]. The base-exchange capacity calculated at this inflexion point varies from 55 m.e. to 100 m.e. per 100 gm. for entire hydrogen clay fractions.

Another criterion for differentiating kaolinitic clays from those containing montmorillonitic minerals has been found and is based on the effect of addition of caustic soda on the viscosity of aqueous suspensions of the hydrogen clays. On the gradual addition of the alkali to hydrosols of hydrogen bentonites[9] and montmorillonitic hydrogen clays[10], their viscosity increases and passes through a maximum value at a point corresponding to about 75 per cent neutralization of the amount of the acid given by the inflexion point of the titration curve. Apart from a slight initial decrease, the alkali has no marked effect on the viscosity of hydrogen kaolinite and hydrogen clays containing only kaolinitic minerals within the range *p*H 4–11. The viscosity of one of the hydrogen kaolinites, *D*, slightly increased on the addition of the alkali, after which the viscosity remained practically constant. X-ray analysis showed that it contains montmorillonite in addition to kaolinitic minerals. Six subfractions having average equivalent spherical diameters 1·4, 0·70, 0·50, 0·32, 0·21 and less than 0·18 microns were isolated by the graded centrifugalization of *D*. A concentration of montmorillonite in the finer subfractions was indicated by the chemical compositions; nature of potentiometric titration curves with caustic soda; base-exchange capacities; and the effect of the alkali on the viscosity.



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Antioxidants and Prevention of Rancidity in certain Pacific Coast Fish

DURING recent years it has been established that herring muscle[1] and pork muscle[2] possess a lipoxidase enzyme (or enzymes) which is capable of accelerating post-mortem oxidation of the tissue fats. This enzyme catalyses the formation of peroxides from the unsaturated fatty acids present, and consequently facilitates the development of rancid odours and flavours in the flesh. The enzyme concerned is sensitive to heat, will function actively at temperatures well below 0° C. and its action is markedly accelerated by pure sodium chloride. This last-named property has been used to explain the fact that certain cured fish and meats are particularly liable to become rancid during storage.

On the north Pacific coast of America the flesh of many of the most valuable food fishes is rich in fat, and consequently cold storage of such fish under conditions which will prevent the formation of rancid fat has always presented a problem. The practice of lightly brining fillets prior to freezing them in order to prevent drip when they are thawed is by no means uncommon on this continent[3], and this procedure is well known to lead to the premature development of a 'salt fish' flavour and rancidity in treated fillets.

TABLE 1.

Expt.	Treatment	Peroxide value after storage for 64 days at average temperature of − 3° C.
1	Minced flesh untreated	4·95
	Minced flesh with 1 per cent sodium chloride incorporated	20·3
	Minced flesh with 0·02 per cent ethyl gallate incorporated	0·1
	Minced flesh with 1 per cent sodium choride plus 0·02 per cent ethyl gallate incorporated	0·2
1	Fillets untreated	13·3
	Fillets dipped in 20 per cent sodium chloride	33·6
	Fillets dipped in 20 per cent sodium chloride containing 0·5 per cent ethyl gallate	0·3
	Fillets dipped in 20 per cent sodium chloride followed by 0·25 per cent ethyl gallate	1·35
	Fillets dipped in 0·25 per cent ethyl gallate followed by 20 per cent sodium chloride	6·15
	Fillets dipped in 20 per cent sodium chloride containing 0·25 per cent ethyl gallate	0·3
		After storage for 46 days at average temperature of − 5° C.
2	Fillets untreated	17·6
	Fillets dipped in 1 per cent ethyl gallate	2·2*
	Fillets dipped in 0·5 per cent ethyl gallate	2·0*
	Fillets dipped in 0·1 per cent ethyl gallate	6·5
	Fillets dipped in 1 per cent sodium gallate	13·0
	Fillets dipped in 0·5 per cent sodium gallate	17·6
	Fillets dipped in 0·1 per cent sodium gallate	17·0

* In this experiment, bait herring which had been frozen for some months in blocks were used, the initial peroxide value of the fat being 2·0, while in the first experiment strictly fresh herring in which the peroxide value was zero were used.

In this connexion, recent work[4] has shown that fillets of certain species of Pacific salmon readily become rancid when they are stored at temperatures which are commonly employed commercially (−12° and −20° C.), and that this susceptibility is significantly increased when the fillets are lightly brined prior to freezing. The practice of 'glazing' whole fish with a thin layer of ice undoubtedly retards the development of rancid fats. Storing fish at low temperatures (−28° to −30° C.) has also been found to exert a desirable effect[5], but such temperatures are seldom realized commercially.

In view of these facts, experiments were commenced in order to determine the possible value of antioxidants as a means of inhibiting the development of a rancid condition in the flesh of local fatty fish. For convenient practical application an antioxidant which is sufficiently soluble in water so that it can be added to a liquid in which the fish are immersed, and yet which is highly soluble in fat so that it will be readily absorbed by the flesh, was sought. It was also realized that such an antioxidant would have to be fairly cheap and relatively non-toxic. Recently ethyl gallate, 1 : 5-dihydroxynaphthalene and guiacum resin have been used experimentally to hinder the development of oxidative rancidity in certain foods[6,7]. Of these substances, ethyl gallate was selected for the present work since it possesses the following properties. It is fairly soluble in both water and in fats, has little or no adverse effect on the flavour of foods in concentrations which strongly inhibit fat oxidation, is not very expensive and is comparatively non-toxic for mice[8]. In addition, it is known that gallic acid itself is practically non-toxic and that about one third of the aqueous extracts of tea leaves consists of tannins which are rich in gallic acid. Some experiments were also made using sodium gallate, which would in practice be somewhat cheaper than the ester.

In the experiments described below, fish fillets were immersed from one minute in the solutions, a draining period of one minute being permitted between two successive dips. Sodium gallate solutions were prepared by bringing solutions of gallic acid to *p*H 6 with sodium hydroxide. Treated fillets were wrapped in moisture-proof 'Cellophane' paper during storage. Peroxide values on the extracted fat were determined by Lea's method[9], the results being reported as ml. of 0·002 *N* sodium thiosulphate per gm. of fat. The results of two experiments with herring are given in Table 1.

It will be seen that in the case of minced flesh the addition of 1 per cent sodium chloride greatly increased the peroxide value obtained on storage. The incorporation of 0·02 per cent ethyl gallate in the flesh strongly suppressed peroxide formation even in flesh treated with sodium chloride. Immersing fillets in sodium chloride brine greatly increased the peroxide value of the stored fish, while addition of 0·5 per cent ethyl gallate to the brine strongly retarded peroxide formation. Results obtained using 0·25 per cent ethyl gallate solutions showed that lower peroxide values resulted when fillets were treated with ethyl gallate after brining than when treated prior to or during the brining procedure. Sodium gallate solutions were not nearly so effective as ethyl gallate solutions, presumably due to the low solubility of the sodium salt in fat.

The results of an experiment in which white spring salmon fillets were treated with various solutions and then stored at 0° C. are given in Table 2. The results at this temperature were naturally complicated by the fact that considerable bacterial growth occurred, and it is known that reducing systems of bacteria normally inhibit peroxide formation[9]. It will be seen that so far as accumulation of peroxides was concerned, the use of sodium chloride temporarily accelerated their formation, but that after fifteen days, when bacterial decomposition was very marked, similar values were obtained in both the brined and untreated fillets. At the natural *p*H of the fish flesh (about 6·2), sodium nitrite, which has marked bacteriostatic properties[10], exerted a slight antioxidant effect. For the short storage period

TABLE 2.

Treatment	Peroxide value after		Bacteria in millions per gm. by direct count after	
	6 days	15 days	6 days	15 days
Untreated	0·4	0·95	125	380
Dipped in 0·5 per cent ethyl gallate	0	0	1·7	410
Dipped in 0·5 per cent sodium gallate	0	0	3·8	980
Dipped in 0·5 per cent sodium nitrite	0	0·15	0·3	2
Dipped in 20 per cent sodium chloride	1·3	0·95	6·2	540
Dipped in 20 per cent sodium chloride containing 0·5 per cent ethyl gallate	0	0	0·1	210
Dipped in 20 per cent sodium chloride containing 0·5 per cent sodium gallate	0	0·1	1·7	640

studied, ethyl gallate and sodium gallate proved effective antioxidants. Sodium nitrite strongly retarded bacterial decomposition. Ethyl gallate, and to a somewhat slighter extent sodium gallate, inhibited bacterial growth. In this connexion it must be noted that experiments with minced salmon flesh have shown that the incorporation of 0·02 per cent ethyl gallate retards both bacterial growth and the onset of oxidative rancidity. The bleaching of the astacin pigments of salmon during cold storage is largely prevented by ethyl gallate.

It is intended to publish the detailed results of these experiments in the *Journal of the Fisheries Research Board of Canada*.

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Apparent Respiration of Wheat Grains and its Relation to a Fungal Mycelium beneath the Epidermis

THE experimental evidence summarized below has led us to the conclusion that the carbon dioxide produced by stored wheat, apparently by respiration of the grain itself, is in fact produced almost entirely by micro-organisms growing in the pericarp ('bran') of the grains.

Respiration measurements made on wheat stored at 25° C. show a progressive increase in the rate of carbon dioxide output over a period of several months. The increased respiration-rate persists if the wheat is removed to a lower temperature, and may be many times greater than that of wheat which has been stored for the same period at the lower temperature. The effect is greatest in wheat having a water content higher than 15 per cent (wet-weight basis), but we have observed progressive increase in respiration-rate of wheat drier than this when stored at 25° C. for periods of six months or more. This is confirmed by some of the results of Robertson, Lute and Gardner[1].

Progressive increase in respiration-rate suggests progressive development of actively respiring tissue, but it has not been possible to detect any corresponding increase in the size or differentiation of the wheat embryo.

Wheat grains from which the embryo has been removed by the attack of larvæ of a moth, *Ephestia elutella* Hb., have a respiration-rate nearly as high as that of undamaged grains hand-picked from the same sample. Since the embryo is the only part of the wheat grain which would be expected to be actively respiring, this suggests that the chief source of respiratory carbon dioxide is external to the seed proper and is much greater than that of the embryo.

Leach[2] has recently reported respiration measurements on wheat grains the embryos of which were removed by drilling, and has similarly shown that there is little, if any, fall in respiration-rate on removal of what is presumably the most active tissue of the fruit. From this Leach has come to a conclusion similar to our own, namely, that the respiration of wheat which is too dry to germinate is due almost entirely to micro-organisms that infect it. Since wound reactions and other effects may follow removal of the embryo, we do not consider this evidence, by itself, a sufficiently firm basis for the conclusion.

The pericarp of wheat grains is largely removed by abrasion if a sample of grain is shaken with coarse carborundum powder in a sealed glass bottle for about 48 hours. We have found that this process reduces the rate of carbon dioxide output to about 5 per cent of its original value. Such wheat is not injured or dead, for it will germinate as rapidly and completely as before treatment provided that the abrasion process has not been carried too far.

That the lowering of respiration-rate is not due to a toxic effect of carborundum powder is shown by the fact that a similar effect may be obtained by the use of crushed flint or glass powder. Also, if carborundum is mixed with whole wheat the respiration-rate is unaffected.

This experiment shows that the carbon dioxide produced by wheat originates largely in the pericarp; yet microscopical examination of sections of this structure shows few, if any, cells which appear to be actively developing or even living.

The epidermis of the pericarp may usually be stripped from a grain of wheat, sometimes almost entire, after soaking for a few minutes in water. Staining with aniline blue will usually reveal a number of fungal hyphæ, and in some samples an extensive mycelium, on the *inner* surface of the epidermis. Unless grains are obviously mouldy, no hyphæ can be found on the *outer* surface of the epidermis. It seems likely that this fungal mycelium is part, at least, of the micro-flora the existence of which is suggested by the experiments described. We have demonstrated the existence of a similar flora under the epidermis of maize, particularly over the embryo and basal parts of the seed.

The mycelium is abundant in many samples of English wheat immediately after harvest, when the water content may range from 15 to 25 per cent or even higher, and is detectable, though in rather small quantity, in Canadian and other wheats with a water content in the region of 12 per cent. The abundance of mycelium may be a measure of the dampness of the grain during the period immediately before harvest.

It is important to note that we have demonstrated a mycelium which is absent from the surface of the grain. Previous reports of fungi associated with wheat, and measurements of their amount, have been based on the numbers of colonies obtained by shaking grain with sterile water. Such investigations probably reveal only superficial spores which, until they have germinated, can make no measurable contribution to the apparent metabolism of the wheat grain. Such estimates of fungal and bacterial population are irrelevant to the probable life of grain or other seeds in storage, unless the humidity becomes high enough to permit spores to germinate rapidly.

Since the mycelium is vegetative, we have been unable to identify any of the organisms which compose it or even to verify that they are fungi, and we have not so far been successful in isolating them free from contamination by the spores which are

invariably present on the outer surface of the epidermis. We are, however, attempting to grow wheat to maturity under aseptic conditions from sterilized seed in order to obtain a small crop of grain free from contamination for comparison with normal wheat. When data for this comparison are available we will publish our detailed results elsewhere.

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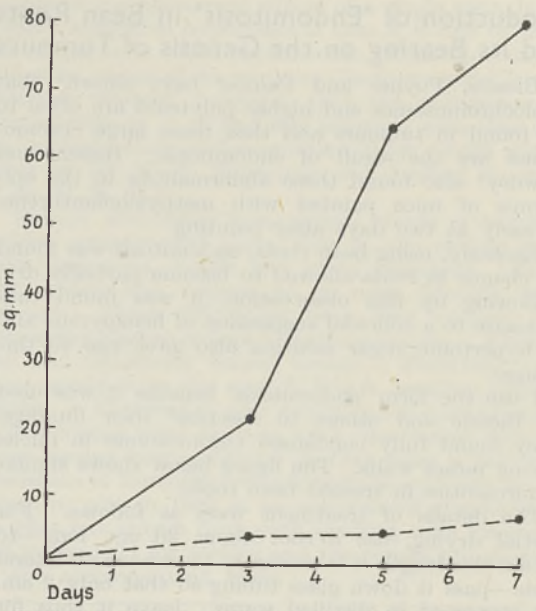
Concurrence of Growth-promoting and Growth-inhibiting Factors in Extracts of Adult Rat Tissues

IN previous papers[1] from this laboratory it was shown that saline extracts of adult tissues and organs have a marked growth-promoting effect on cell colonies *in vitro*. Under given experimental conditions, the growth-promoting activity of certain adult tissue extracts is several times that of embryonic tissue extracts of the same concentration. Although most tissues and organs of the adult organism display the growth-promoting power, the activity of the extracts varies from organ to organ. It is particularly high in heart, brain and smooth muscle, and low in kidney, bone marrow and liver.

Organs of almost all species tested (dog, sheep, cow, rabbit) were found to yield active extracts[2]. Extracts of rat organs, on the other hand, are exceptional in their behaviour with regard to cell-growth activation[3]. Of rat organs and tissues, only brain and embryo tissue displayed marked growth-promoting power; extracts of all other rat organs have either no growth-promoting property or inhibit the growth of cells *in vitro*. The unequal growth-promoting power of extracts of different origin could be accounted for by either of the following assumptions: (1) that the growth-promoting principles are present in amounts varying from organ to organ and species to species; (2) that the difference in activity is due to the simultaneous presence in varying concentration of growth-inhibiting factors, which counteract cell proliferation.

Our experiments have shown that the absence of growth-promoting ability in extracts of most organs of adult rats can be explained in accordance with the second assumption. In the investigations reported below, the procedure previously used[4] by us for the partial purification of active principle from growth-promoting adult tissue extract was used. The experiments were performed with extracts of rat heart muscle, which have either no stimulating action or even inhibit cell growth. Minced heart muscle was extracted with four volumes of normal saline and this extract was precipitated with four volumes of alcohol. The precipitate obtained was then treated in a Soxhlet apparatus with acetone or petroleum-ether. The extracted material after drying was taken up in 'Tyrode'. Solutions thus obtained were added to standardized cultures of chicken fibroblasts in Carrel flasks. The growth of the cell colonies in medium containing this solution as supernatant fluid phase was compared with the growth of controls (sister halves) growing in protective medium composed of plasma diluted with 'Tyrode' 1 : 2 and covered with 'Tyrode' solution. The growth of cultures was recorded according to the method of Ebeling.



EXPERIMENT 11245 A. GROWTH OF CHICKEN FIBROBLASTS (FULL CURVE) IN MEDIUM CONTAINING SOLUTION OF ALCOHOL PRECIPITATE OF RAT HEART EXTRACT, TREATED WITH PETROLEUM-ETHER; AND GROWTH IN PROTECTIVE MEDIUM (BROKEN CURVE).

It could be shown that originally inactive rat tissue extracts are rendered active by the above treatment. Even alcohol precipitates of the extracts had slight growth-promoting activity. Subsequent treatment with petroleum-ether or acetone proved to be decisive. Petroleum-ether and acetone convert material originally inert and only slightly active after alcohol treatment into definitely active preparations.

The curves of the accompanying graph show the growth of a culture stimulated with a petroleum-ether-treated alcohol precipitate of rat heart extract compared with that of a control. These curves illustrate the optimal activation obtained, the average stimulation amounting to 450 per cent.

It may be concluded that the inability of rat tissue extracts to stimulate the growth of cells *in vitro* is due to the fact that in rat tissues (heart muscle) the growth-promoting substance is masked by the predominance of growth-inhibiting factors. The latter are probably of a lipoid nature.

Details of our experiments are being published elsewhere.

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Production of 'Endomitosis' in Bean Roots and its Bearing on the Genesis of Tumours

Biesele, Poyner and Painter have shown[1] that diplochromosomes and higher polytenes are often to be found in tumours and that these large chromosomes are the result of endomitosis. Biesele and Cowdry[2] also found these abnormalities in the epidermis of mice painted with methylcholanthrene, as early as two days after painting.

Recently, using bean roots, endomitosis was found by chance in roots allowed to become partially dry. Following up this observation, it was found that exposure to a colloidal suspension of benzpyrene and to hypertonic sugar solution also gave rise to this change.

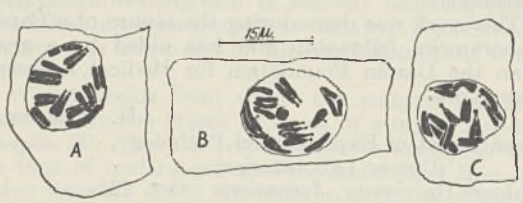
I use the term 'endomitosis' because it was used by Biesele and others to describe[1] their findings. They found fully condensed chromosomes in nuclei having intact walls. The figure below shows similar abnormalities in treated bean roots.

The details of treatment were as follows. For partial drying, use a root about 20 cm. long—to obtain this length it is necessary to remove all lateral roots—pass it down glass tubing so that only 2 cm. are immersed in distilled water; leave it thus for 12 hours and then examine histologically. For benzpyrene treatment, substitute for the distilled water a colloidal suspension of 0·05 per cent in distilled water (good suspensions cannot be made in the presence of salts); under these conditions, the action of benzpyrene and of partial drying are combined, and abundant endomitoses are produced. Benzpyrene treatment without partial drying is obtained by filling the tubing to the top with colloid, but longer exposures of 24–48 hours are required. The effect is not obtained with short roots and before leaves have formed; it seems that an abundant volume of water must be absorbed—and this does not occur with short roots—for a sufficient amount of benzpyrene to enter. The suspended particles do not appear to enter, but only benzpyrene in solution. Occasional endomitoses were obtained by placing the roots in 8–10 per cent dextrose.

It is to be noted that two of the agents are potent to produce increased viscosity of the cytoplasm; as regards benzpyrene, information is wanting. Further, Guyer and Claus, using the ultracentrifuge, have shown[3] that tumour cells present great stiffening of the cytoplasm in comparison to cells of normal tissues, and that this applies not only to experimentally produced hepatomas, but also to liver cells in pre-cancerous stages.

It is likely, therefore, that endomitosis, polytene, polyploid and polynuclear cells of tumours are secondary to an increased stiffness of the cytoplasm and no more than signs of such a change.

Increased viscosity of the cytoplasm was observed[4] as a common reaction of ciliates to a wide range of tumour-producing agents, and led to races of multiple organisms.



THE FIGURE SHOWS THREE CELLS FROM ROOT TIP OF BEANS, STAINED WITH IODINE GENTIAN VIOLET: *A*, TREATED FOR 20 HOURS WITH BENZPYRENE; *B*, FOR 12 HOURS BY PARTIAL DRYING; AND *C*, WITH 8 PER CENT DEXTROSE FOR 24 HOURS. THE CHROMOSOMES ($2n = 12$) ARE ABNORMALLY CONDENSED AND THE CHROMATIDS CLOSELY APPLIED AS IN LATE METAPHASE. AT THE SAME TIME A FINE NUCLEAR WALL IS PRESENT. IN *B* THE NUCLEOLUS HAS NOT BEEN ENTIRELY ABSORBED. IN *A* AND *B* THE CENTROMERES APPEAR TO HAVE DIVIDED AND IN *C* TO BE UNDIVIDED. IN *B* AND *C*, LATERAL TRABANTS ARE PRESENT.

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Effect of some Pure Substances on Plant Growth

INCREASING concentration of heteroauxin in lanolin – water paste causes progressive inhibition of the growth of hypocotyls of dark-grown *Helianthus* seedlings. At moderate concentrations definite swellings are produced. These effects can be considered as being the result of a progressive disorientation of the cytoskeleton with corresponding loss of cell polarity. A higher degree of disorganization would naturally lead to autolysis. In the presence of the sodium salts of alizarin and quinizarin sulphonic acids, the above effects can be so modified that it requires a higher concentration of heteroauxin to produce an effect similar to that produced with lower concentrations of heteroauxin alone. Tests with the alizarin sulphonate indicate that in aqueous solution it does not destroy heteroauxin to any great extent when this is estimated colorimetrically.

The growth of oat roots can be inhibited by *o*-, *m*- and *p*-phenylene-diamine, benzidene, benzoquinone and other substances, these simultaneously staining the cell wall. In an extremely dilute solution of phenanthraquinone, roots gave a growth value only 16 per cent of those grown in tap water. Gallic and di-gallic acids in 0·01 per cent solution gave values of about 50 per cent. These substances have the property of reacting with proteins and would act as molecular cross-linkages[1] between the proteins of the embryonic cells of the root tip, thus preventing development of the normal dynamic cytoskeleton.

On a hypothesis that auxin by some means disengages certain bonds of attachment between the proteins or components of the cytoskeleton, the various effects of auxins become more understandable. Normal extension of a cell would result from the action of auxins on the three-dimensional lattices[2,3] of the cell wall and cytoskeleton. An artificial cytoskeleton such as would be formed in the root tips with some protein reactants would be stable and non-reactive to auxins. It is possible that alizarin and quinizarin sulphonic acids act more selectively on the hypocotyl cells.

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Formation of Creatinine in the Animal Body

H. Borsook and J. W. Dubnoff[1] have discovered that phosphocreatine is changed into creatinine in water solution at 38° and *p*H 7, by splitting off phosphate, and they consider that this spontaneous reaction is the way in which creatinine is formed in the animal body. In connexion with this important discovery, I want to direct attention to similar results which I published in 1940, and which for obvious reasons did not reach any abstracting journal published abroad.

I found[2] that in minced muscle (38° C.) in the presence of fluoride, iodacetate or hydrogen cyanide, the formation of creatinine was greatly accelerated, and I tried to explain that fact by a non-hydrolytic dephosphorylation of phosphocreatine. The idea that creatinine is formed not by splitting off water from creatine but by the splitting of phosphate from phosphocreatine is now made fully evident by Borsook and Dubnoff's experimental work.

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Prolongation of the Effect of Narcotics by Combination with Mucic Acid

A SEARCH for improved methods of prolonging the effect of the injection of morphine and other narcotics resulted in the observation that, for a given dose of morphine, the period of narcosis can be considerably extended if the base is administered in the form of mucate instead of the usual salts such as tartrate, sulphate, etc. This prolongation of effect is also obtained with the mucic acid compounds of other physiologically active bases such as adrenaline and ergometrine.

Some of these compounds are now undergoing systematic pharmacological and clinical test, the results of which will be published elsewhere in due course. In the meantime, other compounds of mucic acid, its homologues, analogues and their derivatives are being prepared and examined to ascertain if this particular property is exhibited by them all to a greater or lesser extent.

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Inheritance of the 'Bolter' Condition in the Potato

'BOLTERS' occur[1,2] in many potato varieties and are distinguished from the normal plants of the variety by the following characteristics: the haulms are more vigorous, taller and with longer internodes, the tubers are coarser and the crop heavier at maturity, maturity is much later, and flowering is much freer. The 'bolter' condition is perpetuated by the tubers, and Davidson[1] states that bolters obtained in 1917 from the variety Snowdrop have always produced bolters.

This group of characters by which the 'bolter' differs from the normal plant of the variety might be due to the pleiotropic effects of a single gene, but a more attractive hypothesis is that it is due to the loss or gain of a whole chromosome. Root-tip counts of 'bolter' plants of the varieties Gladstone and Ulster Chieftain showed, however, that the chromosome number was $2n = 48$ and was identical with that of the normal plants of the varieties (these counts were made by Mr. N. W. Simmonds and checked by one of us, H. W. H.).

'Bolters' also differ from normal plants in having 'wilder' underground parts, that is, the stolons are more numerous, longer and more persistent. The root system also appears to be more strongly developed. These differences have been utilized in comparing the two crosses, Gladstone female × Flourball and Gladstone 'bolter' female × Flourball. A third family from the cross U.S.D.A. seedling 41956 female × Flourball is also available for comparison.

The crosses were made in 1942 (the 'bolter' Gladstone having been collected in 1941 from a field of Gladstone in Northern Ireland) and the seedlings were raised in pots in 1943 in an insect-proof glasshouse. In 1944 two tubers from each seedling were planted out in the field for scoring and the results are shown in the accompanying table.

Family	Cross	No. of distinct seedlings	Percentage of plants with underground parts			
			cultivated	somewhat wild	wild	very wild
50/43	Gladstone 'bolter' × Flourball	25	20	44	24	12
49/43	Gladstone × Flourball	52	58	25	17	0
47/43	U.S.D.A. 41956 × Flourball	133	62	20	17	1½

Families 49/43 and 47/43 have similar percentages of plants in the four groupings of underground parts, but family 50/43 from the 'bolter' Gladstone cross differs in having many fewer plants with the cultivated type and more plants with the somewhat wild, wild and very wild underground parts. Thus there seems no doubt that 'bolter' Gladstone differs in being genetically 'wilder' than normal Gladstone. On August 10 families 49/43 and 50/43 were scored for flowering; 38 per cent of the plants in family 49/43 had flowered as compared with 57 per cent in family 50/43.

Mr. John Clarke (the well-known Northern Ireland potato breeder) of Broughgammon, Ballycastle, Co. Antrim, has told us in conversation this year that he obtained similar results when comparing the cross Epicure 'bolter' × Herald with the cross Epicure × Herald. More than 50 per cent of the plants in the family from the 'bolter' cross were 'wild' types as compared with a small percentage from the cross Epicure × Herald.

Since a series of intermediates between the normal and bolter type occur and since it is known that maturity, flowering and stolon development are influenced strongly by the length of day, it is possible that the 'bolter' condition arises through the mutation of the gene or genes governing the photoperiodic reaction.

G. P. CARSON.
H. W. HOWARD.

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School of Agriculture,
Cambridge. Oct. 19.

[1] "Potato Growing for Seed Purposes" (Dublin, 1937).

[2] "The Maintenance of Pure and Vigorous Stocks of Varieties of the Potato", Revised ed. (Edinburgh, 1944).

Body-Weight as Determinator of Physical Efficiency

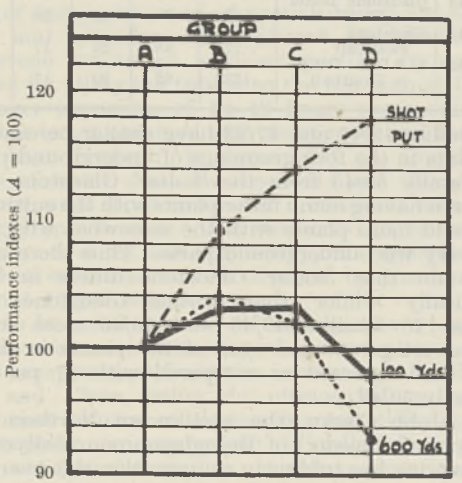
In view of the nutritional, educational and other implications of physical development, it is desirable to arrive at an objective evaluation of anthropometric measurements. Among the determinators of muscular efficiency which a study of physical fitness of school children in South Africa has revealed[1], body weight has been found to be of significance. We apply three performance tests intended to yield information with regard to neuro-muscular skill and speed (100 yards running), circulatory and respiratory endurance (600 yards running) and muscular strength (putting the 12 lb. shot). As the accompanying table and graph indicate, a specific determination of performance standards through body-weight is noticeable. In the 100-yard race, underweight and overweight are about equally disadvantageous. In the 600-yard race overweight is more disadvantageous than underweight, while in putting the shot only underweight is disadvantageous. The medium body-weight levels are associated with the best all-round physical efficiency.

The tests were conducted with 1,514 boys of between 6 and 17 years of age. Baldwin and Wood's age-weight tables were used as standards. The four weight sub-groups (*A*—*D*) were calculated according to Bogert's[2] recommendation.

A detailed account of our findings, with special reference to nutritional problems, will appear in *Manpower* (Pretoria), the official organ of the National Advisory Council for Physical Education.

Item	Unit	Group*				Mean differences	Remarks on differences
		A	*B*	*C*	*D*		
Number of Boys		351	492	544	127		
100 *Yd. Running*:							
Mean	Sec.	16·16	15·62	15·63	16·54	*A* – *B* : + 0·54	Significant
S.D.	,,	2·205	2·252	2·175	2·235	*B* – *C* : – 0·01	Not significant
S.E.M.	,,	0·118	0·102	0·093	0·203	*C* – *D* : – 0·91	Significant
Mean Index†	*A* = 100	100	103	103	98	*A* – *D* : – 0·38	Not significant
600 *Yd. Running*:							
Mean	Sec.	141·1	136·3	138·0	151·0	*A* – *B* : + 4·8	Significant
S.D.	,,	18·15	20·70	20·10	20·85	*B* – *C* : – 1·7	Not significant
S.E.M.	,,	0·969	0·933	0·862	1·890	*C* – *D* : – 13·0	Significant
Mean Index†	*A* = 100	100	104	102	93	*A* – *D* : – 9·9	Significant
Shot Put (12 *lb.*)							
Mean	Inches	142·9	156·4	162·7	168·2	*B* – *A* : + 13·5	Significant
S.D.	,,	67·56	77·82	84·66	82·32	*C* – *B* : + 6·3	Not significant
S.E.M.	,,	3·605	3·508	3·630	7·463	*D* – *C* : + 5·5	Not significant
Mean Index	*A* = 100	100	109	114	118	*D* – *A* : + 25·3	Significant

* *A* : Underweight, that is, 7 per cent or more under normal.
B : Slightly underweight, that is, less than 7 per cent under normal.
C : Normal and slightly overweight, that is, less than 15 per cent over normal.
D : Overweight, that is, 15 per cent or more over normal.
('Normal', according to Baldwin and Wood's Table.)
† Calculated by using reciprocals of means, since short running times indicate good performances.



E. Jokl.

Medical Research Committee,
National Advisory Council
for Physical Education,
Pretoria.
Oct. 25.

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Analogy between Pseudopodia and Nerve Fibres

A good many years ago, Verworn[1] developed in some detail a supposed analogy between rhizopod pseudopodia and nerve fibres. He suggested that these represent two extreme types of living substance in which the effects of stimulation are transmitted respectively with and without decrement.

Though this suggestion has not proved fruitful as a basis of further research, some points in a recent letter by J. Z. Young[2] on the structure of nerve fibres revive the possibility that it may not be entirely without significance. Both nerve fibres and foraminiferan pseudopodia[3,4] apparently owe their form to the linear arrangement of micellæ, and are thrown into coils when this orientation is disturbed. In both, the internal protoplasm is in a more or less fluid condition and streaming movements can be observed.

Some observations made in the course of a prolonged study of foraminiferan pseudopodia at the Ghargaqa (Red Sea) Marine Biological Station some years ago may be compared with those of Young on the effects of cutting a nerve fibre. When a pseudo-

podium is cut, the proximal part is rapidly withdrawn. Sometimes this takes place rather violently, and the pseudopodium is then thrown into loose spiral coils in the process. In the part distal to the cut the streaming movements continue unchanged for some time; but gradually the movement becomes preponderatingly towards the cut, and protoplasm accumulates there in the form of a swollen mass. Little or no movement can be seen in this mass, which is therefore probably more solid than the ordinary pseudopodial protoplasm. Subsequent slow general contraction of the whole of the pseudopodial reticulum distal to the cut results in the withdrawal of this part away from the place of the cut; but usually before this contraction is complete new pseudopodia begin to grow out from various parts of this now enucleated fragment. I have no record of coiling ever occurring during this slow contraction.

Thus, in contrast to the cut nerve fibre, in a cut pseudopodium it is the part connected with the nucleus which shrinks, while the swelling occurs at the distal side of the cut. Coiling only occurs in the nucleated fragment, and then only if the retraction is sudden. The fact that new pseudopodia grow from the enucleated fragment shows that contact with the nucleus is not required in order to orientate the micellæ or chain molecules, the existence of which has to be assumed in order to account for the structure and movements of the pseudopodia.

The weakness of Verworn's analogy lies largely in the fact that the pseudopodium is not to any extent specialized for the purpose of conduction. A stimulus given to one part of the pseudopodial reticulum has no effect on adjacent parts unless it involves a gross mechanical disturbance or a change in the streaming movements sufficient to extend to those parts. Nevertheless, from the point of view of the conditions necessary for maintaining physical stability in fine elongated strands of protoplasm, the larger Foraminifera provide particularly attractive material for study.

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[1] Verworn, M., "Irritability" (Yale Univ. Press, 1913).
[2] Young, J. Z., *Nature*, **153**, 333 (1944).
[3] Lepeshkin, W. W., *Biologia Generalis*, 1, 368 (1925).
[4] Sandon, H., *Nature*, **133**, 761 (1934).

Energy Imparted by Active Nitrogen

SPECTROSCOPIC evidence[1] shows that the maximum energy of excitation which a molecule of active nitrogen can impart to another molecule (or atom) is 9·45 eV. Lord Rayleigh, however, from a study of the incandescence of metals immersed in active nitrogen, finds[2] that each molecule of active nitrogen delivers to the metal energy of, at the least, 10 eV. These apparently conflicting results can be reconciled and satisfactorily explained on the hypothesis recently proposed by me, namely, that active nitrogen is simply the ionized molecule of nitrogen $N_2^+(X')$ produced by the discharge.

The molecules (or atoms) introduced into the vessel containing active nitrogen are excited by a three-body collision process as follows:

$$N_2^+ + e + M \rightarrow N_2 \text{ (excited)} + M \text{ (excited)}.$$

Now, the lowest electronic level of excitation to which N_2 can drop, on neutralization, is the A-level, with energy 6·1 eV. The levels lying immediately below it are high vibrational levels of the ground state (X) with distances of nuclear turning-points very different from the nuclear separation of N_2^+ (X'). Transitions to any of these levels will violate the Franck-Condon principle. The maximum energy left over for exciting the third body is thus $15{\cdot}58 - 6{\cdot}1 = 9{\cdot}48$ eV. This explains why repeated attempts by spectroscopists have failed to produce excitation levels above 9·45 eV.

The possible levels below the A-level to which the neutralized N_2 molecule can drop are the ground-level (X) and a few of the vibration-levels immediately above it. But this would mean that nearly the whole of the energy of ionization is either radiated away or is taken up by M. The reaction in this case would be:

$$N_2^+ + e + M \rightarrow N_2 \text{ (normal state)} + M \text{ (excited state)}.$$

I do not know if the probability of such reactions has been studied. In my opinion the probability would be very small.

To explain the higher value of energy as obtained by Rayleigh we recall that for neutralization of N_2^+ on the surface of a solid, the latter acts as the third body. The electrons first arrive on the surface of the solid and remain there as surface charge. The N_2^+ ions then arrive and combine with the electrons, giving up the energy of recombination to the solid surface. Since the solid, with its complicated structure, has many modes of vibration, it can take up the whole of the released energy, 15·58 eV. This, in other words, means that though spectroscopically active nitrogen can impart energy only up to a maximum of 9·45 eV. to an atom or a molecule, it can impart much greater energy (15·58 eV.) to the surface of a solid. This explains the apparently conflicting results mentioned above.

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c/o Royal Society,
London.
Nov. 10.

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[2] Rayleigh, Lord, *Proc. Roy. Soc.*, A, **176**, 17 (1940).
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Permeability of Adsorbing Substances

KING has shown[1] that at low concentrations the diffusion constant of water in keratin becomes extremely small in comparison with its value at higher concentrations. This effect is already known from the behaviour of the hair hygrometer[2], the response of which (dependent on the internal diffusion of water in keratin) is much slower at low than at high relative humidities. The magnitude of this effect is shown by the following figures I have obtained for the times (τ) of half-change of the length of hair (of 0·1 mm. diameter) after a sudden small change of humidity, at 18° C.

Per cent relative humidity	τ (sec.)
10-25	150
25-34	65
34-49	40
49-63	26
63-75	15
75-92	< 10

That this phenomenon is characteristic not only of keratins but also of other adsorbing substances, for example cellulose, can be shown by a very simple experiment, reminiscent of King's[1], but more suit-

able for obtaining quantitative results. A glass tube is divided into three compartments by two cellulose membranes. After evacuating the three partitions, the end spaces are filled with water vapour of different but constant pressures. The pressure in the intermediate chamber then adjusts itself so that the pressure differences across the membranes are inversely proportional to the diffusion constants. It was found that this pressure was always much nearer to that of the high vapour pressure side, independent of the direction of the diffusive flow. If one side was completely evacuated, the pressure in the middle chamber rose until it was equal to that of the high-pressure side, thus leading to the paradox, mentioned by King, that the amount diffusing may decrease with increasing concentration gradient.

These results can be explained most simply by taking into account two or more states of adsorption of the diffusing vapour in the adsorbing material, in which states the adsorbed molecules have markedly different mobilities. Then Fick's law applies, not to the adsorbed total, but only to the concentration of the mobile part (for keratin, Speakman's "capillary water"[3], and for cellulose Peirce's loosely bound "β-water"[4]) which reach appreciable values only at the higher concentrations of total water. A fuller account of the quantitative relationship between adsorption and the diffusion constant in the case of hair will be given elsewhere[5].

There is some evidence that similar phenomena can occur in the diffusion of adsorbed substances even where no swelling takes place (for example, in the diffusion of dyestuffs through cellulose[6]), though these conditions are complicated by the presence of ions. Here, too, the diffusion 'constant', as in the case of water diffusion, rises with the total concentration of the adsorbed material.

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Nov. 11.

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[2] Spilhaus, A. F., Massachusetts Inst. of Technology, Meteorol. Course. Prof. Notes No. 8 (1935).
[3] Speakman, J. B., *Trans. Far. Soc.*, **40**, 6 (1944).
[4] Peirce, F. T., *J. Text. Ind.*, T. **20**, 133 (1929).
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Plant Nutrients in the Sea

Two difficulties have been raised by critics of the suggestion that, for the benefit of the fisheries, large-scale addition of plant nutrients to selected parts of the sea may be considered in the future[1]. The first difficulty concerns the quantities of nutrients required; Michael Graham describes these as "mountainous, nay astronomical"[2], and Dr. W. R. G. Atkins, on surer grounds, estimates the annual turnover of phosphorus in the phytoplankton of the English Channel at about one ton for each square kilometre of surface. The quantity is neither astronomical nor even discouraging.

The Agricultural Statistics for 1937, the latest available, show that the quantity of phosphatic nutrients used in the United Kingdom and Eire in that year represented 201,000 tons as P_2O_5, equivalent to 2,718 lb. P_2O_5 or 1,187 lb. of phosphorus on each square kilometre of all crop and pasture land (41 million acres). But most fertilizers are applied to arable land (13½ million acres), so that the quantity of phosphorus distributed annually on an arable square kilometre is probably more than 3,000 lb. This is considerably in excess of the annual turnover in a square kilometre column of the English Channel. Dutch farmers use about six times as much fertilizer per acre as we do, so that compared with their liberal broadcasting on the surface soil, the turnover in the equivalent column of the English Channel seems almost puny.

The truth is that neither quantity nor cost of fertilizers matters very much to the farmer, provided a profitable return is produced. The return, and not the "mountainous" quantities or "vast expenditure", should be the criterion also in the sea. Furthermore, I conceive that if plant nutrient experiments are ever made in the North Sea, they will at first be limited in extent and confined to areas where currents, plankton and bottom fauna suggest possibilities of success. It seems more reasonable to develop a mediocre into a rich feeding ground with a minimum of labour than to transplant fish from one to the other.

The second suggested difficulty is that the soluble fertilizers once added to the surface waters will be "dissipated into the ocean"[3]. But the indications are that, in suitable areas, the fertilizers are almost immediately converted into phytoplankton, which is rapidly converted into zooplankton and bottom fauna, and no one suggests that the plankton or bottom fauna are dissipated into the ocean. The waters of the sea and their contents are more stable than might be supposed. There will be some loss, but there is considerable loss of fertilizers even on arable land, owing to rainfall and chemical action—the test again must be, are sufficient quantities utilized to make a profitable return? That has still to be decided.

JAMES RITCHIE.

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[2] Graham, M., *Nature*, **154**, 366 (1944).
[3] Atkins, W. R. G., *Nature*, **154**, 490 (1944).

Professional Service in Universities, Technical Colleges and Industry

READERS of the leading article on "Professional Institutions" in *Nature* of December 9 may be interested to know that my Council had in fact taken the initiative in the way suggested in its opening paragraph. The views of the vice-chancellors of the universities and the principals of technical colleges of Great Britain are being sought as to:

(i) The conditions under which scientific workers of different grades in universities and technical colleges should undertake research or consulting work for industry, Government and Government-subsidized organizations.

(ii) The provisions that could usefully be made for the ready interchange of scientific workers between teaching posts, industry and Government service.

The nature of the replies will determine in what way we shall pursue the matter further.

ROBERT H. PICKARD.
(Chairman.)

Joint Council of Professional Scientists,
c/o The Institute of Physics,
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Reading, Berks.
Dec. 12.

RESEARCH ITEMS

Logarithmic Series and the Index of Diversity as Applied to Ecological Problems

In a recent paper in the *Journal of Animal Ecology* (32, May 1944), Dr. C. B. Williams of the Rothamsted Experimental Station discusses this subject. He describes the application of a logarithmic series to a number of problems. It is found to fit extremely well to a large number of frequency series whether they be taken from insects, birds or plants. It also fits well to the number of genera with different numbers of species in standard classifications of groups of both animals and plants. The idea of the index of diversity is applied to problems of the number of species of plants on different areas and to the comparison of floras of different areas with interesting results. The author gives a classification of the 171 families of dicotyledons according to their index of diversity. It is hoped in this way to stimulate discussion of the factors which control differences and resemblances in this index. As a general rule it is found that those families with numerous species and genera have a large index of diversity, but yet there may be a very wide range of index in families of about equal size. This paper is one of considerable interest and deals in the main with problems of species, area and numbers of individuals and with the grouping of species into genera, many examples of both being quoted.

New Zealand Turridæ

The Turridæ is the largest family of gasteropod molluscs, and not only does it contain numerous living members, but it also has a large number of fossil representatives extending back with certainty to the Cretaceous if not earlier. In view of its extent and mixture of living and fossil forms it is not surprising that it presents a number of problems. 398 species of New Zealand Turridæ are described and figured in a well-produced memoir by A. W. B. Powell (*Bull. Auckland Inst. and Mus.* No. 2; 1942); 31 genera and subgenera and 144 species are new. The author takes advantage of this large amount of material to treat of several matters of general importance in the family, and includes a section on nomenclature in which he has endeavoured to give a synonymy of the generic names. The 362 names that have been employed are reduced to 284, which he considers are satisfactory both from the points of view of nomenclature and taxonomy. The second of the major general problems is the classification of the group with keys to the sub-families and genera. In this respect it is interesting to notice that classification according to the type of radula cannot be correlated with that based on shell features, but as too few of the radulæ are known it is not desirable to draw useful conclusions from this.

Fishes from the Panama Bight

John Treadwell Nicholls and Robert Cushman Murphy describe a most valuable collection of fishes based mainly on material from an expedition conducted by the junior author on behalf of the American Museum of Natural History, February-May 1941, using as a base of operations the Diesel schooner *Askoy* ("A Collection of Fishes from the Panama Bight, Pacific Ocean", *Bull. Amer. Mus. Nat. Hist.*, 83; 1944). The Panama Bight is defined as the part of the Pacific bounded by the concavity of the American coast between the Gulf of Panama and Point Santa Elene, Ecuador, and extending offshore towards the west and south. The pelagic collection at Station 49 (between the Colombian Coast and Malpelo Island) is of special interest. Here was encountered the upwelling of deep water, and the ocean was troubled by vertical waves in completely calm weather, resulting in large surface hauls of deep-water animals. The bulk of the material from this collection, however, was from coral brought up chiefly by the diving operations of Dr. John C. Armstrong, second in command of the expedition. The value of this paper is much augmented by the biological notes taken on the spot from the live specimens. These include descriptions of behaviour and coloration, not only of the captured fishes but also of those observed in their natural surroundings in the sea, such as the 'leaping mantas' which make somersaults in the air, and large sharks.

Inheritance of Resistance in Melons

S. S. Ivanoff (*J. Hered.*, 35; 1944) describes the methods and results obtained in raising melons suitable for market which are resistant to downy mildew and aphid attacks. Resistance behaves as a partial dominant during segregation. For example, the number of aphids on susceptible leaves was 433, on F_1 leaves 62, and on resistant leaves 4. Similarly, the number of lesions due to the fungus showed incomplete dominance. There would appear to be some connexion between resistance to aphid attack and resistance to the fungal attack, but the mechanism whereby resistance is achieved is unknown. The present resistant characteristics were derived from West Indian varieties of melons. When the original selections from the F_1s' were made, powdery mildew was not prevalent, so the new strains do not possess resistance to powdery mildew; but new selections are being made to obtain varieties resistant to all three troubles.

Changes in X-Ray Sensitivity in Different Stages of Meiosis

A. H. Sparrow (*Proc. U.S. Nat. Acad. Sci.*, 30, 147; 1944) has irradiated the different stages of meiosis from leptotene to the end of anaphase I in *Trillium erectum* and has compared the number of aberrations at each stage. He finds that if the sensitivity at leptotene-zygotene is 1·0, early pachytene is 2·3, pachytene 1·7, late pachytene 2·6, metaphase 1, 5·9, anaphase 1, 8·7, and microspore resting nucleus between 1 and 1·7. He suggests that the high concentration of desoxyribose nucleotides found at metaphase and the sensitivity to X-ray dosage are correlated. It is concluded that X-ray hits do not induce immediate breaks but potential breaks, which are not actually realized until the following division. The relationships of tumour and radiosensitivity to nucleic acid content are discussed.

Hot Water Injury of Narcissus Bulbs

The practice of treating narcissus bulbs with hot water at 110° F. for three hours is now a standard control for internal pests. Occasional subsequent damage to the flowers has been reported, however, and J. Wood (*J. Roy. Hort. Soc.*, 69, Pt. 10; Oct. 1944) has investigated the difficulty. Splitting of the corolla can be minimized by storage at 80° F. instead of 60° F. after lifting and before treatment

with hot water. Early lifted bulbs are also more susceptible to trumpet splitting, whereas late lifting may bring damage to the roots. Storage after treatment should be at a cool temperature of 48° F.

Limiting Flow of Gas through a Nozzle

As previously mentioned in *Nature* (154, 90; 1944), J. R. Green and R. V. Southwell investigated the two-dimensional flow of a compressible fluid through a nozzle by Southwell's general 'relaxation' method. This method failed when the velocity was *supersonic*, that is, exceeded the local velocity of sound in the fluid. To deal with the supersonic case an iterative method, not depending on 'relaxation', was suggested. This has now been worked out in detail by L. Fox and R. V. Southwell (*Proc. Roy. Soc.*, A, 183, 38; 1944) for irrotational flow with steadily decreasing pressure and density. It is recalled that Osborne Reynolds's early (1886) approximate treatment of the nozzle problem found that the velocity of discharge could never exceed a certain limit, which was attained when the velocity in the narrowest section or 'throat' was equal to the local velocity of sound. He also concluded that there were two and only two possibilities after the gas had left the throat. Either its density and pressure steadily increased as it passed to the exit, or they steadily decreased. One of these two states, it was conjectured, was unstable. No intermediate state was possible. The more exact treatment of the present paper shows that there are *two* slightly different limiting values of the velocity of discharge. One of these is attained when the velocity both before and after the throat is subsonic, though, curiously enough, the velocity has supersonic values at two small regions near the wall at the throat. The other limiting value is for the case when the velocity is supersonic at the part of the nozzle between the throat and the exit. The second value is very slightly greater than the first, by 0·045 per cent. Osborne Reynolds's estimate of the first needs a small increase of 0·083 per cent. The convergence of the iterative process appears to show that the irrotational flow is stable from low velocities up to the lower limit, which gives great stability. On the other hand, the unique supersonic state appears to be unstable, though it may exist. The discussion of the physical interpretation of the work is reserved for a later paper.

Hydrogen Bonds in Ethyleneimine

ALTHOUGH the existence of N—H—N bonds in nitrogen compounds has often been discussed, the compounds have been relatively complicated, such as pyrazoles, indazoles, amidines, etc. W. H. Thompson and G. P. Harris (*J. Chem. Soc.*, 301; 1944) have found good evidence of hydrogen bonding in the simple compound ethyleneimine. The infra-red absorption band at 3 μ due to the NH group in this is appreciably displaced in wave-length on passing from the vapour to liquid, whereas other bonds are not much affected. Solutions in carbon tetrachloride, examined with wave-lengths between 2·9 μ and 3·5 μ, showed the sharp band at 3·01 μ in dilute solution giving way at higher concentrations to a broader and more intense band with a maximum at about 3·1 μ. The effect is precisely similar to the 'association' band found with hydroxylic substances, and points to association through N—H—N bonds. This is supported by boiling point relations.

The Faintest Star

THE March issue of *Sky and Telescope* contains an account of van Biesbroeck's discovery of a faint companion to the star BD +4·4048°; Science Service has also described the discovery. Van Biesbroeck was comparing two plates taken at the prime focus of the 82-in. McDonald Observatory reflecting telescope when he discovered the companion of magnitude 18 at a separation of 74″ from the brighter star of magnitude 9·5. This separation corresponds to a distance of about 440 astronomical units, the distance of the system being nearly 20 light-years. The absolute magnitude of this star is 19 as compared with 5 for our sun, and about a million of these faint stars would be required to produce a combined brilliance equal to that of the sun. Owing to its great distance from the brighter star, it is almost certain that it shines, not by reflected light, but by its own light, and hence is a real star, not a planet. In the case of the invisible companion of 61 Cygni, the mass but not the luminosity were determined, and as its mass was about sixteen times that of Jupiter it was classified as a planet. If van Biesbroeck's new star has a mass comparable with that of the companion to 61 Cygni, it seems highly possible that the distinction between planet and star may cease to exist. Information which may be of assistance to astronomers is as follows: The position angle of the faint star is 150°; the common proper motion is 1·45″ towards position angle 204°, and the parallax is 0·17″.

The Solar Eclipse of June 19, 1936

S. VSESSVIATSKY and E. Bougoslavsky, Kiev Astronomical Observatory, Sverdlovsk, U.S.S.R., deal with the coronal structure and the relationship observed between chromospheric and coronal phenomena during this eclipse (*Mon. Not. Roy. Astro. Soc.*, 104, 3; 1944). Four standard chronographs were located in the path of the eclipse at Beloretchenskaya, Ural, Omsk and Kuibyshevka, and thirty excellent plates of the corona and chromosphere were obtained. A number of important conclusions were deduced as a result of the work, but these cannot be dealt with in full. A very brief outline of them is as follows: Phenomena in the chromosphere and in higher-lying coronal regions are due to foci or centres of excitation on the sun's surface. Their frequency as well as their peculiarities of distribution are related to the heliographic latitude and they change with phases of the sun's activity. The coronal arch systems and the fan forms involved occasionally take on a helmet-shaped summit. This changes into thin rays distributed over the centres of excitation, these rays being connected by dark fibrous formations or dark flocculations. In the chromosphere, excitation gives rise to prominences which are 'imprisoned' in the interior of the coronal arch systems. The fan-shaped forms which characterize the structure of the corona over excited areas of the sun's surface have a discrete structure and represent a system of successive arches. From the presence of the helmet-shaped summits observed on many of the fans it is inferred that there are vertical fields in different regions of the corona at distances of ½ to 2 solar radii. The influence of the general field of the sun is reflected in the peculiarity of the inclination of the axes of the fans to the normal and also by the change in their inclination in relation to the phase of solar activity. This influence is also shown by the existence of a weakened luminosity inside the corona in a narrow equatorial belt of width about 7°.

THE WILLOW TREE (*Salix* sp.)

By ALEXANDER L. HOWARD

"There is a willow grows aslant a brook
That shows his hoar leaves in the glassy stream".
SHAKESPEARE.

AMONG the many trees which adorn the countryside of Britain, this tree is one of the best known, and especially to those whose lives have been spent from earliest childhood in the country. A great many people have earned their livelihood in one way and another from its products, but those who have interested themselves in conserving or replenishing the stock are far too few, and almost entirely confined their attention to the bat willow, although perhaps with the exception of the ash tree the willow is one of those which will repay the planter within the least number of years. The fisherman, the basket-maker, and the gipsy are very intimate with the particular species which they know about, the first-named because of his continued controversy with the overhanging branches which interfere with his sport, but the latter since it has contributed to their livelihood.

It is unnecessary to describe the leaf or appearance of the tree, as it is so well known. Indeed, the narrow-pointed leaf, unlike most of our broad-leaved trees, is so prominent that its name has been borrowed for the description of other trees, such as the willow oak (*Quercus phyllus*), etc.

Everyone must be quite familiar with what we know as 'the willow pattern' of Chinese and Japanese origin in pictures and china ware; and also with the blue willow pattern of our own china, and more lately when a great designer made use of this attractive medium by the introduction of it into wall-papers. The Morris willow pattern also has become a well-known and admired addition to our domestic art. Whether the original Chinese, etc., pictured the willow as we know it is in some doubt. It has been suggested that perhaps the tree *Koelreuteria*, also a native of China, inspired the original willow pattern. While it would be interesting to decide the point, the beauty and likeness of both these trees is the principal subject of our interest.

The willow tree is regarded by different people with strangely opposite views: some think it a dull tree and take little interest in it, while others are delighted with the graceful form of the foliage and leaves, and its association with the banks of streams and rivers. The silvery blue presented by the leaves of many trees waving in the breeze adds greatly to the beauty of the landscape in those parts of the country frequented by the heron, the snipe and the duck. By the banks of streams, and in osier beds and the like, the willow figures more as a bush than a tree, and here it serves the purpose which it shares with the alder, of consolidating the banks, preventing erosion.

If care, and the study and practice of scientific measures are adopted, the tree will yield a very satisfactory financial result to the grower; but to succeed, diligence and study are required.

General knowledge is limited to two or three kinds, but Elwes mentions more than a hundred and sixty species, and Loudon more than two hundred. Many of these have been introduced from other countries.

The male and female trees of the original indigenous kinds have become the progenators of numbers of hybrids. I shall limit my remarks to seven kinds which are the better known and most prominent, namely: white willow, cricket bat willow, goat willow, bay willow, crack willow, golden willow, and the weeping willow.

White Willow (*Salix alba*)

In single form this tree will attain a height of more than 100 ft., with a girth of 25 ft. 6 in., but generally speaking large-sized trees are not common. The white willow (*S. alba*) with its close relative *S. alba coerulea* are by far the most important, as these two yield the best wood for the making of cricket bats. *Salix alba* may easily be recognized by 'witches brooms'—a formation caused by a mite (*Eriophes salicis*).

Elwes mentions:

"a tree at Bury St. Edmunds, figured by Strutt . . . as the Abbot's willow, is one of the largest white willow of which we have record. It was measured . . . in 1822, when it was 72 ft. high by 18½ ft. in girth, and was estimated to contain 440 ft. of timber".

Inquiries at Bury St. Edmunds to-day (1944) fail to reveal any information about this tree, and for many years it has been inquired for with no better results.

Cricket Bat Willow (*S. alba coerulea*)

This is a tree the origin of which would seem to be obscure, but it has been known in Great Britain since the beginning of the nineteenth century. It will attain a height of perhaps 100 ft. Of this Elwes says:

"Many trees of remarkable size, but comparatively young, have been felled for conversion into cricket bats. One of the largest was a tree at Boreham, Essex, which was planted in 1835, and felled in 1888, when it was 101 ft. high and 5 ft. 9 ins. in diameter. It weighed upwards of 11 tons, and was perfectly sound. It was felled by B. Warsop & Sons, who made from it no less than 1,179 bats".

Elwes was not often mistaken; but it would seem doubtful if any tree could make such growth in fifty-three years, as would equal more than one inch for every year.

He also says:

"Mr. Stuart Surridge purchased for £25, in 1910, a tree near St. Albans, which was about 80 ft. high and measured 5 ft. in diameter at 3 ft. from the ground. Judging from a photograph, it had a clean stem of about 16 ft. He states that the largest tree known to him grew at Robertsbridge, in Sussex, and measured 21 ft. in girth. This was felled in 1902, and produced over 1,000 cricket bats".

Mr. D. N. Bridger informs me that one of his workmen well remembers this tree being cut down and cleft. Mr. Bridger says that all the trees of *S. alba coerulea* are female, and he also says that many trees of *S. alba* have provided as good timber for cricket bats as *S. coerulea*. Elwes says, however, that the wood of *S. alba* is used for making cricket bats of an inferior kind. I also recall an occasion when an indignant purchaser of what he thought would prove to be cricket bat quality was informed that he had purchased the product of *S. alba* when he should have purchased *S. alba coerulea*. After exhaustive study I think the best results could be expected from the last-named, but it is quite possible that in the last thirty to forty years the character of the trees which have reached maturity may have altered.

The cricket bat manufacturer has become expert in his selection of the trees, but the same knowledge is not general among those who would find it to their advantage to become planters. Mr. Bridger emphasizes the importance of an abundant provision for the future of the cricket-bat making industry, his estimate of the annual output being in the neighbourhood of 250,000 bats per annum, men's size alone, while others name an even higher figure.

In 1915, it was discovered that in tropical countries, where the white ant has become a major pest, artificial limbs became a prey to these insects, and Prof. Groom and I were asked to find a wood which was immune to this attack. Exhaustive inquiry failed to discover anything except the willow suitable for the purpose, and in reply to an inquiry this year (1944) at the hospital at Roehampton, Mr. A. W. Shaw confirms the opinion, and says :

"willow is still the wood used in relation to wooden artificial legs, and no other wood has yet been found suitable. For metal artificial legs the foot is of willow".

The wood is pinkish-white, with a tough but softish grain, and besides the before-mentioned uses, provides the best-known timber for trug baskets, fruit baskets, linings for carts, barrows, and brakes for railway and other wagons, being especially good for the last-named, as it does not fire so readily as other woods from the friction of the wheels.

Goat Willow (*Salix caprea*)

This tree is naturally regenerated by seed, but can be propagated by cuttings and by sets. Its principal value is for prevention of erosion, and it is used for making fences and sheep hurdles, for trug baskets and for handles of rakes.

Bay Willow (*Salix pentandra*)

This is more noticeable for its attractive foliage than for its uses ; it is distinguishable by its broad shining leaves.

Crack Willow (*Salix fragilis*)

This is sometimes called 'open-bark' willow. The wood is of little importance, but the Rev. C. A. Johns tells us that "the roots afford a purple-red dye, and are still used in Sweden and in France to colour Easter Eggs".

Golden Willow (*Salix vitellina*)

This tree is familiar to most people, and can be found in many gardens, parks and pleasure grounds. Fortunately, the nurseryman has found it sufficiently attractive to warrant production in large numbers, so that of late years householders have been able to gratify their inclination to make their gardens ornamental, and in this manner the tree has been justly introduced on a scientific scale. Elwes says :

"we have seen no trees of great size, the finest being probably two trees at Glasnevin, which are about 65 ft. in height and 8 ft. in girth".

The tree should be encouraged for its unusual grace and beauty.

Weeping Willow (*S. babylonica*)

There must be very few who have not enjoyed the beauty of the weeping willow, a tree much more commonly seen half a century ago than to-day, and one which, if the plans for re-afforestation for the future are limited alone to the economic aspect, may insensibly vanish from our landscape.

It would appear that the first tree introduced to Great Britain was planted at Twickenham, and became famous, for Johns tells us :

"the first tree was planted at Twickenham, either by Mr. Vernon, a merchant of Aleppo, or by Pope. This was a favourite tree with the poet, and after his death became the object of so much curiosity that the possessor of his villa cut it down, to avoid being annoyed by persons who came to see it".

He also says :

"Loudon informs us that this tree was introduced into St. Helena from Britain by General Beaton, 1810. It was planted among other trees on the side of a valley near a spring ; and having attracted the notice of Napoleon, he had a seat placed under it, and used to go and sit there very frequently, and have water brought to him from the adjoining fountain. About the time of Napoleon's death, in 1821, a storm shattered the willow in pieces, and after the interment of the Emperor, Madame Bertrand planted several cuttings from it on the outside of the railing which surrounded the grave. As none of these flourished, they were renewed in 1828 ; and from one of them, which outstripped the rest, were brought most of the cuttings which have been reared in various parts of the country. The oldest now in existence in Europe derived from this stock stands in the garden of the Roebuck Tavern on Richmond Hill".

And again :

"So popular has the weeping willow become as an ornamental tree, that it is said to be commoner in almost every country than in its native habitat, the banks of the Euphrates".

We are accustomed to the introduction of fashions in many directions, but it is curious that this should apply to the planting of particular trees. Sometimes the fashion has been to plant oak, another time acacia, and further instances might be quoted. Following the reign of terror and the Napoleonic era, certainly a wave of fashion spread over Europe, including Great Britain, for the planting of weeping willows, so that almost all the gardens and parks which date from this period included it among their ornamental trees.

Elwes gives some interesting information relating to this tree, and says :

"this was the name given by Linnaeus to the common weeping willow cultivated in Europe, which he erroneously supposed to have been identical with the trees growing by the rivers of Babylon, which are mentioned in Psalm cxxxvii, 1, 2.

"By the rivers of Babylon,
There we sat down, yea, we wept,
When we remembered Zion.

Upon the willows in the midst thereof
We hanged up our harps.

"The latter are, without doubt, a species of Poplar (*Populus euphratica*). . . . The best that I have seen is perhaps a tree on the Promenade, Cheltenham, which was planted about 1860, and is still thriving, although its limbs have been supported by iron rods for some years. It measured in 1911 about 75 ft. by 9 ft. and on 24th November, 1911, after a severe frost, it still retained most of its leaves.

"There are several picturesque trees, but of no great height, growing on the banks of the Cam, behind the Colleges of Cambridge. These are exceeded in size by one

in the Fellows' Garden of King's College, which was about 45 ft. high and 10 ft. in girth in 1912, with the trunk decayed and mended with cement".

The weeping willow is surprisingly distributed. In addition to the numberless places in Asia and Europe where it thrives, Elwes informs us that "it attains much greater size and beauty in warm countries than it does in England" and that he had "seen none finer than in Chile".

THERMODYNAMICS OF SORPTION ISOTHERMS: THE HYSTERESIS LOOP IN CAPILLARY CONDENSATION

By DR. D. H. BANGHAM

British Coal Utilisation Research Association

IN any two-component system if m_A, m_B are the masses of the components A and B and g_A, g_B their respective Gibbs free energies *per gram*, then so long as there is equilibrium,

$$SdT = VdP + m_A dg_A + m_B dg_B = 0, \quad . \quad . \quad (1)$$

where S is the entropy and V the volume of the 'complex' of A and B whatever form it may take. If the 'complex' contains only condensed phases and the pressure is kept substantially constant (say, below 1 atmosphere) we can disregard the second term, and write for isothermal equilibrium:

$$m_A dg_A + m_B dg_B = 0 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

An advantage of (2) over the more usual form of equation in terms of molecular quantities is that it is immediately applicable in cases where the molecular weight of one of the components (say, A) is large or unknown; it is particularly helpful, therefore, in examining the sorption relations of gels, the interaction between solid polymer and 'plasticizer', and such cases. Supposing B to be a volatile liquid of molecular weight M, and that the 'complex' is at equilibrium with the vapour of B at a pressure p, f being the corresponding fugacity, we have, on substituting $RT/M\ d\log_e f$ for dg_B,

$$m_A dg_A + \frac{m_B RT}{M} d\log_e f = 0$$

$$g_A^0 - g_A = -\frac{RT}{M}\int_0^p \frac{m_B}{m_A} d\log_e f \quad . \quad . \quad . \quad (3)$$

where g_A^0 is the (Gibbs) free energy of *pure* A. The right-hand member of this equation can be evaluated experimentally.

The only conditions attached to the validity of (3) are that the structure and composition of A should be statistically uniform (so that m_B/m_A has a definite meaning) and that the same equilibrium should be attained by approach from either side. Primarily, we do not need to ask ourselves whether or not a true chemical compound is formed, whether the 'complex' is to be regarded as a one- or as a two-phase system, whether B is or is not molecularly dispersed (to give a true solution), or whether, supposing surface interactions are involved, these are taking place at plane or at curved surfaces. In fact, however, a large number of cases have come to light where the relation between ($g_A^0 = g_A$) and $m_B/m_B M$ corresponds to well-recognized two-dimensional equations of state or to a sequence thereof[1,2,3]. Where this occurs it appears justifiable, *prima facie*, to infer that: (1) B is adsorbed as a film at the surface of A; (2) A is characterized by possession of a definite surface area (Σ) per unit weight; and (3) that $(g_A^0 - g_A)$ stands for a decrement of *surface* energy and can be equated to $\Sigma(\gamma_0 - \gamma)$, where γ_0 is the surface energy of A *in vacuo* and γ its value in contact with the vapour of B at p. It is convenient to assign the symbol Π to $(\gamma_0 - \gamma)$ and regard Π as a two-dimensional 'film pressure'; thus

$$\Pi\Sigma = (\gamma_0 - \gamma)\Sigma = \frac{RT}{M}\int_0^p \frac{m_B}{m_A} d\log f \quad . \quad . \quad . \quad . \quad (4)$$

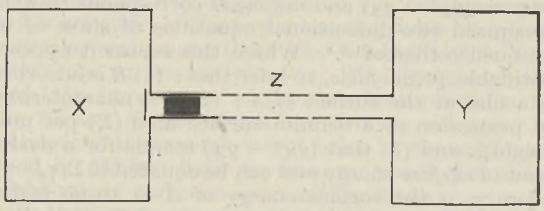
Now the sorption relations of many gels are such as to suggest the *filling-up* of capillary spaces, the quantities of different adsorbates at saturation representing roughly equal volumes of the different liquids[4]. According to the well-known capillary condensation hypothesis, the quantities sorbed at pressures below saturation are determined by the distribution of pore radii (the pores usually being considered cylindrical), the surface tensions γ_B of the liquids, and the equilibrium angles of contact θ, the relation between these parameters being the Kelvin equation:

$$p/p_0 = \exp.(-2V_m\gamma_B \cos\theta/rRT), \quad . \quad . \quad . \quad (5)$$

where p_0 is the saturation pressure of the liquid and V its molecular volume. A necessary condition for capillary condensation is that $\theta < 90°$. Several authors have attempted to derive 'structure curves' for pore-size distributions from their sorption data on the basis of equation (5), θ generally being taken as zero. A weak point about this procedure is that, apart from its ability to become wetted by the component B, the only adjunct of A that is allowed to have a determining influence is the single property of *curvature*: p should thus be uniquely determined by r.

By the use of equation (4), on the other hand, Gregg[2] has brought to light instances hitherto universally accepted as examples of capillary condensation, but in which the relations between Π and the surface concentration reproduce in detail those of certain insoluble films on water. As the concentration rises, first a 'vapour', then an 'intermediate' and finally a 'liquid expanded' (or 'liquid condensed') film is formed. Thus, at the hands of different workers, the same sorption data may receive mutually incompatible interpretations in terms of film-forming characteristics on one hand and of pore structure on the other. The issue is complicated by the appearance of a hysteresis loop in some of the experimental adsorption isotherms referred to[5]; for over the range of the hysteresis the basic requirement of equations (1)-(4), namely, that the equilibria should be independent of the direction of approach, is no longer satisfied. For this reason we shall resort to the more cumbrous method of argument based on work cycles in the discussion which follows of the tenets of the capillary condensation hypothesis.

We suppose two large enclosures X and Y containing the vapour B at pressures p and $(p = dp)$ respectively, the corresponding fugacities being f and $(f = df)$. Connecting X and Y is a long length of capillary tubing Z of suitable material and of such (uniform) diameter that according to (5) capillary



condensation will just take place at p. Z has a shutter at the end nearer X. Fitting into Z also is a light piston of such diameter that as it moves it leaves the adsorbed film undisturbed, and merely prevents the liquid from leaking past. The following cycle is carried out isothermally: (1) Z is first exposed to the vapour in Y, so that the adsorption equilibrium is established at $(p - dp)$, the shutter at X being closed. (2) The piston being in position at the end of Z nearer X, the shutter between X and Z is opened. Capillary condensation thus takes place, the piston being driven back. If Σ is the internal area of the tube (more strictly that of the adsorbed film) the maximum work obtainable from the system by the pressure on the piston is $\Sigma\gamma_B \cos\theta$. (3) Z is shut off from X and (after removing the piston) exposed to Y, permitting the vaporization of the capillary-condensed molecules. According to the capillarity hypothesis based on equation (5), this process is *spontaneous*, so that *no work need be done* on the system. (4) The appropriate number of molecules of B is compressed from $(p - dp)$ to p and transferred back to Y.

The cycle as outlined contravenes the second law of thermodynamics, as indeed must any cycle in which the isothermal transfer of molecules from X to Y is made to yield a finite amount of work. The infringement lies in the assumption (implicit in calculations based on the Kelvin equation (5)) that the capillary-condensed liquid will evaporate spontaneously at $(p - dp)$.

The essential requirement for compliance with the second law is that, if the tube fills at p, the fluid filling the tube should be able, without evaporation, to reduce its free energy by $RT\ d\log f$. This necessarily implies that $\gamma\cos\theta$ is a function of p; for V_m cannot vary unless $\gamma\cos\theta$ varies. It follows that if we attempt to empty the tube by isothermal evaporation alone (as opposed to pushing the liquid out simultaneously with a piston) we must reduce the pressure in Y by a *finite* amount to $(p = \Delta p)$. In other words, there will be a *hysteresis* loop in the isotherm.

To sum up, it has been established that: (1) where capillary condensation occurs, $\gamma\cos\theta$ is variable and not constant; and (2) capillary condensation cannot occur without hysteresis, though the converse statement does not necessarily hold. It further suggests itself that a quantitative relation must exist between the area within the loop and the work $\Sigma\gamma \cos\theta$. This relation and the more general form of equation (4) required to cope with cases of hysteresis and capillary condensation will be discussed in a later communication.

[1] Bangham and Fakhoury, *J. Chem. Soc.*, 1324 (1931). Bangham, Fakhoury and Mohamed, *Proc. Roy. Soc.*, A, **147**, 152 (1934).
[2] Gregg, *J. Chem. Soc.*, 696 (1942).
[3] Harkins and Jura, *J. Amer. Chem. Soc.*, **66**, 1356 (1944).
[4] Anderson, J. S., *Z. phys. Chem.*, **88**, 191 (1914).
[5] Gregg (*loc. cit.*) explains such cases in terms of a delayed phase-change.

THE FAILURE OF PATULIN

IN an earlier issue (*Nature*, 152, 619; 1943), some account of patulin was given, and the results of a clinical trial of it for the treatment of the common cold, conducted by Surgeon Commander W. A. Hopkins, R.N., with the aid of Naval personnel, as described in *The Lancet* (ii, 625, Nov. 20, 1943), were outlined. In that trial 57 per cent of the patients recovered completely in 48 hours, while only 9·4 per cent of the controls recovered in this time. Commander Hopkins was, however, wisely cautious about the interpretation of these results and pointed out that the etiology of the common cold is not yet fully understood. Prof. H. Raistrick stated at the time that patulin would not be issued for general use until the results of large-scale trials had been obtained. *The Lancet* now publishes the results of two such trials, which fully justify the earlier caution about the effect of patulin on the common cold.

J. M. Stansfield, A. E. Francis and C. H. Stuart-Harris (*The Lancet*, 370, Sept. 16, 1944) report on their laboratory experiments with patulin and on two clinical trials with it for the treatment of colds in 100 soldiers of an army primary training wing. For the second of these trials the method of administration used was the same as that used by Hopkins. Briefly, their conclusions are that patulin is bacteriostatic against a wide range of both Gram-positive and Gram-negative organisms, although its bacteriostatic action is materially reduced by incubation in broth or by the addition of horse serum. The margin between concentrations which kill mice and those which are bacteriostatic *in vitro* is small. Two experiments with mice indicated that it failed to cure infections with *Bact. typhosum* or with influenza virus A. (Hopkins (*loc. cit.*) found that patulin did not appear to have influenced the course of influenza in five human patients.) Controlled clinical trials for the treatment of the human common cold showed no advantage from the use of patulin as compared with the use of control buffer solutions without patulin, and that patulin did not appear to be useful for the treatment of human conjunctivitis.

Another trial (*The Lancet*, 373, Sept. 16, 1944) was more extensive. It was conducted by the Patulin Trials Committee of the Medical Research Council, the chairman of which was Prof. H. P. Himsworth; the committee included Prof. Raistrick and Dr. C. H. Andrewes. For this trial 668 patients were treated and there were 680 controls, the subjects being personnel of the Post Office, the Ministry of Supply, Haileybury and Rugby Schools and various engineering and electrical firms. The conclusion of this Committee is that "In a large clinical trial of patulin in widely distributed areas of Great Britain and lasting from the beginning of December 1943 to the middle of April 1944 no evidence was found that patulin is effective in the treatment of the common cold".

Thus ends a manful and commendable attempt to control that bugbear of our lives, the cold in the head, the effects of which are so great that it is not surprising that uninstructed people rushed into print to claim for patulin more than it could perform. It should not be forgotten that those who produced it never exceeded the scientific scepticism which awaits proof before it commends, and even then avoids exaggerated claims. Meanwhile, much has been learnt from these trials. All those who have conducted them emphasize the difficulty of assessing the effect

of treatment of a condition like the common cold, in which there are no real objective signs by which the patient's subjective feelings can be checked. All the investigators made provisions for this and endeavoured to eliminate the subjective element. The experience thus gained will be of great value when further remedies are presented for test.

Discussing these trials, *The Lancet* suggests that the good results obtained by Hopkins may have been due to the effects of patulin on the particular organisms responsible for the colds which he treated, or that, in view of patulin's failure in the later Army and Medical Research Council trials, its success in the Navy trials was one of those rare events which do sometimes happen.

Whether patulin may yet have other uses, further work will doubtless show. G. LAPAGE.

THE HEATHER BEETLE

THE British Field Sports Society has recently issued a booklet entitled "Report on the Biology and Control of the Heather Beetle". In view of the damage caused by this insect in the past, this report and its findings will be of very definite interest to those who are concerned with the management and preservation of moorlands. These include not only the moor owner and his shooting tenants, but also the sheep grazier and, to a lesser degree, the bee-keeper. The activities of this beetle deplete the numbers of grouse, impoverish the grazing and decrease the honey-flow. The report under notice is based upon investigations carried out between 1937 and 1940 under the direction and supervision of Dr. A. E. Cameron, of the Department of Agriculture and Forest Zoology, University of Edinburgh.

The beetle in question is *Lochmæa suturalis*, a member of the family Chrysomelidæ. Severe damage to the heather is most prevalent in Scotland; it is also troublesome in Germany and Holland. In July and August, the leaves and stems of heather attacked by the larvæ of the beetle become fox-red where they have been chewed and partially stripped of bark, and especially the ends of young shoots. The most severe damage is done to old heather of twenty years or more. Young heather is also attacked but permanent damage rarely happens. Attacks are most prevalent and the beetles most abundant over flat wet moorlands, but well-drained slopes are not often affected. The eggs of the beetle require humid conditions for their development and are chiefly laid on *Sphagnum* moss. Rainfall in spring and early summer during its breeding season is believed to determine its rate of multiplication. Seasons of very low precipitation seem, on the other hand, to check its activities. There is only one generation in the year. The beetles overwinter in the ground or among moss, etc., and begin to lay eggs in mid-April. Incubation lasts three to four weeks in Nature, and hatching of the larvæ begins early in June when they climb the plants in order to feed on the young shoots and leaves. The adult beetles appear first in the latter half of August but do not become abundant until late in September. Ling heather, *Calluna vulgaris*, is the chief and perhaps the only food plant of this insect. The only natural enemy of any importance was found to be the ladybird *Coccinella hieroglyphida* which, however, did not appear to exert any significant degree of control of the beetle.

The problem of dealing with the insect is a question of moorland economics. Treatment of the heather with derris and pyrethrum dusts serves to check the larvæ. General adoption of this method over wide areas of moorland is out of the question owing to the costs of material and labour. Muir-burning in Scotland is not permissible at the time it would be most efficacious. There is no practice of moorland management that should be more encouraged than a ten-year rotational system of burning, since it induces young growth which recovers more quickly from beetle attack than does old heather. Dusting and burning, however, are of secondary importance to drainage. The elimination of excessive moisture by a proper system of surface drains is the only known means by which permanent control of the pest may be achieved.

This report, it may be added, can only be obtained direct from the British Field Sports Society, Petworth, Sussex, price 1*s.* post paid. It is well printed and, with thirteen full-page half-tone plates, is remarkably cheap.

FORTHCOMING EVENTS

Monday, January 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 2.30 p.m.—Mrs. Harold Ingrams: "Young People of the Hadhramaut" (with films) (Christmas Lecture for Young People).

Tuesday, January 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 3: "How we get our Time" (Christmas Lectures).

INSTITUTION OF CIVIL ENGINEERS (WORKS CONSTRUCTION DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Lieut.-Colonel C. M. Norrie: "The Organization of Civil Engineering Work".

Wednesday, January 3

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Lieut.-Commander Rupert T. Gould: "The Art of Measuring Time" (Dr. Mann Juvenile Lecture).

Thursday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 4: "Finding the Longitude" (Christmas Lectures).

Friday, January 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 2.30 p.m.—Surgeon-Commander Bingham: "Sledging with Dog Teams in the Antarctic" (with films) (Christmas Lecture for Young People).

Saturday, January 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 5: "Clocks and Time Keeping" (Christmas Lectures).

APPOINTMENTS VACANT

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

IRRIGATION ENGINEER, Soils Mechanics Laboratory, Irrigation Department, Ceylon—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1258.A) (January 1).

INSPECTOR OF AGRICULTURE, Sudan Government—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3285.XA) (January 2).

EXECUTIVE ENGINEER by the Government of Trinidad—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1266.A) (January 3).

ANALYTICAL CHEMIST for manufacturers engaged on high priority work, S.E. London area—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3292.XA) (January 4).

EXPERIENCED ENGINEERS, QUANTITY SURVEYORS and ARCHITECTS at the Building Research Station, Garston, Watford, for work in connexion with the preparation of codes of practice—The Ministry of

Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1084.A) (January 4).

ELECTRICAL ENGINEER (temporary staff) by the Nigerian Government Public Works Department—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D.926.A.) (January 9).

ASSISTANT LECTURESHIP IN MECHANICAL ENGINEERING, and an ASSISTANT LECTURESHIP IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (January 12).

ENGINEER and MANAGER OF THE HARROGATE WATER UNDERTAKING—The Town Clerk, Municipal Offices, Harrogate (endorsed 'Water Engineer') (January 15).

ASSISTANT CYTOLOGIST to take part in routine and research investigations on Cancer—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (February 1).

SENIOR CENTRIFUGAL PUMP DESIGNER for a firm in the South Midlands—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2396.XA) (February 4).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Eighth Report from the Select Committee on National Expenditure, Session 1943–44. The Chemical Controls. Pp. 12. (London: H.M. Stationery Office.) 2*d*. net. [1611

Ministry of Education. Memorandum on the Draft Building Regulations: Being the Draft dated November 3, 1944, of the Regulations prescribing Standards for School Premises, 1944, proposed to be made under Section 10 of the Education Act, 1944. Pp. 24. (London: H.M. Stationery Office.) 6*d*. net. [1611

Evolution—Fact or Fable: or, Do We Really Come from an Ape-like Stock? By R. L. Wheeler. Pp. 42. (London: The Author, 111 Capel Road, E.7.) [1711

Recruitment to Established Posts in the Civil Service during the Reconstruction Period: Statement of Government Policy and Civil Service National Whitley Council Report. (Cmd. 6567.) Pp. 24. (London: H.M. Stationery Office.) 4*d*. net. [2311

British Library of Political and Economic Science. Annual Report, 1943–44. Pp. 20. (London: London School of Economics and Political Science.) [2311

Ministry of Health and Department of Health for Scotland. Interim Report of the Inter-Departmental Committee on Dentistry. (Cmd. 6565.) Pp. 26. (London: H.M. Stationery Office.) 6*d*. net. [2311

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 2, September 1943. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Keuneman. Pp. iv+87–158. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [2311

Association of University Professors and Lecturers of the Allied Countries in Great Britain. Second Education Conference, April 15, 1944: Some Comparisons between Universities. Pp. xvi+64. (Oxford: Basil Blackwell.) 2*s*. 6*d*. net. [2311

University of London: University College. Calendar, Session 1944–1945. Pp. xxxv+132. (London: Taylor and Francis, Ltd.) [2311

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 25, 1942. Pp. iii+286. (Sheffield: The University.) 21*s*. [2911

Amgueddfa Genedlaethol Cymru: National Museum of Wales: Thirty-seventh Annual Report, 1943–44. Pp. 34. (Cardiff: National Museum of Wales.) [412

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 62, Part 1, No. 5: On the Interpretation of Electrocephalic Potentials. By Dr. C. A. Beevers. Pp. 43–50. 1*s*. 3*d*. Vol. 62, Part 1, No. 6: The Tumour Virus disseminated from Rous No. 1 Tumours. By J. G. Carr. Pp. 51–53. 6*d*. Vol. 62, Part 1, No. 7: Lack of Transmission of Avian Tumour Virus from Carrier Hens to their Offspring via the Egg. By J. G. Carr. Pp. 54–58. 9*d*. Vol. 62, Part 1, No. 8: Action of Sex Hormones on the Adrenal Cortex of the Golden Hamster. By Dr. O. Peczenik. Pp. 59–65. 1*s*. 6*d*. Vol. 62, Part 1, No. 9: The Validity of the Bunsen-Roscoe Law in the Production of Mutations by Radiations of Extremely Low Intensity. By S. P. Ray-Chaudhuri. Pp. 66–72. 1*s*. 3*d*. (Edinburgh and London: Oliver and Boyd.) [412

The New Town Hall: or Our Borough. An unconventional History of a famous Metropolitan Borough. By W. Margrie. Pp. 48. (London: The Author, 65 Trafalgar Avenue, S.E.15.) 1*s*. [412

Medical Research Council. War Memorandum No. 1: The Treatment of 'Wound Shock'. (Instructions produced by the Medical Research Committees on Traumatic Shock and on Blood Transfusion, in co-operation with the Army Medical Service.) Second edition. Pp. 32. (London: H.M. Stationery Office.) 6*d*. net. [612

National Parks: their Creation and Administration. Pp. 8. (London: Standing Committee on National Parks.) 3*d*. [712

Part-time Scientific and Technical Education. Pp. 12. (London: Association of Scientific Workers.) 3*d*. [712

Imperial Agricultural Bureaux. Cultivation and Breeding of Russian Rubber-bearing Plants. Pp. ii+53+4. (Aberystwyth: Imperial Agricultural Bureau.) 2*s*. 6*d*. [812

London Shellac Research Bureau. Technical Paper No. 25: Reconditioning of Old and Blitzed Lacs. By N. R. Kamath and Dr. B. S. Gidvani. Pp. 20. (London: London Shellac Research Bureau.) [812

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 10: The Genus Primula, Section Petiolares. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 271–314. 11*s*. Vol. 61, Part 2, No. 11: A Previllous Human Ovum, Aged Nine to Ten Days (the Davies-Harding Ovum). By Dr. Francis Davies. Pp. 315–326+2 plates. 4*s*. (Edinburgh and London: Oliver and Boyd.) [1112

British Empire Cancer Campaign. Twenty-first Annual Report, 1944. Edited by J. P. Lockhart-Mummery. Pp. 96. (London: British Empire Cancer Campaign.) [1212

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Twenty-ninth Annual Report, 1943. Pp. 77. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd.) [1412

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 792, Vol. 238: The General Motion of the Aeroplane. By S. Brodetsky. Pp. 305–355. 8*s*. No. 809, Vol. 239: On Invariant Theory under Restricted Groups. By D. E. Littlewood. Pp. 387–417. 5*s*. (London: Cambridge University Press.) [1412

Medical Research Council. War Memorandum No. 13: Arterial Injuries: Early Diagnosis and Treatment. By the Vascular Injuries Sub-Committee of the M.R.C. War Wounds Committee. Pp. iv+24. (London: H.M. Stationery Office.) 4*d*. net. [1512

National Institute of Agricultural Engineering. Publication No. 504/44: Annual Report for the Year ending August 31st, 1944. Pp. 16. (Askham Brian, York: National Institute of Agricultural Engineering.) 3*d*. [1812

Science and the Real Freedoms. Pp. 16. (London: Association of Scientific Workers.) 3*d*. [1812

Ministry of Agriculture and Fisheries. Bulletin No. 113: Rhubarb. By Dr. H. V. Taylor and E. E. Skillman. Pp. 24+6 plates. (London: H.M. Stationery Office.) 9*d*. net. [1912

Ministry of Education. Community Centres. Pp. 40. (London: H.M. Stationery Office.) 9*d*. net. [1912

The Natural Resources of Ireland. A series of Discourses delivered before the Royal Dublin Society on April 12th, 13th and 14th, 1944, in commemoration of the Centenary of the publication by the Society of Sir Robert Kane's "The Industrial Resources of Ireland". Pp. 90. (Dublin: Royal Dublin Society.) 2*s*. 6*d*. [1912

Other Countries

Smithsonian Miscellaneous Collections. Vol. 104, No. 8: A New Shipworm from the Panama Canal. By Paul Bartsch. (Publication 3774.) Pp. ii+4+1 plate. (Washington, D.C.: Smithsonian Institution.) [1411

Proceedings of the United States National Museum. Vol. 94, No. 3177: Parasitic Copepods in the United States National Museum. By Charles Branch Wilson. Pp. 529–582+plates 20–34. Vol. 95, No. 3179: A Collection of Birds from Northern Guanacaste, Costa Rica. By Alexander Wetmore. Pp. 25–80+plates 3–6. (Washington, D.C.: Government Printing Office.) [1411

Proceedings of the United States National Museum. Vol. 95, No. 3181: The Fishes of the Family Characinidae from Venezuela, with Descriptions of Seventeen New Forms. By Leonard P. Schultz. Pp. 235–368. (Washington, D.C.: Government Printing Office.) [1711

Indian Lac Research Institute. Bulletin No. 56: The Effect of Storage on Lac. By M. Rangaswami and S. C. De. Pp. 12. 11 annas. Bulletin No. 57: Lac-melanine and Lac-melanine-formaldehyde Resins. By Y. Sankaranarayanan and H. K. Sen. Pp. 6. 3 annas. (Namkum, Ranchi: Indian Lac Research Institute.) [2311

Proceedings of the United States National Museum. Vol. 95, No. 3182: New Genera and Species of Oriental and Australian Plant Bugs in the United States National Museum. By Tsai-Yu Hsiao. Pp. 369–396. (Washington, D.C.: Government Printing Office.) [2311

The South African Frog (*Xenopus lævis*) in Pregnancy Diagnosis. A Research Bulletin by Dr. Abner I. Weisman and Christopher W. Coates. Pp. xiv+134. Supplement: Queries relating to *Xenopus lævis*. Pp. 12. (New York: New York Biologic Research Foundation.) [2311

Yale University School of Medicine. Second Annual Report of the Historical Library, 30 June 1942. Pp. 81. (New Haven, Conn.: Yale University School of Medicine.) [2911

Nyasaland Protectorate. Annual Report of the Forestry Department for the Year ended 31st December 1943. Pp. 12. (Zomba: Government Printer.) 1*s*. [2911

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin 179: Lubrication Between the Piston Rings and Cylinder Wall of a Running Engine. By J. S. Courtney-Pratt and G. K. Tudor. Pp. 24+9 plates. (Melbourne: Government Printer.) [112

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology. No. 15: Items 5674–5787, January to June 1944. By Ernest A. Hodgson. Pp. 251–268. (Ottawa: King's Printer.) 25 cents. [1112

Indian Forest Leaflet No. 67: Some Groundnut Protein Glue Formulae and their Application. By D. Narayanamurti. Pp. ii+5. 4 annas; 5*d*. Indian Forest Leaflet No. 68: Note on Sap Stain and its Prevention. By D. Narayanamurti and J. N. Bande. Pp. ii+12. 6 annas: 7*d*. (Dehra Dun: Forest Research Institute.) [1112

Smithsonian Miscellaneous Collections. Vol. 104, No. 7: The Feeding Apparatus of Biting and Sucking Insects affecting Man and Animals. By R. E. Snodgrass. (Publication 3773.) Pp. ii+113. (Washington, D.C.: Smithsonian Institution.) [1112

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 21, No. 2: Zur Kenntnis der Morphologie, Enzystierung und Taxonomie von Dinophilus. Von Gosta Jägersten. Pp. 90+6 plates. Serien 3, Band 21, No. 3: On the Dermal Bones, Sensory Canals and Pit-lines of the Skull in *Eusthenopteron foordi* Whiteaves, with some Remarks on *E. sävesöderberghi* Jarvik. By Eric Jarvik. Pp. 48. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.) [1212

Sociedad Nacional Agraria: Institute of Cotton Genetics. Bulletin No. 1: The Selection Experiment with Peruvian Tangüis Cotton. By Sydney Cross Harland. Pp. 98. (Lima: Sociedad Nacional Agraria.) [1212

United States Department of Agriculture. Leaflet No. 242: The Spruce Budworm. By R. C. Brown. Pp. ii+4. (Washington, D.C.: Government Printing Office.) [1212

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin 177: A Soil Map of Australia. By Dr. J. A. Prescott. Pp. 15+map. (Melbourne: Government Printer.) [1412

Cooper Union for the Advancement of Science and Art. The Director's Report for the Eighty-fifth Year ending June 30, 1944. Pp. 34. (New York: Cooper Union.) [2012