NATURE

No. 3934 SATURDAY, MARCH 24, 1945 Vol. 155

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Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London

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RATIONALIZATION OF LOCAL GOVERNMENT IN BRITAIN

THE White Paper on Local Government in England and Wales during the Period of Reconstruction* may be pragmatic, but no one could claim that it is bold or imaginative. The assumption that opposition to any drastic innovation such as regional government makes such a step inexpedient during the reconstruction period may be well founded. Furthermore, it is probably true that some improvement in administration might be achieved without abandoning the main features of the county and county borough system, subject to the establishment of appropriate machinery where it is shown to be necessary for combined action by neighbouring areas. But the central, and indeed only, recommendation of the White Paper is the establishment of a Local Government Boundaries Commission. The field of joint authorities is regarded as the most suitable for the development of units of administration where large areas are required, and within its limited field the proposed commission may have considerable advantages. Centralizing in one body, subject to review, all boundary questions, would promote the accumulation of an unrivalled fund of experience and enable the relations of county and county borough, of town and country, to be seen clearly and regulated as a whole. It would also be an advantage to have much of the work done on the spot with a full use of local knowledge, and if the commissioners are skilful in promoting local agreement, it should lead to substantial economies in the cost of boundary alterations.

Part 2 of the White Paper, forming the major section, is devoted to this procedure for adjustment of local government areas. It is frankly recognized that the system of counties and county boroughs cannot be static, but must be capable of adaptation by changing boundaries to meet changing conditions. The proposal to improve the effective machinery for periodic review has been hailed as a solid and promising advance, and the proposed boundary commission appears to meet the conditions put forward in the White Paper; namely, it must command public confidence; it must work smoothly and expeditiously; it should be such as to reduce to the minimum the cost of making the adjustments, and it must ensure that all the proposals affecting a county, whether for adjusting county districts or altering the boundaries between county and county, or county and county borough, are properly correlated and not considered in isolation.

It is not for this positive proposal that the White Paper is to be regarded as weak and disappointingly cautious. It is because the proposal, however sound in itself, only touches the fringe of the problem, and because the analysis of the problem is hesitant and shallow. Nowhere are the fundamental issues laid bare. There is no contribution to that fundamental thinking about the relations of local and central government which is indispensable if we are to evolve

* Cmd. 6579. (London : H.M. Stationery Office, 1945.) 4*d*. net.

machinery adequate to serve the needs of to-day, either at the centre or at the circumference. Finally, as a contribution to the education of public opinion on the issues involved, the White Paper compares unfavourably with those that have been issued on other questions such as employment policy, education, health—with all of which this issue of local government reform is closely concerned. The White Paper, for example, indicates the two main arguments for large units: that many local government authorities are too small to provide the new and extended services required in these and in other fields; and the inadequacy of the present system of local authority finance, based upon property rates, to maintain existing burdens or ensure their independence. But it fails conspicuously to point out that if regional development is inexpedient at the moment, it is on account of local prejudices which have no sound or rational basis, but which it should be the work of time and education to remove. Nor is there any reference to that scientific study of the rating system and its variations in incidence, sponsored by the National Institute of Economic and Social Research, in which Prof. J. R. and Mrs. Hicks have shown the tangle, also disclosed by the Fitzgerald Committee, which must be unravelled before the system can be brought back to life and the independent income of the local authorities substantially increased.

The White Paper, indeed, compares poorly with reports like that of the committee of the National Association of Local Government Officers on the reform of the local government structure, or of the Labour Party on the future of local government, or with Dr. D. M. Goodfellow's "Democracy and Local Government" issued by the Association for Education in Citizenship as No. 12 in the Handbooks for Discussion Groups series. While Dr. Goodfellow only deals incidentally with some of the reasons that are forcing the reconsideration of the relations between local and central government, he indicates clearly enough the weaknesses of the existing system and the questions that should be asked. His pamphlet is admirably designed to stimulate that closer discussion and wider public interest which are indispensable conditions of effective local government reform and of the continued functioning of our democratic institutions. He is concerned with the general question; and while he brings certain aspects of it into clear focus, for example, that of the entry to, and staffing of, the local government service and the reasons for regional proposals, he does not enforce consideration of the problem as an urgent practical issue in the same way that recent Government proposals have done in such fields as those of town and country planning, health and education. Moreover, it is scarcely so suggestive in regard to constructive proposals as Guy Hunter's admirable pamphlet, "The British Way in Local Rule", in the British Way series. Writing before the publication of the Beveridge Report, Mr. Hunter contributes a critical review of our present social services under local government and also anticipates strikingly some of the proposals and implications in this field of the Beveridge Report, and the White Papers on Educational Reconstruction and a National Health Service, for example.

In its scheme for educational reconstruction in Britain, the Government could not avoid some revision of the present system of local educational administration to meet the needs of a new statutory system of public education. Whether or not the proposals of the White Paper on local government are those best calculated to preserve and stimulate local interest in educational matters and at the same time secure both efficiency and a really national system, the proposal that the councils of the counties and the county boroughs only shall be the local education authorities, with powers to combine for educational purposes, is advanced from departmental considerations alone. It has no relation to the grouping that might be most profitable from a general or national point of view, and it is already evident that the proposed system offers no safeguard that the outlook and resources of the local education authorities will ensure uniformity in such a matter as the salaries and status of the teachers.

The existence of such dangers is shown very significantly in independent surveys such as McColvin's report on the public library services, and it is particularly apparent in proposals for a national health service. The Government's White Paper on health starts with the view that there is no case for departing generally from the principle of local responsibility, coupled with enough central direction to obtain a coherent and consistent national service; but it recognizes the need within the administrative structure for some largely professional body which can concern itself with the professional welfare of medical practitioners who take part in the service. None the less, for the future hospital service, it will be essential to obtain larger areas than at present, both for planning and administration. Most of the areas of the existing authorities fail to meet the essential needs of an organized area, namely: a population and financial resources sufficient for an adequate service to be secured on an efficient and economical basis; a type where town and county requirements can be regarded as blended parts of a single problem and catered for accordingly; and definition as to allow of most of the varied hospital and specialist services being organized within its boundaries, leaving for inter-area arrangement only a few specialized services. Outside the hospital and consultant service, the Government holds that existing organizations should be upset as little as possible consistent with achieving a unified health service for all. While still conducted locally with all the advantages of local knowledge and enthusiasm, they should be regarded in future as the related parts of a wider whole, and should fit in with all the other branches of a comprehensive service in their planning and distribution. To secure this, the Government proposes a new joint authority, again presumably responsible for planning from a purely departmental point of view.

The argument for some comprehensive regional plan is set forth even more cogently by Sir Arthur MacNalty in the Nuffield College paper "The Reform of the Public Health Services". Sir Arthur indicates the imperative need for a large administrative area in respect of the maternity and child welfare services, the school medical service, infectious diseases, tuberculosis, venereal diseases, cancer, rheumatic diseases, as well as hospital services and general practitioner services. He proposes to provide the co-ordinated effort between local authorities by a system of regional health councils ; and there is much to be said for such an arrangement, coupled with a Government undertaking to tackle the whole problem of adapting local government machinery to modern needs as soon as circumstances permit.

In health, as in other fields, an adequate programme of reform and reconstruction cannot be executed without creating the appropriate planning machinery at the centre, and forming units large and competent enough to administer and execute the policy over areas large enough for efficiency. The debate on the Town and Country Planning Act in the House of Commons showed how urgent in that field is the need for some adjustment of local government boundaries and resources, or some further measure of Government support.

It must also be recognized that we cannot continue to frame policies for re-building, for town- and country-planning and for the re-organization of education, health and other services, without giving thought to the repercussions of such policies on the structure of local government as a whole. Constructive thought about the principles and whole relation of local administration to the central government is required. It is not sufficient to recognize that certain public services require for their efficient operation administrative areas substantially larger than those of many of the existing local authorities. We must distinguish clearly the contribution which local support and interest can make to the effectiveness of those services ; and we must see that departmental proposals are duly co-ordinated and harmonized with one another and with the needs of the situation as a whole. This the report of the Liberal Party Committee on Local Government conspicuously fails to do. The report is disturbing as well as disappointing, not merely for the absence of any constructive proposals, but still more for the refusal to recognize the necessity of some form of regionalism.

Much of the material proper to an inquiry into local government reform and basic to a decision on policy has already been collected and is available in such reports as those of the Barlow Commission and the Uthwatt and Scott Committees. The facts are largely displayed already. The need now is rather for clear and constructive thinking about the facts, analysis of the evidence, the formulation of principles and policy, and the courage to take the necessary decisions to execute a reasoned policy, whether or not that appears to conflict with what may be regarded as the traditional or vested interests of a particular professional body or local council.

In the attempt to view as a whole the effect upon the general structure of local government of the changes in administrative areas which are inherent in the extension of the scope of particular social services, there must first be faced the main question : Should the present tendencies to mark out large administrative areas for each main service, mainly on purely technical considerations, be permitted to proceed unchecked, or should an attempt be made to find a single comprehensive area of large size which would serve tolerably well for the administration of all or most of the extended services ? But a decision on this point of area is bound up with questions of the constitution and powers of the new regional authorities. For those there appear to be three possible types : an *ad hoc* authority, a joint authority or a compendious primary authority of the type of the existing local authority. Here again, as in the choice between an elective or nominated body, exercising either executive or advisory powers, the decision must be determined by the view we take of the relation between local and central government, and of the way in which that relation can best give expression to the democratic ideal.

The decisions to be taken do indeed depend on first principles, and whatever intermediate forms of government are evolved must conform to those principles laid bare in the Machinery of Government Report nearly three decades ago. That is what presumably is being considered *inter alia* by the Committee of Ministers and the interdepartmental committee of permanent heads of departments, which already in 1943 were understood to be at work on the machinery of government. It is with that in mind that the present White Paper on local government appears to be so disappointing ; so far from laying bare the fundamental issues, it is at pains to cover them up and to temporize.

Given the assurance that the fundamental issues were really being faced and that a serious attempt was being made by the Committee of Ministers and the interdepartmental committee to arrive at a comprehensive solution and not to postpone decision or action, the proposals of the White Paper might be accepted without prejudice so far as they go. Some real effort must, however, be made to deal constructively and nationally rather than departmentally with the outstanding questions, pending the reports of these committees. It must be remembered that it is no bad thing in itself that we should retain the wider freedom of experiment at this juncture that is possible, for example, with local administration, or even with regional administration, in such fields as education and health, as compared with a fully centralized national system, where the consequences of a mistake may be so much more serious. Again, the effectiveness of local government clearly depends on the extent to which it can attract the right type of men and women and secure the wider interest and support of the community. It is part and parcel of that process of re-integration in which civil defence has already shown the way in promising experiments and on which the report of the Commission of the

Church Assembly in "The Church and the Planning of Britain" rightly laid such stress. There above all lies the real solution of the problem of town- and country-planning and the location of industry, of central and local government. Handled wisely, the new extension of the social services, as Sir William Beveridge has been quick to note, gives us opportunities of harnessing to the evolution of a constructive democracy new interests and new forces in an increasing proportion of the population. If that is to be achieved, however, there must be proceeding at the centre, the careful thought, inquiry and analysis necessary to lay down the pattern of organization within which those new interests and forces can function and find effective expression.

Regional government is now inevitable; but it is essential that it should not be a form of provincial bureaucracy, and that it should be viewed and established in the right relation to the local councils and authorities and to the central government, and that there should prevail the spirit of co-operation and goodwill without which no organization can function effectively. It should be remembered that it is the multiplicity of independent local authorities that is the problem: the local council provides and must continue to provide, as Mr. Guy Hunter points out, the local leadership, the inspiration to the citizen to make the plan for Britain a plan for his town and street; to give his service voluntarily and with zest; to see a tangible result of local rule and take his part in it. Only at this level can we hope effectively to harness to our post-war purposes, the enthusiasm and unselfishness which have found expression in civil defence; and on the local authority, too, must lie a large measure of responsibility for the execution of our plans for better education, health and other social services. Again, not only will there come locally, within the limits of the regional plan, the internal planning of the town or district, but also the capacity for experiment and variation which is so much harder for the central government to attempt.

At the regional level will come those plans which must cover a wider area, as emphasized in the debates on the Town and Country Planning Act, particularly with reference to the replanning of destroyed cities and the problem of 'overspill', or of population as in Sir Arthur McNalty's proposals for the health service. Here we should seek to achieve the proper balance between town and county, industry and agriculture, between central and local control. Finally, at the national level, under the eye of Parliament, the broad national plan and lines of policy must be determined, the balance held between regions, and the solution of legal and financial obstacles to planning found. Here alone can we look for the slow adaptation of the whole system to the changing needs of the national community, and ultimately of the world as a whole. This can never be achieved without the continuous devolution of local responsibility for the execution of policy as far as possible. If regionalism is required to provide the resources for tackling some of our urgent post-war problems, it is equally required to relieve the central government of some of its burdens. But that can only be done when there is creative thinking about the first principles of the machinery of government, and the clear enunciation of policy and the taking of decisions which will allow regional and local authorities to proceed in their own sphere with confidence. Hitherto there has been little sign of this at the centre; the Requisitioned Land and War Works Bill is the latest of a series of measures in which national planning is conspicuously absent and in which the Government has eschewed any attempt to see that departmental views and prejudices do not override the general interest even to the thwarting of a national plan.

Courage and vision are the first requirements: courage to grapple with whatever private or vested interests obstruct progress; and vision to see the possibilities of a civil or local government service fitted by training and experience to concern itself with the achievement of immediate concrete purposes. The fear of bureaucracy typified in the Liberal Party report will never allow us to achieve the possibilities inherent in a 'positive' Civil Service wholeheartedly with the people and eager in its struggle for a fuller human life. As John MacMurray has pointed out, under positive government there must be a considerable extension of local rule, and the new conception of the Civil Service and of the functions of central government depend on a lively and effective participation in self government by the general body of citizens. But without courage and the readiness to shed prejudice, we shall never achieve the forms of government which make such participation effective, and at the same time secure the continuous application of scientific knowledge and technique to the betterment of the conditions of human life. To be timid, no less than to be weak, is to be miserable.

BIOCHEMISTRY OF PROTEINS

Advances in Protein Chemistry
Edited by M. L. Anson and John T. Edsall. Vol. 1. Pp. xi + 341. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1944.) 5.50 dollars.

FEW would deny that protein chemistry, in all its aspects, is one of the most important branches of biochemistry. Not only do the proteins constitute a unique group of related compounds containing numerous types and perhaps an infinity of individuals, but also their functions are many and diverse, each type appearing to be adapted to one particular function. They form, for example, hormones, antibodies, genes and, either alone or in association with prosthetic groups, enzymes and respiratory pigments. The proteins clearly offer for investigation a wide field and a multitude of problems, the complete solution of which would probably yield the key to the elucidation of the nature of living matter. On these grounds we welcome this, the first of a series of volumes to be devoted exclusively to advances in protein chemistry. Nevertheless, when we reflect that there already exists an extensive review literature on biochemistry and related subjects, and that much of protein chemistry is inseparable from other branches of biochemistry, we foresee some danger of a considerable duplication of subjects in the various

reviews. That such a danger exists is, indeed, apparent from the present volume, which contains several articles dealing with topics which have recently been reviewed elsewhere.

It was apparently the intention of the editors to publish in each volume articles by various authors dealing with related subjects. In their preface they state that the second volume will be devoted mainly to protein nutrition, and that in the first "special emphasis is laid on proteins as they occur in nature, as components of complex biological systems". The latter statement is, however, scarcely borne out by an examination of the volume. It consists, in fact, of eight articles dealing with widely differing subjects.

As is to be expected in a volume of this kind, the articles are of varying quality and interest. Some give excellent accounts of the subjects with which they deal. As examples may be specially mentioned those dealing with immunology and muscle proteins. For those who are not conversant with the relationship of immunology to proteins, the former provides an excellent introduction. The subject and its terms are first concisely explained in such a manner as to render intelligible the description of the more recent work which forms the main subject of the article. In our opinion this is a model of what a review should be. In the same category, although dealing with a less extensive field, is the article on muscle proteins. The main subject of this is, of course, the protein myosin, and the results described illustrate the inseparability of protein chemistry from biochemistry. In myosin one encounters a protein which apparently serves a dual function, probably acting as an enzyme (adenosinetriphosphatase) and also forming the contractile element of muscle. In so far as they have been analysed, there is a striking similarity in the composition of the myosins from different species; but the author is wise not to draw the conclusion that all myosins, or even some of them, are chemically identical. Similar resemblances in composition occur among other proteins serving identical functions in different species, and, as is pointed out in the article on immunity, the more nearly related the species from which analogous proteins are obtained the greater is the serological relationship, as evidenced by cross-reactions, between them. The diminution in the serological relationship as the species diverge is no doubt due to the proteins becoming more dissimilar in composition. This suggests that the species specificity of proteins is, in general, a reflexion of the specificity in the protein forming the genic material of the gametes.

Another article deals with the structural proteins of cells and tissue and gives a brief résumé of a recent symposium on cytochemistry. But it is chiefly concerned with the results obtained by the examination by physical methods of proteins, or of structures which are believed to consist of protein, or to contain a protein component. There are, for example, a few interesting electron micrographs of structures such as sperm tails which illustrate the possibilities of the electron microscope. But this must at present be regarded as morphology rather than protein chemistry.

The article entitled "The Purification and Properties of Certain Protein Hormones" is sufficiently described by its title if it is mentioned that it is limited mainly to hormones from the pituitary gland, and does not describe their physiological properties. Those who have always regarded adrenaline as a hormone will be surprised to read in the introductory sentence: "All the animal hormones which have been isolated so far are either steroids, proteins, or polypeptides". Surprise may also be felt at the prospect of the possible revival of Abel's so-called unitarian theory of the hormones of the posterior lobe of the pituitary. According to the author, however, a protein apparently possessing the characteristics of a pure substance and exhibiting both oxytocic and pressor activities has been isolated from the posterior lobe.

Short articles discuss soy-bean protein in human nutrition (this might well have been held over for the second volume), the combination of calcium with protein, and lipoproteins.

The longest, and hence the main, article of the volume is entitled "Nucleoproteins". This is comprehensive in scope, dealing with nucleic acid, nucleoproteins, protamines and histones, viruses and cytochemistry. This group of subjects undoubtedly constitutes a very attractive section of biochemistry, but unfortunately the treatment of it is marred by the author's discursive style, by the inordinate length of the sections dealing with the obscure phenomenon of the 'depolymerization' of nucleic acid and related subjects, by the over-emphasis of some details and the omission of others, and by the adoption of a descriptive method for recording deductions from the results of cytological experiments, a method which tends to elevate hypotheses to established facts. Limitations of space preclude a detailed criticism of this review, but a few specific points may be mentioned.

It is emphasized that the deoxyribosenucleic acids in the nuclei of different types of cells may not be identical, but no mention is made of Feulgen's isolation in 1937 of nucleic acid from the nuclei of rye embryos and its chemical identification as thymus nucleic acid, which has an important bearing on this point. On p. 214 it is stated that the ribosenucleic acid from the pancreas yields the same kind and proportion of bases as yeast nucleic acid. This ignores Jorpes' work (1934), which seemed to show that the purine bases were in a different ratio. In the absence of decisive evidence to the contrary, this may mean that the cytoplasmic 'nucleic' acid of all animal cells is of the pancreas and not the yeast type. The acceptance, on slender evidence, of the view that a ribosenucleic acid is present in nuclei obscures the otherwise established fact that the name nucleic acid is correct as applied to deoxyribosenucleic acid but a misnomer for ribosenucleic acid. The classification of globins as histones is incorrect. They differ in their mode of occurrence and composition as well as in their chemical and physiological properties. The old analytical data for thymus histone, reproduced in Table IV, are clearly unreliable and should be replaced by the more limited data provided by Felix (1931), which leave no doubt about the presence of sulphur. On p. 266 it is stated that chromosomes appear "to join and disjoin during separate phases of the mitotic cycle". Kossel's hypothesis of the direct conversion of complex proteins into histones and of histones into protamines, to which so much prominence is given, is improbable and has no experimental basis. Finally, the apparent acceptance of the view that chromosomes undergo extensive changes in composition during mitosis necessarily leads to the corollary that the giant chromosomes of the salivary glands of Diptera, which are claimed by geneticists to give a picture of the genetic constitution of the individual in which they occur, differ chemically from the genic material received from the sperm.

E. STEDMAN.

INDUSTRIAL RADIOGRAPHY

Handbook of Industrial Radiology

By Members of the Industrial Radiology Group of the Institute of Physics. Edited by Dr. J. A. Crowther. Pp. viii+203. (London: Edward Arnold and Co., 1944.) 21*s*. net.

AS Dr. Crowther remarks in the introduction to this book, a volume put together as this one is "cannot have the degree of orderly development" that is to be expected in a book written by a single person. Consequently there is a certain amount of overlapping and a noticeable disjointedness which must inevitably occur when a series of discrete papers make up one volume.

The book is timely. During the War the use of X-rays in the inspection and examination of engineering structures has increased enormously, and X-ray inspection has proved itself to be an essential process in engineering development. It is astonishing that such a wide variety of applications of X-ray inspection should have manifested themselves without the appropriate differentiated development in radiographic apparatus. This, of course, may be understandable under war conditions.

The widespread use of X-rays during the War affords a very clear pointer concerning the importance of this branch of science in post-war activity, and there can be no question that the subject will be developed intensively to take its place as perhaps the most important branch of non-destructive testing.

The Radiology Group of the Institute of Physics is indeed to be congratulated on having culled the experience of so many pioneer workers and gathered together their views in the form of these articles. In this book there is very little matter which is not instructive and the collection cannot fail to be of the utmost value to those young scientific men who are now devoting themselves to this branch of technical activity.

It is really undesirable to draw invidious distinctions between papers of such excellence as those collected together in this volume, but special mention must be made of what is perhaps the outstanding contribution by Dr. L. Mullins—outstanding in the comprehensiveness with which he reviews this subject of industrial radiography. The potentialities of the method, both present and future, are strikingly illustrated by the examples he has collected and described in his article.

Attention should also be directed to another outstandingly useful contribution made by Dr. R. Jackson. In describing his experience in the radiography of heavy steel castings, he provides information of the utmost practical value. Of particular interest is his suggestion of zoning as a method of possible standardization of radiography in relation to the inspection of steel castings. This is a subject of unquestionable importance and one that bristles with difficulties, and Dr. Jackson is to be congratulated on the courage with which he has attacked the problem.

There is also a most valuable chapter on physical principles involved in X-ray practice contributed by Mr. W. J. Wiltshire. It cannot be over-emphasized that the would-be industrial radiographer must know something of the physical principles underlying the 'tool' which he intends to use, and Mr. Wiltshire has been quite remarkably skilful in putting so much valuable and fundamental information into the short chapter available to him. The first is by no means the least important chapter in the book.

The Institute of Physics has performed invaluable service to industry in having formed a special group for the study and encouragement of industrial radiology. In sponsoring this valuable collection of lectures containing so much practical information, it has emphasized that service.

The book under review is described as a "Handbook on Industrial Radiology". Some aspects of industrial radiology are not included, for example, the supremely valuable branch of the subject known as X-ray crystallography. Perhaps "A Handbook on Industrial Radiography" would have been a more generally appropriate title.

V. E. PULLIN.

CONTEMPORARY THOUGHT OF THE RENAISSANCE

Sociology of the Renaissance

(International Library of Sociology and Social Reconstruction.) Translated from the German by W. L. Luetkens. By Alfred von Martin. Pp. x+100. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1944.) 8*s*. 6*d*. net.

IT is something of an achievement to have written a book, even a small one, about the Renaissance without a mention of Walter Pater. But then he was a gentle creature, whereas Dr. von Martin is a little aggressive. Nevertheless, there is much of interest here for the man of science, psychologist and historian, not least because, as the author indicates, the phenomena he describes are of significance far beyond the particular period under review.

Much of the turmoil of those years, the estrangements and the efforts to compromise might well be transported bodily into our experience to-day. In fact, against a background of friction, the essential continuity of the sequence Medievalism-Renaissance-Baroque is exceedingly well brought out; and that alone is worth a great deal. Against it, however, stand a few odd contrasts. An example is the note, referring to the High Renaissance, to the effect that Catholicism was more or less compelled to set the 'here and now' with its stresses and strains, in quasi-opposition to the 'hereafter' with its axiomatic harmony. So far as the *philosophia perennis* goes (and this is supposedly what matters in the present context), such a view is scarcely tenable, since, of all systems, Thomism—whatever its defects—is probably the most comprehensive yet devised, and thus capable of fusing all the various 'knowledges' into something approaching coherence. That it was temporarily decadent is neither here nor there; its potency remained, and in consequence its inherent ability to smooth out the jolts.

Meanwhile, contemporary thought and action were alike obsessed with the boundless possibilities opening up for applied science; art and technics were not seldom practised by one and the same person, notably the peerless Leonardo da Vinci. How bitterly his brother artists complained that he had deserted them for engineering. It was no mere accident that he venerated Archimedes and shunned Aristotle, a point upon which it would be good to have Dr. von Martin expound. But there is no mention of it. Leonardo ends almost immersed in numinous rapture over the problem of natural law, while the merry men of the Renaissance carried on until one of the greatest storms in human history had blown itself out.

F. IAN G. RAWLINS.

RÖNTGEN CENTENARY AND FIFTY YEARS OF X-RAYS

By PROF. J. A. CROWTHER
University of Reading

WILHELM KONRAD RÖNTGEN was born on March 27, 1845. The discovery of X-rays was communicated by him to the Physico-Medical Society of Würtzburg in November 1895; a translation of his paper appeared in *Nature* of January 23, 1896. The present year thus marks the centenary of the birth of the discoverer, and the fiftieth anniversary of the epoch-making discovery with which his name is associated. It has sometimes been suggested that the discovery of X-rays was a happy accident; but there is no doubt, from the nature of his preparations, that Röntgen had, as he himself stated, set out to see whether the electric discharge through a gas at low pressure gave out any kind of 'invisible radiation' capable of detection outside the walls of the glass tube in which the discharge was taking place. The discharge tube (an ordinary Crookes tube of the cylindrical pattern, with a flat cathode at one end, and an anode tucked away in a side tube) had been wrapped in black paper, to cut off all the visible glow from the discharge, and a primitive fluorescent screen, consisting of a few crystals of barium platinocyanide on a piece of cardboard, lay handy on an adjacent bench—barium platinocyanide being a substance commonly used at the time to detect the invisible rays in the solar spectrum. On exciting the tube by means of a small induction coil to see if the light from the discharge was properly obscured by its black paper wrapper, Röntgen found that this was, indeed, the case; but he also noticed that his primitive fluorescent screen was now glowing brightly. The discovery of X-radiation had been made.

It was as simple as that; but it was not 'accidental', unless it be regarded as a happy accident that Röntgen should have thought it worth while to investigate a possibility so remote from current physical thought that, although research into the physics of the Crookes tube was being actively pursued in some of the leading physical laboratories, no other experimenter had thought it worth while to make the very simple tests involved. Some workers had, in fact, been inconvenienced by the fogging of photographic material kept in the same laboratory as their Crookes tubes; but, finding that the trouble could easily be overcome by storing the material elsewhere, they proceeded with the researches on which they were engaged without further thought or hindrance.

Röntgen showed that the new X-radiation affected a photographic plate, and he was able to take a photograph through the thickness of a stout pinewood door separating two of his laboratories. He also noticed that a strip of beading, which had been stuck on the door panel with white lead, cast a distinct shadow on the negative; the thin layer of lead being much more opaque to the radiation than the wood itself. Thus the foundations of the science of radiography were laid.

Both for its practical importance, and for its immense value as a tool for further research, the discovery of X-rays ranks high among the germinal discoveries of physics. The power of the radiation to penetrate considerable thicknesses of materials opaque to ordinary light, and to cast shadows of structures of greater or smaller density concealed within them, caused considerable popular excitement, and had obvious possibilities. The fact that the discovery was first communicated to a medical society has been taken as an indication that Röntgen immediately foresaw its importance in medical diagnosis; though the possibility that he merely took the readiest means of establishing his claim to what was clearly a discovery of first importance cannot altogether be overlooked. However this may be, the new radiation was taken up by members of the medical profession in all countries, in Britain among the first, with a zeal and devotion quite beyond praise. The pioneers among them began work with apparatus little more effective than, and quite as troublesome as, that with which Röntgen made the original discovery. A radiograph of even such an easy subject as the human hand required an exposure measured in minutes. Gradually, however, the insistent demands of the medical radiologists for more and more penetrating power, and shorter and shorter exposures, bore fruit. With the realization that there would be a substantial market for X-ray equipment, engineers became interested in the problem, and the modern diagnostic set is capable of producing excellent radiographs of any part of the human body in a matter of seconds, and with little more trouble to the operator than would be involved in switching on an ordinary electric lamp.

Progress in the interpretation of the radiographs has been equally marked. In medicine, X-rays have evolved from an exciting novelty into a standard routine. Some of the pioneers are with us still; others, we recall, as in duty bound, lost their lives through their devotion to their work, since the dangerous nature of the radiation was not at first realized.

It is not the purpose of this brief article to sketch the story of the evolution of medical radiography, but its recent invasion of the field of preventive and social medicine deserves at least a passing notice. Mass radiography, that is to say, the routine radiography of all workers, has already begun, and will undoubtedly be extended as conditions permit. In such diseases as pulmonary tuberculosis, early diagnosis is nine-tenths of the battle, and the presence of the disease can often be identified by radiography long before any physical symptoms occur to direct attention to it. In a recent survey of some 20,000 operatives, some 1½ per cent were found to be affected, and were sent for treatment. Thus some three hundred workers will owe their escape from serious incapacity, and possibly from a premature death, to this development of Röntgen's discovery of X-rays.

The use of X-rays in the treatment of disease has scarcely made such satisfactory progress as its use in diagnosis. Many malignant growths, sarcomas, carcinomas and the like respond rapidly to the action of radiation, and fade away under its influence as if by magic. For many types of these scourges upon humanity, X-radiation, either alone or accompanied by radium radiation (which, after all, is only a kind of naturally occurring X-radiation), is by far the most hopeful treatment, and no great hospital is complete without a well-equipped and well-staffed radiotherapy department. It must be confessed, however, that there is as yet an uncertainty about the action of the rays which is very tantalizing. Complete success appears to be so near, and yet continues to elude us. The action of the X-rays on tissue cells, whether healthy or diseased, is, it must be

understood, always destructive; the possibility of using X-rays to cure disease rests on the fact that malignant cells are, on the whole, less resistant to the action of the rays than healthy tissue. Some of our troubles are undoubtedly due to the difficulty of administering a lethal dose to the malignant growth without damaging the surrounding healthy tissues. This is, primarily, a problem in physics, and the appointment of qualified physicists to the staff of the radiotherapy departments, which is now becoming general, will undoubtedly lead to some solution in due course. Probably a more vital handicap has been that little or nothing was known of the way in which the radiation exerted its destructive powers on the cell. Treatment, therefore, has had to be largely empirical. Recently, however, thanks to ingenious co-operation between physicists and cytologists, it begins to look as if a breach had been made into the problem. If so, not only may methods of treatment gain in certainty, but also X-rays may add a new chapter to our knowledge of the living cell, as they have already added more than one to our knowledge of the atom.

Industry, on the whole, was slower to grasp the utility of X-rays than the medical profession. Some small amount of radiographic testing of materials for hidden defects was carried out during the War of 1914–18, mainly in connexion with aeroplane construction, in which the importance of ensuring the complete soundness of every part justified the very considerable skill and trouble involved in making adiographs with the comparatively primitive apparatus then available. Gradually, however, the value of X-rays as a non-destructive method of investigating the soundness of castings, weldings and other industrial products received fuller recognition, and the number of industrial radiologists, in this second World War, must very greatly exceed that of medical radiologists. The demands of industry, even more effective than those of medicine, since they are backed with much larger capital, have resulted in still greater advances in the design of X-ray apparatus. Million-volt X-ray tubes, enclosed with the high-tension generator which feeds them in a single unit weighing three-quarters of a ton, are now on the market, and in heavy industry (in which they are mainly employed) are regarded as quite portable. With such an outfit, successful radiographs can be made through a 6-in. steel plate, and, under suitable conditions, cracks or flaws of no more than a tenth of an inch in thickness can be detected with certainty.

To one who began X-ray work not many years later than Röntgen's original discovery, the contrast between one of these huge but obedient 'genii of the lamp' and the miscellaneous and extremely temperamental assortment of physical apparatus with which Röntgen first revealed the existence of X-rays (and which, with a few minor improvements, served experimenters for the next twenty years or so) is astounding. By their creation, applied science has gone far to repay the debt which it owes to pure science for the discovery of the radiation. When times are again favourable, pure science will no doubt respond by using these powerful tools to make still fresh discoveries. Nor has the limit yet been reached. A two-million volt tube, some 10 ft. long, is now in operation, while another carries (for a millionth of a second) a current of 2,000 amperes at 300,000 volts; and has been employed for making instantaneous radiographs of the passage of a high-velocity shell through a 1½-in. armour plate.

Still higher voltages, accompanied by still greater penetration and power in the radiation, is promised by a new type of generator, working on entirely novel principles, which has recently been constructed in the United States. From this machine, which has been christened the 'betatron', X-radiation at energies up to thirty million volts can be obtained. When it is remembered that the most penetrating radiation from radium is equivalent to X-radiation at only two million volts, it will be realized that the betatron carries us into an entirely novel and unexplored region of the X-ray spectrum. Such radiation will penetrate not merely the outworks, but also the central citadel or nucleus of the atom; and its effects, particularly in radiotherapy, are quite unpredictable. They may be beneficial, or disastrous; but it is evident that we cannot afford to leave them unexplored. It is greatly to be hoped that the various bodies in Great Britain, whether Governmental or voluntary, interested in radiotherapeutics, and particularly in cancer research, will make the necessary provision for British research workers (who have already done so much, often with painfully inadequate resources) to play their part in the quest.

It is natural, in tracing the consequences and developments of Röntgen's discovery, to dwell first on its more immediate applications. X-radiation was, however, one of those germinal discoveries, which are at least as important for the new knowledge which they make possible as for their direct utility. Coming, as it did, a year or so before the complementary discovery of the electron by Sir J. J. Thomson, it opened the way to entirely new regions of experimental research, including the structure of atoms and molecules, and the nature of radiation itself. It may well be that when the final balance comes to be struck, the importance of X-rays as a means of winning fresh knowledge may be judged to outweigh their more directly utilitarian merits.

A knowledge of the nature of the rays was a necessary preliminary to their intelligent application in further research. The true explanation was put forward by Stokes within a few months of Röntgen's discovery. He suggested they were electromagnetic pulses produced by the sudden stoppage of the electrified particles carrying the discharge, and therefore of the same nature as light (though probably of much shorter wave-length). So far, however, did Röntgen's discovery stand apart from the general trend of the physical thought of the time, that there was an interval in which some physicists were inclined to associate the radiation with the vivid fluorescence of the glass walls of the Crookes tube, which is an invariable accompaniment of the electric discharge. Becquerel was led to investigate whether X-rays were also given off by naturally occurring fluorescent materials. Uranium was one of the substances tested, and thus the natural radioactivity of uranium was discovered. The isolation of radium, by the Curies, followed. Thus the whole science of radioactivity may be regarded as a direct offspring, though perhaps an illegitimate one, of Röntgen's discovery.

Although Stokes's suggestion was soon generally accepted, and was supported by Barkla's demonstration that X-rays, like light, could be polarized, progress was at first slow. Such evidence as there was indicated that the wave-length of the radiation must be of the order of one ten-thousandth of that of ordinary light, and attempts to apply the diffraction

methods used in determining optical wave-lengths seemed almost hopeless. It was not until 1912, when Laue suggested that the regular spacings of the atoms in a crystal might serve as a naturally occurring diffraction grating for X-rays, that real progress was made. The suggestion was immediately verified by Friedrich and Knipping, and in the following year W. L. Bragg, by a most ingenious combination of crystallography and optical theory, succeeded in determining simultaneously the grating constant of a rock-salt crystal, and the wave-length of the X-radiation employed.

This achievement has a double significance. If the spacing of the atoms in a crystal is known, we can, from diffraction measurements, determine the wave-length of the radiation impinging upon it, and thus obtain an X-ray spectrum. Conversely, if the wave-length of the radiation is known, we can deduce the spacings or lattice constants of the crystal. Thus, in the X-ray spectrometer, crystallography has found a most powerful research tool which has given quite a new impetus to this rather old-fashioned science. The practical importance of X-ray crystallography in metallurgy can scarcely be over-estimated. Since each chemical compound has its own unique set of lattice constants, it is possible to identify, not merely the elements present in a given substance (a task for which ordinary spectroscopy or chemical analysis will suffice), but also the actual compounds which these elements form with each other, and the temperatures at which these compounds form, or at which they disappear. When the field has been fully surveyed, and the X-ray crystallographic index which is already in active preparation is completed, it will be possible to identify any crystalline compound in an alloy or mixture by X-ray analysis. Nor is the field limited to true crystals. Many long-chain organic substances are sufficiently regular in their make-up to act as X-ray gratings, and much information, valuable both on the theoretical and the industrial side, has already been obtained (to quote only one example) on the structure of the fibres used in the weaving of textiles. To understand why substances behave as they do, in terms of the position of the atoms within them, is the first step in a scientific search for new and better materials; and X-ray crystallography seems destined to play a part in industry even more important than in radiography.

To attempt to survey the part played by X-rays in atomic research would involve the recital of the greater part of the history of that part of the subject dealing with the structure of the electron atmosphere which surrounds the central nucleus and on which most of the chemical and physical properties of the atom depend. Most of our exact knowledge—and it is very exact—of the arrangement, or to be more precise, the energy-levels, of the electrons in the atom, is derived from X-ray data. It may be recalled that Moseley's early survey of the characteristic X-ray spectra given out by the elements provided the first clear demonstration of the fundamental importance of the idea of atomic number; that is to say, the charge upon the atomic nucleus as opposed to the atomic weight, which was shown to be of only secondary importance. It is interesting to notice that Moseley's results showed that four elements still remained to be discovered, and that two of these have since been identified by their X-ray spectra. It may also be mentioned that the most accurate determinations of the two fundamental physical constants, the charge on an electron and Planck's constant, are, in all probability, those derived from X-ray measurements.

The temptation to moralize on the history of the discovery of X-radiation, and its consequences, is strong; but the task may be left to the reader. Nature is full of surprises, and it is not always the most obviously desirable researches which yield the richest harvest. The lone experimenter who is prepared to follow his own inspiration, even if it seems to lead him away from the main current of research, has often played an important part in the progress of science; and pure science in particular, and society in general, owe much to the inspired curiosity of Wilhelm Konrad Röntgen.

DIFFRACTION METHODS IN MODERN STRUCTURAL CHEMISTRY

IN the Tilden Lecture delivered before the Chemical Society on January 18, Prof. J. M. Robertson outlined first the scope, limitations and possible future developments of the X-ray and electron diffraction methods, and then went on to consider the nature and lengths of bonds with particular reference to the results of recent diffraction studies. The emphasis throughout was on organic structures, as would be expected from one who has contributed more than any other single worker to our knowledge of the precise crystal structures of organic compounds.

In comparing the electron and X-ray diffraction methods, a number of points were brought out. The great value of the former is that it is applicable to gases and the vapours of easily volatile substances, which cannot conveniently be studied by the X-ray method. In this sense the two methods are complementary. We might add that, as regards inorganic compounds, they are complementary in another sense. In general, the same finite molecules exist in the vapour as in the crystals of an organic compound, but this is not usually so in inorganic chemistry. Electron diffraction studies of the vapours of many metallic salts and of some of the compounds of non-metals give information about the structures of molecules which do not exist in the crystalline material.

A comparison was made of the nature of the experimental data obtainable by the two methods and of the ways in which they are interpreted. To the eye the electron diffraction photograph shows merely a number of rings on a background of decreasing intensity, and their positions and intensities are estimated visually. The X-ray photograph from a single crystal, on the other hand, shows a large number of discrete spots, and the positions and intensities of these can be determined with considerable accuracy. This apparent advantage of the X-ray method is, however, offset by two complications. First, the molecules in the gas scatter independently of one another and they are oriented in all possible ways. This makes it possible to calculate the diffraction effects to be expected for any given molecular model and to compare them with those observed, the parameters in the model being varied until agreement is obtained. In the case of diffraction by a crystal, this cannot be done. In the crystal the molecules are definitely oriented with respect to one another, so that not only has the molecular model to be varied

but also the mutual orientations, and hence the intermolecular distances. Secondly, it is usually impossible to utilize more than a small fraction of the X-ray data on the photographs. Apart from purely technical difficulties, which can eventually be overcome, there is a complication inherent in the X-ray method, namely, that the structure amplitude F_{hkl} corresponding to a particular reflexion is a complex quantity with an amplitude and a phase constant. From the observed intensity we can in general determine only the amplitude. Except in certain cases, therefore, it is necessary to work by a trial and error method based on a probable molecular model which is progressively refined as the structure-determination proceeds. The difficulty of determining phase constants may sometimes be overcome by making comparisons of data from isomorphous compounds or by studying crystals containing heavy atoms. If we assume complete ignorance of phase constants, then all the X-ray data are summarized on a Patterson vector diagram which is directly derived from the observed intensities. An analogy was drawn by Prof. Robertson between the Patterson method for X-ray diffraction and the radial distribution method for electron diffraction. Apart from the difficulty of interpreting Patterson diagrams, owing to the overlapping of peaks, there is the more fundamental difficulty that the same vector diagram (and hence the same X-ray diffraction pattern) may arise from different arrangements of atoms. The discussion of the uniqueness of the solutions of diffraction problems may appear to some chemists rather academic, especially as Prof. Robertson emphasized that a structure must always be consistent with all the other available physical and chemical evidence. However, while it is true that in the case of simple structures there is seldom any doubt as to the correct interpretation of the data, it is important, as the compounds studied become more and more complex, to re-examine the fundamental theory of all methods of interpreting diffraction data.

When discussing possible future developments, Prof. Robertson emphasized the need both for making fuller use of the experimental data and for improving its range and quality. He pointed out that many of the difficulties now encountered in making precise analyses are not fundamental, "and there is no doubt that they can be overcome, largely by the proper planning and organisation of the research, which will have to be on a fairly large scale". Although hopeful that diffraction methods will eventually give information about the positions of hydrogen atoms and about electron densities in bonds, he was careful to indicate some of the difficulties of interpreting the finer details on electron-density maps. On the whole, it would seem advisable to defer drawing conclusions from two-dimensional electron-density projections, and possibly to make detailed studies of the effect of temperature on electron-density distributions in selected crystals using sections through three-dimensional summations, in order to discover the effect of the thermal movements of the molecule as a whole and of different parts of the molecule relative to one another. More emphasis might have been placed on an essential difference between electron and X-ray diffraction, namely, that the nuclei are more effective than the orbital electrons in scattering high-speed electrons, whereas the scattering of X-rays is due to the orbital electrons alone. It is difficult to see how the electron diffraction method in its present form can provide information comparable with the electron-density maps derived from X-ray studies of crystals. Also, just as the thermal vibrations in solids result in the blurring of these maps, so the greater flexibility of some molecules in the vapour state makes it difficult, or even impossible, to obtain a complete picture of the molecule by the electron diffraction method. For example, the Sn-I distance in SnI_2 can be determined, but not the I-Sn-I bond angle. Provided the molecule possesses sufficient rigidity, however, quite complex structures may now be studied by the electron diffraction method, as shown by the recent work on pirylene, diphenylene and tri-(phosphonitrile chloride).

Diffraction methods not only provide information about the general configurations of molecules but also they lead to accurate determinations of interatomic distances and inter-bond angles. The X-ray method, of course, gives data on intermolecular as well as intramolecular bonds, and although the weak van der Waals bonds are of comparatively little interest to the chemist, much valuable information about hydrogen bonds has been obtained from studies of crystals. A feature of modern structural chemistry is the detailed analysis of data on bond-lengths with the object of discovering more about the nature of the bonds. At one time 'chemical' bonds were regarded as either ionic or covalent, and in the latter case as single, double or triple bonds. The present view is that all bonds, other than those between atoms of the same element, have some ionic character and also that bonds intermediate between single and multiple bonds exist in many molecules. Bonds of these intermediate types are described in terms of resonance between structures with different arrangements of bonding electrons.

Prof. Robertson discussed the 'order' of carbon-carbon bonds. The C–C distances for pure single-, double- and triple-bonds are well established; 1·54 A. in diamond, 1·34 A. in ethylene and 1·20 A. in acetylene. Assuming 50 per cent double-bond character in benzene (C–C = 1·39 A.) and 33·3 per cent in graphite (C–C = 1·42 A.), Pauling, Brockway and Beach constructed a curve relating percentage double-bond character to bond-length, from which can be estimated the amounts of double-bond character of other bonds with lengths between 1·54 and 1·34 A. The more detailed calculations of 'bond order' which predict minor variations in length among the bonds in molecules such as naphthalene and coronene cannot yet be checked as the differences are of the same order of magnitude as (or less than) the present experimental errors. This illustrates the need for more precise determinations of interatomic distances. On the other hand, there appear to be some abnormal bond-lengths which cannot at present be accounted for theoretically.

Dealing with bonds between unlike atoms, Prof. Robertson mentioned the recent revisions of certain of the Pauling-Huggins radii, so long adopted as the basis for discussions of interatomic distances. Observed distances which were less than the sums of these radii were considered exceptional, and elaborate explanations in terms of partial ionic character and partial double-bond character have been put forward. With the new (higher) values for the covalent radii of nitrogen, oxygen and fluorine, many bond-lengths are now seen to be appreciably less than the sums of the appropriate covalent radii, even where there is no likelihood of partial double-bond character. The empirical relationship of Schomaker and Stevenson attributes these differences to the ionic character

of the bond, and uses the electronegativity coefficients of Pauling to correct the sums of the Pauling-Huggins radii. In other words, the fact that bonds are shorter than the sums of the true covalent radii is on this later view assumed to be due in many cases to the partial ionic rather than the partial double-bond character of the bonds. In view of the importance now to be attached to Pauling's electronegativity coefficients in discussions of bond type, it is well to remember that our difficulties in this field are an indication that we have not so far solved one of the most complex and fundamental problems in chemistry.

The early electronic theory of valency assigned electronic formulæ to many molecules, but offered no explanation either of the observed inter-bond angles or of the differences in properties between atoms with the same number and arrangement of valency electrons. As regards bond angles, it was necessary to find a way of investigating the 'group properties' of a number of valency electrons, and this problem has been solved to some extent by the methods of wave-mechanics. We are still, however, far from being able to account for the chemical properties of an atom. Although elements of a group such as the halogens, all with similar sets of outermost electrons, have certain characteristics in common, nevertheless each halogen has a distinct 'individuality' and the changes in properties do not all run parallel with the increase in size (or atomic number). Thus although the properties of the atoms are to some extent determined by their outer electronic structures, the finer differences between atoms which are similar in this respect will not be explained until we are able to take into account the effect of the nuclear charge and the remaining shells of electrons.

Until we find some theoretical way of specifying these distinctive chemical properties in terms of the structure of the isolated atom, they can only be estimated from the way in which the atom interacts with other atoms. The use of the electronegativity concept represents an attempt to deal with the problem in this way. The electronegativity coefficients are derived from experimental observations on the interactions between atoms, namely, from bond energies. The new empirical relation connecting actual bond lengths with true covalent radii and electronegativity coefficients simply expresses the fact that the difference between the length of a bond A–B and the arithmetic mean of A–A and B–B is related to the difference between the energy of the bond A–B and the arithmetic mean of the energies of the bonds A–A and B–B. Some relationship is obviously to be expected; it was not apparent earlier because incorrect radii had been assigned to three of the most electronegative elements. It is, however, relevant to inquire whether the same relationship should apply to all pairs of dissimilar atoms; that is, whether the nature of a bond is the same for any pair of atoms with a particular difference in electronegativity regardless of the absolute values of the electronegativity coefficients. It will also be necessary to inquire into the general validity of Pauling's curve relating the percentage ionic character of a bond to the difference between the electronegativities of the atoms, a curve based on the dipole moments of the halogen halides. For example, are we justified in assuming that two electrons are shared in exactly the same way between two fluorine atoms as between, say, two carbon atoms, and is the relation between bond type and electronegativity the same for atoms in a horizontal row as in a vertical column of the Periodic Table? The difference between the electronegativity coefficients of carbon and silicon is greater than that between those of, say, carbon and nitrogen, yet Pauling quotes the carbon-silicon distance in tetramethyl-silane as an example of the additivity of covalent radii.

In order that future discussions of the nature of bonds shall be put on a sound basis, it is to be hoped that some of these points and some of the experimental data will be critically examined. The results are of great general interest to many chemists, of whom relatively few may be in a position to criticize the conclusions reached by the specialist. This is one of the dangers attending the increasing specialization which is a characteristic of modern science. Perhaps there is still room for a Carneades, of whose function Boyle (in "The Sceptical Chymist") wrote, "that having thus drawn the chymists' doctrine out of their dark and smokie laboratories, either judicious men shall henceforth be allowed calmly and after due information to disbelieve it, or those abler chymists will be obliged to speak plainer than hitherto has been done, and maintain it by better experiments and arguments". A. F. WELLS.

THE SCIENCE OF PLANT BREEDING

By D. LEWIS
John Innes Horticultural Institution

THAT breeding is an art and not a science is an opinion frequently expressed by many who are concerned with plant and animal improvement. Whatever they have meant by art in this generalization, it appears that, in their hands, breeding is mainly unscientific. It is certain, however, after reading Dr. Harland's report on cotton breeding in Peru[1] that, in his hands, breeding is truly scientific and as such can give good results quickly. It is scientific because measurements of the relevant characters were his standards for selection, and because genetical principles were the guide in calculating the number of plants required, and in deciding the type of breeding. Therefore, he did not rely upon the hazards of hit-and-miss intuition of the art side of breeding.

Tanguis, originating as a chance seedling in 1908, has been the main variety of cotton grown in Peru since that date. It was originally of excellent quality and yield; but subsequent contamination from crossing and seed mixing with other stocks has caused much deterioration. In 1940 Harland had the task of reviving and improving its characteristic qualities, and in three years he has increased the mean fibre length by $\frac{3}{8}$ in. above the mean for commercial *Tanguis*, and has also made improvements in ginning percentage, boll weight, colour and yield. So that in 1943, 2,100 acres were planted with his improved seed.

How was this remarkable achievement brought about? The taxonomic position and origin of the variety *Tanguis* are first considered, since these are prerequisites to any scientific breeding programme. *Tanguis* has most of the characters of *Gossypium barbadense* with the early maturity of *G. hirsutum*, as a result of which previous Peruvian workers believed it to be a hybrid. But some early work of Harland showed that it is pure *barbadense* and that the early maturity arose by selection due to associa-

tion with *hirsutum* in mixed plantations and not to intercrossing between them.

The objectives of the work, nine in number, included improvement in such characters as yield, fibre-length, colour and disease resistance. In a description of his work, Harland examines and criticizes the orthodox pure-line breeding, which has been slavishly adhered to by many breeders. The advantage of a pure line is the uniformity of the commercial product, and he concluded that the value of this has probably been overrated, at least in cotton. For example, fibre-length from single seeds was found to be almost as variable as that from commercial bales made up from plants of diverse genotypes. On the other hand, the disadvantage of early fixation of the genes (favourable and unfavourable) has sometimes been overlooked, as effective selection is then confined to the original plants and the first selfed generation. In the past, far too few original plants have been used to provide sufficient genetic diversity for selection. As Harland shows, it is necessary, in theory, to start with 1,024 strains in order to obtain eight strains which will be above the average in seven characters at the end of selection. Furthermore, when a good pure line has been found, it is not necessarily good in the majority of the environments that any good commercial plant is likely to encounter. Lack of plasticity does not allow the slight adjustments by natural selection which would occur in a mixed population.

For the purpose of maintaining a certain degree of diversity from which further selection would be possible, and also for obtaining effective results quickly, Harland abandoned pure-line breeding. No self-fertilization was practised, and mixtures of strains were propagated. Selection was started on 22,000 boll samples, each taken from a single plant, from various commercial fields. A first selection based on all characters rejected all but 2,863 of them. Ten plants of each selected strain were grown, and bulk samples of the ten plants were examined for all characters. This not only saved much labour in single-plant selection; but it also eliminated heterozygotes which, although themselves good, produce bad offspring by segregation. Forty-one strains survived these bulk tests, which after single-plant selection provided two hundred plants for progeny testing. Two thousand seedlings were raised from these, and after subjecting them to bulk and single-plant selections forty-three strains finally remained. Ten of these were propagated, giving sixty-three strains in the following year. These were mixed together and distributed as commercial seed.

Thus Harland has been able to restore the good qualities of the cotton plant in Peru, and indeed to add further improvement in a very short time while retaining genetic diversity for further selection. In grasses, mixed strains have been bred at the Welsh Plant Breeding Station and utilized with success[2]. Hitherto it has been thought that, in respect of the requirements of variation, pasture crops were different since less uniformity is necessary than in more highly specialized crops, but in view of the success in cotton the mixed strain is worthy of trial in other plants. It should be especially useful in crop plants which suffer from pests and diseases in epidemic form, when genetic heterogeneity may prevent widespread destruction.

[1] Harland, S. C., "The Selection Experiment with Peruvian Tanguis Cotton", Inst. of Cotton Gen., Lima, Peru, Bull. No. 1 (1944).
[2] Stapledon, R. G., "The Breeding of Herbage Plants, etc.", Imp. Bur. of Plant Gen., Bull. No. 3 (1931).

OBITUARIES

Prof. J. K. Catterson-Smith

JOHN KEATS CATTERSON-SMITH, professor of electrical engineering at King's College, University of London, was born on December 27, 1882, and died on January 25, 1945. His father was a well-known artist who became head of the Birmingham School of Art. The son received his early education at the City of London School and then entered the University of Birmingham. Here he held the Bowen research scholarship during 1902–4 and published the results of investigations on transformers, direct current motors and rotary converters. After three years at Siemens Dynamo Works, Stafford, he returned to academic life as lecturer in electrical engineering, and after a period at the University of Liverpool became chief assistant to Prof. Silvanus Thompson at the City and Guilds of London Technical College, Finsbury.

Between 1904 and 1914 Catterson-Smith published a number of papers on the starting of motors, on commutation in direct current motors, on harmonics in three-phase networks and on the manufacture of large turbo-alternators. He also contributed to the theory of transformers, induction motors and cascade motors. In 1915 he joined the Navy in the R.N.V.R. and was sent to help enlarge the wireless station at Demerara. Upon returning to Portsmouth he took part in the new developments of thermionic radio apparatus, especially in connexion with submarines. He served at sea in submarines and was promoted to lieutenant-commander. In some of the radio and supersonic developments he and I collaborated at Portsmouth and Toulon, and in particular we solved the problem of synchronizing an electric motor with a tuning fork, in preparation for facsimile transmission. Some of this work was done at Finsbury, after he had returned to his old post. Here, also, he published papers on audio-frequency amplifier design and on the theory of intervalve transformers.

In 1918 he married Miss Rita Thom and settled down to academic life again at Finsbury; but in 1923 he was offered the professorship of electrical technology at the Indian Institute of Science, Bangalore, where Sir Martin Forster was then director. At Bangalore he spent several ardent years building and equipping new laboratories, installing heavy-current plant and inaugurating a wireless research laboratory. He founded the Institute journal *Electrotechnics* and probably wrote most of it during its infancy. He and his wife, I have been told, assisted greatly in promoting the social life of the Institute.

In 1930 Catterson-Smith was appointed professor of electrical engineering at King's College, London, in succession to Ernest Wilson. Among his original researches of this period are those on the paralleling of large transformers, and on the theory and measurement of positive and negative sequence components of three-phase currents and voltages in three-wire unbalanced networks. Then came the War and the College moved to Bristol.

In the domain of electrical engineering Catterson-Smith will be remembered for the originality of his experimental work, for the careful workmanship of the apparatus he constructed and for his lucid exposition of what may be called the physiology of electrical machines—which ranged from large turbo-alternators to electric kettles and electric toys. His was one of those minds that restlessly endeavour

to improve the operation of every machine encountered; his mental processes consisted in first gaining a thorough insight into the operation of the existent machine and then applying remedies to the weaknesses disclosed. This passion for improving and inventing continued to the end of his life. For example, during the last two years he had been working on an improved electrical tele-mechanism of great ingenuity.

In Catterson-Smith there was an unusual and happy blend of art and science. His artistic instincts called for craftsmanship and appropriateness, his scientific instincts for accuracy and efficiency. These qualities imbued all his work. In addition, he possessed a personality of great friendliness and charm. No wonder he gained the affection of all his students and colleagues. W. H. ECCLES.

Prof. James Muir

BY the death, on February 17, of Prof. James Muir, emeritus professor of natural philosophy in the Royal Technical College, Glasgow, there has passed a great teacher and a man singularly devoted to science and to the quest of knowledge for its own sake.

Dr. Muir was born in 1875, and his early interest in science was stimulated by his education at Allan Glen's School, Glasgow. On leaving school, he entered his father's business; but the influence of his school training led him to consult Prof. James Blyth, on whose advice he entered his evening class at the Technical College. Thus began a connexion with that College which was to remain unbroken throughout his life.

Muir graduated B.Sc. in 1896 at the University of Glasgow, with special distinction in engineering and astronomy, and D.Sc. in 1902, having obtained the associateship of the College in mathematics and physics in 1897, in which year he was awarded an 1851 Exhibition Scholarship at Cambridge. His researches at Trinity College, under Prof. Ewing, into the effect of temperature on recovery from overstrain were published in the *Proceedings of the Royal Society*, and he was awarded the B.A. degree of Cambridge, followed in 1904 by the M.A. Returning to Glasgow, he became chief assistant to Prof. Blyth, and then assistant to Prof. Andrew Gray at the University of Glasgow.

In 1906, on the death of Prof. Blyth, Dr. Muir succeeded to the Freeland chair of natural philosophy in the Technical College, Glasgow, and he entered upon his duties with a boundless enthusiasm which continued during the thirty-two years which ended with his retirement in 1938.

Prof. Muir always gave foremost place to his teaching and to the interests of his large classes of day and evening students. Nevertheless, he found time to use to the full the resources of his department in conducting many valuable researches on behalf of the industrial firms of Glasgow, and during the War of 1914–18 these researches were directed to the service of the country. He willingly and enthusiastically entered into any movement for promoting the welfare of the College, such as the work of the *College Research Journal* and the re-arrangement and cataloguing of the founder's library.

Prof. Muir will always be remembered as a great teacher whose constant aim was to induce his students to think for themselves, to abhor anything slipshod and to enjoy hard work as he himself enjoyed it. The sincerity and love of truth shown in his scientific work was carried into his everyday life; 'he nothing common did or mean', nor could he compromise upon ethical principles. His students, like all his immediate colleagues, grew to look upon him with affectionate respect: they found him always approachable and eager to share and stimulate their interests. On his retirement, as an expression of their admiration and regard, his former students and colleagues founded and endowed the James Muir Prizes in natural philosophy, and presented to the College the fine portrait by David S. Ewart which now hangs in his old lecture room.

Dr. Muir's tastes were simple and his wants were few. From his student days he had a great love of the Scottish hills, and friends have most pleasant memories of holiday climbs in his company. At the time of his death he had prepared the manuscript of a text-book on physics and he was engaged on a memoir of the founder of the College. Prof. Muir was unmarried and is survived by three sisters.

Mr. F. R. S. Balfour, C.V.O.

BY the death of Frederick Robert Stephen Balfour on February 2, arboriculturists and horticulturists have lost a valued friend and counsellor. Though primarily an arboriculturist he was also a keen naturalist and a true lover of all kinds of plants. He had the advantages of having the means of travelling and of inheriting from his mother the beautiful estate of Dawyck in Tweeddale which possessed a number of interesting and historical trees. In later life he had important business interests in the City of London, and it was probably his business ability which led him to include experimental forestry plots on a large scale at Dawyck.

Balfour was born on March 11, 1875, and was educated at Loretto and Trinity College, Oxford. In his early days he spent four years on the Pacific coast of North America, and, although he was greatly interested in all the plant and animal life, it was the trees which captivated his imagination. He was familiar also with the trees of eastern Canada and the north-eastern States and had a working knowledge of the wonderful forests of south Chile. He became, therefore, a recognized authority in Great Britain on American trees, especially conifers. When he returned to Scotland he developed the collection of North American trees at Dawyck, introducing several species for the first time, his favourite being the rare *Picea Breweriana*, and trying out practically every species which could be expected to survive. In addition to his New World conifers he had also a collection of the more hardy Asiatic species mostly introduced by E. H. Wilson, whose second expedition to China he helped to finance. He had a great knowledge of British birds and was proud of his notable collection of foreign ducks and pheasants. From the economic point of view his most important contribution to sylviculture concerned the trial of promising, but as yet unfamiliar, species under forestry conditions or on the mountainside.

Balfour's published communications are scattered throughout a number of journals; his account of David Douglas, his "History of Conifers in Scotland" which covered a wide field, and a paper read recently before the Linnean Society on Archibald Menzies being perhaps the most noteworthy.

As a member of the Home Grown Timber Com-

mittee, Balfour was sent to France as liaison officer to the French Government during the War of 1914–18, with reference to the supplies of timber. He was one of the founders and remained a most active member of the Roads Beautifying Association, being at his death chairman of the technical sub-committee. His wide love of plants was shown by his zeal in supplying material for figuring in the *Botanical Magazine*.

Balfour had been a fellow of the Linnean Society for many years and had served on the Council of the Royal Horticultural Society, the latter bestowing on him in 1927 its highest award. He had been a member of the King's Bodyguard for Scotland since 1900 and was made C.V.O. in 1944. His other interests included history, architecture and music, he himself possessing a fine baritone voice. But no notice of him would be complete without emphasis on his exceptional courtesy and charm, which were due largely to his understanding and sympathy and to the genuine pleasure it gave him to do good to his fellow-man. A. D. COTTON.

WE regret to announce the following deaths:

Mr. F. Bligh Bond, formerly director of excavations at Glastonbury Abbey, on March 8, aged eighty.

Mr. G. V. Boys, secretary of the Institution of Naval Architects since 1935, on March 15, aged fifty-one.

Sir Thomas Lewis, C.B.E., F.R.S., physician-in-charge of the Department of Clinical Research at University College Hospital, London, on March 17, aged sixty-three.

Mr. P. W. Paget, a technical assistant of Marconi during his early work in England from 1896 onwards.

Prof. Stanisław Zaremba, sometime professor of mathematics in the University of Cracow, and a member of the Polish Academy of Science, aged eighty-one.

NEWS and VIEWS

Chair of Biochemistry at Sheffield: Prof. H. A. Krebs

THE University of Sheffield has conferred on Dr. H. A. Krebs the title and status of professor of biochemistry in recognition of his eminence in the world of science. Dr. Krebs was awarded the degree of M.D. (Hamburg) in 1925 and that of M.A. (Cambridge) in 1935. He held the post of research assistant at the Kaiser Wilhelm Institute for Biology, Berlin-Dahlem, during 1926–30 under Prof. Otto Warburg. After further experience in Germany he became a Rockefeller research student in the Biochemical Laboratory, Cambridge (1933–34), demonstrator in biochemistry at Cambridge (1934–35) and lecturer in pharmacology at Sheffield (1935–38). In 1938 he was appointed lecturer in charge of the newly created Department of Biochemistry in Sheffield, and attracted to his department research workers from both Europe and America. He is a naturalized British subject, and during the War he has given valuable service in connexion with diet and nutrition. His main contributions to biochemistry are in the field of intermediary metabolism. He showed that the synthesis of urea in the mammalian liver is catalysed by ornithine. This observation led to the formulation of the 'ornithine cycle', according to which ornithine, citrulline and arginine are intermediate stages in the synthesis of urea. His work on the oxidation of carbohydrate in muscle showed that this metabolic process, too, is a cyclic one (known as the 'Krebs cycle'), where a series of organic acids arises periodically.

Prairie Regional Laboratory, Canada: Prof. R. K. Larmour

PROF. R. K. LARMOUR, professor of chemistry in the University of Saskatchewan, has been appointed director of the Prairie Regional Laboratory which is to be built in Saskatoon by the Canadian National Research Council. Prof. Larmour served in the War of 1914–18, and following his return from overseas, he graduated from the University of Saskatchewan and carried out postgraduate work in the University of Minnesota, where he was Shevlin fellow. He joined the staff of the University of Saskatchewan in 1927 and has remained there ever since except for a short period when he occupied the chair of milling industry at a mid-western American university. Dr. Larmour has a high reputation in the field of grain research. The Prairie Regional Laboratory will be concerned primarily with investigations into the utilization of agricultural crops. It will be provided with facilities to undertake all phases of laboratory and pilot-plant investigations in this field.

Colonial Development and Welfare Bill

THE essential feature of the new Bill dealing with Colonial development, which should be of interest to administrators, scientific men and technologists, and all who are concerned with the welfare and advancement of the British Colonial possessions, is that it represents a notable extension of the Colonial Development and Welfare Act of 1940. The extension concerns both the annual provision of funds and the period over which they will be available. Put briefly, whereas the Act of 1940 made available a sum of £5,000,000 per annum for development and £500,000 per annum for research, until 1951, the new Act makes available, unless "Parliament otherwise determines", a sum of £120,000,000 for all purposes during the period 1946–56. A commendable elasticity, which all who are responsible for new schemes whether of research or development will appreciate, is a feature of the new enactment. Thus it is explicitly stated that no time limit is imposed on schemes of research and investigation and up to £1,000,000 can be spent on such schemes in any one year. For all purposes, up to £17,500,000 may be expended in any one year.

Few will disagree with these measures. Substantial help for the Colonies has been long overdue. Now, it is reasonable to hope that definite schemes may not only be planned and set in motion but also actually carried through to fruition. Readers of *Nature* are already familiar with the very diverse developmental, constructional, sociological and research projects which require and are receiving attention under the Colonial Development and Welfare scheme. In particular, it may be pointed out that members of university staffs and of the teaching profession in Britain, as also in the Dominions and in the Colonies,

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

CIVIL SERVICE COMMISSION DUBLIN

Positions Vacant: Meteorological Officer Cadets, Department of Industry and Commerce, Dublin.

Applications for appointment of the above-named situations are invited from Irish Nationals possessing the requisite qualifications. Application forms for and particulars of the posts may be obtained from the Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin. *Salary* : £180 a year, plus bonus of £168 18s 0d. On satisfactorily completing a prescribed course of training extending over not less than two years, Cadets will, on fulfilment of certain conditions, be appointed Meteorological Officers on a salary scale of £200-£20-£500 a year, plus bonus. *Maximum Age Limit* : 32 years on 1st March, 1945, except in certain circumstances. *Essential Qualifications*: (a) 1st or 2nd class honours University degree with Physics *or* Mathematical Physics *or* Mathematics as a major subject and 1st or 2nd class honours in that subject *or* (b) 1st or 2nd class honours University degree in Mechanical and or Electrical Engineering *or* (c) University degree in Meteorology *or* (d) a qualification equivalent to any one of the foregoing.

Latest time for accepting completed application forms : 5.15 p.m. on April 20, 1945.

CHRISTIE HOSPITAL AND HOLT RADIUM INSTITUTE

WITHINGTON, MANCHESTER 20

High-grade technician (male) wanted for Laboratory, concerned with the construction of moulded applicators individually fitted to patients. This would be extremely interesting work for the right type of man and involves handling patients. Real constructional ability and initiative, with experience of plaster of paris, dental or plastic materials is necessary. The salary will be between £4 and £7 per week according to previous experience.

Details of experience and qualifications together with any testimonials to: The General Superintendent.

HERIOT-WATT COLLEGE EDINBURGH

PROFESSORSHIP OF MECHANICAL ENGINEERING

The Governors invite applications from British Subjects for the Professorship of Mechanical Engineering which will shortly become vacant owing to the retirement of Professor A. R. Horne, O.B.E., B.Sc., M.I.Mech.E., A.M.Inst.C.E., F.R.S.E. The Professor is Head of the Mechanical Engineering Department which includes Day and Evening Courses of study. Salary £1,000 by £50 to £1,200, plus War Bonus.

Applications may be submitted by suitably qualified persons now in H.M. Forces.

Further particulars may be obtained from the Principal at the College to whom application must be sent not later than May 14.

J. CAMERON SMAIL,
Principal.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE

(University of London)

Campden Hill Road, London, W.8.

Owing to the approaching retirement of Miss H. Reynard, M.A.(Oxon), the College Council invites applications for the appointment of a PRINCIPAL, to take office in October, 1945.

Further particulars of the appointment may be obtained from the Secretary, King's College of Household and Social Science, c/o University College, Leicester. Completed applications should be received on or before **May 1, 1945.**

ADDENBROOKE'S HOSPITAL CAMBRIDGE

Applications are invited for the post of full-time Physicist at the Radiotherapeutic Centre. The person appointed to the position will also be attached to the Radiotherapeutic Departments at the East Suffolk and Ipswich Hospital, and the Norfolk and Norwich Hospital. He will be required to make his headquarters in Cambridge, as the allocation of his duties to that Centre will not be less than half-time.

The salary attached to the post will be £600 to £800 per annum, according to experience, and in addition travelling expenses to and from Ipswich and Norwich will be allowed.

Superannuation benefits of the Federated Superannuation Scheme for Nurses and Hospital Officers will be available.

Applications, giving age and full particulars of experience, together with copies of not more than three testimonials, should be sent to the undersigned not later than April 7, 1945.

J. A. BEARDSALL,
Secretary-Superintendent.

LADY MARGARET HALL OXFORD

Applications are invited for the post of Tutor in Physiology to take office, if possible, in Oct., 1945. The Tutor will be required to teach Physiology for the Final Honour School and the 1st Examination for the Degree of Bachelor of Medicine, and to supervise the work of undergraduates reading Science; she would have some time for research. The initial salary would be at least £300 a year with full board and residence. Applicants should hold an honours degree in Physiology; a medical qualification would be an advantage but is not essential. Further particulars can be obtained from the Principal, to whom application should be made before April 30.

UNIVERSITY OF GLASGOW

Applications are invited from experienced research workers for I.C.I. Research Fellowships in Chemistry, Engineering, Pharmacology and Physics, to which some appointments may be made during the current academic year. The appointments will date from Oct. 1, 1945, or such later date as may be arranged in the case of successful candidates who are at present engaged in National Service. The stipends will be in the region of £600 per annum, and appointment will be for three years in the first instance. Applications, with list of publications and names of two referees, should be sent not later than April 30 to the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

LEEDS COLLEGE OF TECHNOLOGY

Principal: C. Chew, M.Sc.Tech., F.R.I.C.

DEPARTMENT OF CHEMISTRY

Applications are invited for the post of full-time Lecturer in Chemistry, duties to commence Sept., 1945.

Candidates should possess a good Honours Degree of a British University, together with teaching and industrial experience. The selected candidate will be required to teach mainly Inorganic with some Physical Chemistry. Salary according to the Burnham Scale.

Further particulars and form of application, to be returned not later than April 7, may be obtained by sending stamped addressed foolscap envelope to the Director of Education, Education Offices, Leeds, 1.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

A vacancy in the Chair of Agricultural Chemistry has occurred owing to the resignation of Prof. D. N. McArthur, D.Sc., Ph.D., F.R.I.C. Candidates are requested to apply for particulars of Conditions of Appointment to the undersigned.

Applications are to be lodged with the subscriber on or before April 6, 1945.

A. J. WILSON,
Secretary.
6, Blythswood Square,
Glasgow.

ROYAL HOLLOWAY COLLEGE

(University of London)

APPOINTMENT OF AN ASSISTANT LECTURER and DEMONSTRATOR in BOTANY

The Governors invite applications for the above post, which is resident and open to women only. —Applications are required not later than April 21, 1945. Full particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

The Council of the College invites applications for the following posts in the Department of Physics, viz :

(i) Assistant Lecturer and Demonstrator at a commencing salary of £350 per annum.

(ii) Lecturer, at a minimum commencing salary of £475 per annum.

Further particulars may be obtained from the undersigned, by whom three copies of applications and testimonials should be received on or before April 30, 1945.

LOUIS S. THOMAS,
Registrar.

University College,
Cathays Park, Cardiff.

GIRTON COLLEGE, CAMBRIDGE

Applications are invited from qualified and experienced women gardeners for the post of Garden Steward, with responsibility for the upkeep of about 50 acres of gardens and grounds, including large-scale growing of vegetables. Academic qualifications an asset. Particulars may be obtained from the Secretary, to whom applications for the post should be sent before April 10, 1945.

KING'S COLLEGE, NEWCASTLE UPON TYNE

IN THE UNIVERSITY OF DURHAM

Technician required for the Department of Anatomy: experience in histological technique essential. Applications stating experience and wages required should be addressed to the undersigned.

C. R. HANSON,
Registrar of King's College.

UNIVERSITY OF BRISTOL

The University invites applications for a LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY. Grade II or Grade III according to qualifications and experience. The appointment will date from August 1, 1945, or as soon after as possible.

Applications should reach the undersigned, from whom further particulars may be obtained, on or before April 23, 1945.

WINIFRED SHAPLAND,
Secretary and Registrar.

Applications are invited from Metallurgists, aged 25-35 years, for a position in the Research Department of a large firm in Yorkshire.

Applicants would be required to control the routine analytical and mechanical testing laboratory in the Company's Machine Manufacturing Division, and to undertake investigational work on the materials used. An honours degree in metallurgy and some years experience in the machine or machine tool-making industry is essential. Initial salary £400 p.a.

Applicants should write quoting F.2721XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before April 30, 1945.

Applications are invited from Analytical Chemists, aged 30-40 years, for the position of *Chief Analytical Chemist* in the Research Department of a well-known firm in the London Area. Candidates should have an honours degree in chemistry and a wide practical experience of analytical methods. Salary from £700 p.a. according to qualifications and experience. They will be required to carry out research and development work as well as to control routine analyses.

Applicants should write quoting F.3673XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before April 28, 1945.

A Food Chemist is required in the Research Department of a well known London firm to carry out the analysis of a wide range of food materials packed in metal containers. Applicants should be graduates in chemistry or equivalent qualification and aged 25-35 years.

Some years practical experience in a food analysis laboratory, and particularly in the estimation of nutritional values, would be an advantage. The salary will start at £400 p.a. Applicants should write quoting F.2722XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before April 14, 1945.

Editorial Assistant required by British Council to help in production of a monthly journal published in several languages. Good knowledge of written French and Spanish essential; familiarity with medical terminology an advantage. Salary about £350 per annum, according to qualifications and experience.—Applications in writing (no interviews), stating date of birth, full details of qualifications and experience (including a list in chronological order of posts held), and quoting Reference No. P.Q.144, should be addressed to the Ministry of Labour and National Service, Appointments Department, A.3 (A), Sardinia Street, Kingsway, London, W.C.2.

Government of Trinidad require Geologist to co-ordinate geological information, compile geological map after necessary surveys and advise on geological questions connected with petroleum industry development in Colony. Candidates must be graduates in geology of recognized University with not less than 5 years practical experience in petroleum geology. Knowledge of geological conditions in Trinidad desirable. Non-pensionable post for three years. Salary £1,000 p.a with special bonus in lieu of pension. Free passage both ways. Applicants should write quoting F.3769A to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for necessary forms before August 31, 1945.

An Organic Chemist is required in the Research Department of a well known firm in the London Area, to carry out experimental work leading to the formulation of protective and decorative coatings for sheet metal containers.

Applicants should be honours graduates in chemistry and have had a few years' experience of synthetic resin and varnish chemistry and be aged from 25-35 years. Initial salary £400 p.a. Applicants should write quoting F.2719XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before April 26, 1945.

Physicist required for the Research Staff of an expanding laboratory in a large glass works near Birmingham. Degree in Physics or Mathematics. Salary according to age and qualifications.—Chance Brothers, Smethwick.

Applications are invited from Metallurgists aged 25-35 years for a position in the Research Department of a large firm in S. Wales. Candidates will be required to carry out experimental work on the development of containers for non-ferrous sheet metal, particularly aluminium alloys.

An honours degree in metallurgy and a few years experience in the wrought light alloys industry is essential. Initial salary £400 p.a.

Applicants should write quoting F.2720XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before May 12, 1945.

Applications are invited for the posts of Research Chemist and Research Biochemist by a leading firm of fine chemical manufacturers in the London area. Candidates should have an Honours Degree in Chemistry or Biochemistry, and should preferably have some experience of research. The posts will be permanent and will carry superannuation. Salary according to experience and qualifications.—Box 328, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Institute of Physics, London. Applications are invited for the post of Assistant Secretary from men with qualifications at least up to A.Inst.P. standard. Basic commencing salary up to £375 p.a. Superannuation additional. Applications from candidates who may be unable to take up their duties immediately will be considered. Further particulars from the Secretary, The Institute of Physics, at its emergency office, at The University, Reading, Berks, to whom applications should be submitted before April 28, 1945.

Physicists required immediately for Industrial Research, by large manufacturing concern in the Midlands. Applicants should have a University Degree, preferably with honours in physics or engineering. Reply, giving details of training and experience to Box No. 331, T. G. Scott & Son, Ltd., 9 Arundel Street, Strand, London, W.C.2.

Works Process Chemist required for new factory in India. Applicants should be between 25 and 35 years of age, preferably single, and should have a Degree in Chemistry with some experience in inorganic or electrochemical process work. The successful applicant would be required to undergo training for a period of at least six months in a factory in the North-West Manchester area. Salary whilst training £400 per annum or the salary applicable to the applicant's last place of employment whichever is the greater amount. Salary in India £800 per annum. An allowance of £50 towards the purchase of overseas kit would be given.—Applicants should write, quoting F.3705XA, to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before April 17, 1945.

Well-known Company in the West of England, scheduled under the Essential Work Order, has a vacancy in the Patent Department for a Chemical Assistant having knowledge of patent and trade mark procedures. Acquaintance with technical library routine would be an advantage. Salary according to qualifications and experience.—Write full particulars to Box 327, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Research Chemist wanted by firm of Light Leather Tanners. Should preferably hold a degree in Science, and must have had experience in the Tanning Industry.—Write, giving details of experience, etc., to Box 326, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Instruments and Apparatus. An old-established Company requires an Executive Assistant with experience of Chemical and other scientific apparatus, capable after some training of undertaking the organizing of sales. Applications from members of H.M. Forces will be welcomed.—Write, Box 3480, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Required by manufacturers of anti-fouling compositions, graduate (physical chemistry) with research experience. Salary £450/£650 per annum.—Apply, Box 324, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Photographer enthusiastic and experienced in handling modern high-grade Cameras, with engineering and draughtsmanship inclinations, graduating as Photographic Apparatus Designer-Draughtsman, should apply—Box 330, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Assistant requires senior post in Zoological Laboratory. C. F. Barker, 4 Crabtree Lane, Fulham, S.W.6.

Clockwork or Electric Thermographs wanted. State age, type, make, and price required. Box No. 329, T. G. Scott & Son, Ltd., 9 Arundel Street, Strand, W.C.2.

Microscopes, of all descriptions, only a few available, second-hand, perfect condition. Send details of your requirements, enclosing 3d. stamp.—Telephone or correspondence only, Chards, Forest Hill, S.E.23 (Spring Park 1628).

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

Limited supplies of marine biological material are still available, but orders should be placed well in advance.

For prices and detailed information apply to: The Director, The Marine Biological Laboratory, Plymouth

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have a very real responsibility for the successful outcome of the new Bill. The key to success can be stated in a single word: personnel. Personnel for administration, technology and research. The production of suitable candidates for the many and varied jobs is the task of the schools and universities. In these days it is one beset with difficulties, and it may well be that some years must elapse before suitable staff for some of the research posts, for example, in biology, can be produced. But the task lies clearly before us. The sooner we begin, the better for the welfare of the British Colonies.

Science, Poetry and Religion

THREE lectures delivered by Mr. Geoffrey Hoyland at Woodbrooke Summer School in 1944 have now been printed as a challenging and picturesquely written booklet entitled "The Tyranny of Mathematics" (S.C.M. Press, Ltd., 56 Bloomsbury Street, London, W.C.1. Pp. 52. 1*s*. 6*d*. net). Mr. Hoyland's theme is the age-old dichotomy between the emotional and the rational approach to human problems; but his treatment is fresh, partly owing to his vivid style, and partly because it is unusual to find a religious apologist with a good knowledge of science and mathematics. It is not possible here even to summarize his arguments and exhortations. His conclusion, briefly, is that since the Renaissance, and particularly since Newton and Leibniz added the weapon of the calculus to the armoury of the man of science, we have worshipped at the analytical shrine of mathematics, to the exclusion of the true gods of poetry and religion, which, with science as their handmaid, can alone reveal to us the whole truth about the universe. "If our sick world is to be saved the lover and the poet must take control."

Few men of science will go the whole way with Mr. Hoyland, preferring to believe that a constantly adjusted partnership between the emotional and rational elements in life, rather than the supremacy of either over the other, is the most fruitful treatment of the dichotomy (and indeed the only one that would justify the use of the word 'symbiosis' in the subtitle); but many will be stimulated by this keen analysis of the problems involved, and enjoy the colourful language in which it is couched.

Cultivation of Rhubarb

RHUBARB is one of the oldest cultivated plants, for its history in China, its native home, dates back to almost 3000 B.C. At first it was grown solely for the medicinal properties of its roots and was introduced into England from Siberia on that account some three hundred years ago. Later, interest developed in the edible properties of the leaf stalks, but it was not until the nineteenth century that plantings of rhubarb for culinary purposes became widespread. The literature on rhubarb cultivation is scanty, so the illustrated bulletin, compiled by H. V. Taylor and E. E. Skillman, recently issued by the Ministry of Agriculture (No. 113. H.M. Stationery Office. 9*d*.) should prove a great asset to growers. The advice given relates generally to normal peacetime practice. Only a limited number of varieties are grown for commercial purposes; each is described in some detail and attention directed to the fact that all may be seen growing in the gardens of the Royal Horticultural Society at Wisley. The chief area of production is the West Riding of Yorkshire, though in Essex, Lancashire and Cheshire quite a considerable acreage is devoted to the crop. The high rainfall, acid soil and the capacity of the plant to withstand smoke pollution contribute to the success of the crop in the Leeds district; in fact the contaminated atmosphere is an asset for forcing purposes, as it induces premature leaf shedding and early dormancy. The cultivation of both forced and natural rhubarb are described at some length and a section devoted to grading, packing and marketing. As regards diseases, that termed 'crown rot' appears to cause most trouble. Eelworm infection is now thought to be largely responsible for this, though it is not yet clear whether there are not also other factors which contribute to this condition.

Plea for a Museum for Croydon

DR. H. W. DICKINSON'S presidential address this year to the Croydon Natural History and Science Society discussed the proposal for a museum for the district. Croydon is the largest borough in Great Britain without an adequate museum service, and he stated that the Society is now urging the proposal upon the local authority "as one of the particular objects to be carried into effect in the post-war municipal reconstruction scheme". If the museum materializes, he stressed the importance of a localized policy, and in this connexion suggested that a plan already exists in the form of the Society's Regional Survey of the district. Alluding to museum functions, he placed 'research' before 'visual education', but in view of the present-day urgent need for all forms of education, the smaller regional museums might usefully reverse this order. Dr. Dickinson justifiably deprecated the use of old dwelling-houses for museum purposes, for these do not provide the offices and facilities required for the execution of a useful and progressive service. Referring to the reluctance of municipalities "to spend money on buildings even if they own valuable collections", he reminded the audience that the Nuffield Trust, and the Carnegie United Kingdom Trust, could be approached for financial help. Clearly, Dr. Dickinson has closely studied Markham's report on "The Museums and Art Galleries of the British Isles" (1938), and all authorities undertaking the establishment or reorganization of regional museums in the future could profitably follow his example.

The Cinema

MR. LINDGREN'S pamphlet "The Cinema" (English Universities Press, Ltd. 4*d*. net) well maintains the standard set in this Handbook for Discussion Groups series, and should serve as a useful basis for discussion of various aspects of the cinema, including the Report of the Board of Trade Committee on Tendencies to Monopoly in the Cinematograph Film Industry, of which little has been heard since its publication. This particular aspect is indirectly touched by one of the subjects listed for discussion, but in the brief compass of nineteen pages Mr. Lindgren contrives to supply a good deal of background and to indicate most of the broader issues involved, such as the possibilities of the cinema in scientific research, education, the recording of history, the promotion of international understanding and the field of public information. He touches succinctly on the general problems of the entertainment value of the cinema, its influence and the question of censorship, where in two brief paragraphs he brings out the essential weaknesses and dangers inherent in censorship, and incidentally supplies adequate justification for the attempt to stimulate further discussion

of the whole problem. There is an eminently practical note in the whole pamphlet, and if a word of criticism is called for, it is that the bibliography, even within the limits set, might have been improved.

The Cooper Union : Annual Report

THE report of the Director of the Cooper Union, of New York, for the year ending June 30, 1944, covering the eighty-fifth year of the Institution, indicates that, although in some respects the disturbance of education in the United States under the impact of war has been less profound than in Great Britain, the problems of demobilization and of re-training are being faced along similar lines. There is an interesting parallel between educational thought, as portrayed in this report, in the two countries. Stress is laid upon the necessity of finding a strong and socially satisfying ethical foundation for modern education, on the limitations of the scientific method, and on the importance of no longer confining instruction and discussion in the human and spiritual values to the level of higher education and the liberal arts. The humanities and the social sciences should be brought into the curriculum of the high school, vocational school, junior college, technical institute and engineering school. The Department of Humanities of the Union has been successfully experimenting since 1939 with the integration of social and humanistic studies with the curricula of the schools of engineering and art, and is now offering a sequence of studies which, taken as a whole, should give a perspective of the history of Western culture and an appreciation of their roles as citizens and as individuals.

The report recognizes that the professional world of engineering and art properly demands a breadth and depth of preparation and a sophistication which cannot be gained by conventional class-room routine. The Cooper Union has been able to keep the nucleus of the teaching staff of its School of Engineering reasonably close to normal in the war period, and resumption of full teaching loads after the War can therefore be undertaken with speed and efficiency and with only minor additions to the staff. Policies to be followed with regard to the re-training of the demobilized and their integration into academic and social life are indicated, and a sub-committee of the Engineering Faculty has set itself the task of determining those qualities and attributes which should characterize the products of the four engineering curricula. Reference is also made to the work of the Student Health Service in educating the student in the use of the facilities already existing in the surrounding community, and of the Division of Social Philosophy, which completed its first decade during the year, in the field of adult education.

Museums and Adult Education

AN editorial article in the *Australian Museum Magazine* (June–August, 1944) directs attention to the contribution which museums have already made towards adult education. At the same time, it points out that there still remains the necessity for far greater extensions of the museums' services in this direction. It is suggested, for example, that museums should be available to the public out of ordinary working hours ; that there should be better accommodation for study ; and that there should be an increase of suitably qualified staff to guide and assist students.

Society of Public Analysts and Other Analytical Chemists

THE annual general meeting of the Society of Public Analysts and Other Analytical Chemists, held on March 9, marked the seventieth anniversary of the Society. In the past year the membership of the Society increased by 117 to 1,197, and the circulation of the Society's journal, the *Analyst*, in spite of paper restriction, increased. In pursuance of the policy decided upon a year ago, the Society recently formed, within the framework of its constitution, two Groups concerned with particular branches of analysis, namely, the Microchemistry Group (chairman, Prof. H. V. A. Briscoe ; hon. secretary, Mr. R. Belcher ; present membership, 143) and the Physical Methods Group (chairman, Mr. R. C. Chirnside ; hon. secretary, Dr. F. Wokes ; present membership, 115). These Groups will hold meetings from time to time in London and elsewhere. The proceedings terminated with the presidential address of the retiring president, Mr. S. Ernest Melling, who, after reviewing some of the outstanding events of the past year in the Society's affairs, made some observations on the subject of water and water supplies. Dr. G. W. Monier-Williams was elected president for the present year.

Science Masters' Association : Annual Meeting

THE annual meeting of the Science Masters' Association will be held during April 9–11 at the City of London School. The president, Mr. C. L. Bryant, will speak on "The Impact of Science on Common Thought". The proceedings will include lectures by Dr. J. McG. Bruckshaw on "Physics and Economic Geology" ; Mr. C. Bibby on "Health Education through School Biology" ; "Penicillin", by Sir Alexander Fleming ; "Scope and Limitations of the Science Teaching Film", by Mr. A. Elton (at the Ministry of Information Theatre) ; "The Electron Microscope", by Mr. F. W. Cuckow ; "Chemistry of Plastics", by Mr. R. Maitland ; and a discussion on "The Role of Science in the Future Educational System". There will also be the usual exhibitions. The third lecture on the Science and Citizenship Foundation will be delivered by Mr. J. G. Crowther, who will speak on "The Social Relations of Science" ; this lecture is open to the public, and tickets for visitors can be obtained from Mr. W. Ashhurst, Epsom College, Surrey.

Announcements

THE Bristol Aeroplane Company has given £60,000 to the University of Bristol for the establishment of a Sir George White chair of aeronautical engineering, in memory of the founder of the Company.

THE Biochemical Society and the Nutrition Society have arranged a joint whole-day conference on "The Vitamin B-Complex", to be held on April 28, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Details of the programme will be published later.

PROF. JAMES MACKINTOSH, dean of the London School of Hygiene and Tropical Medicine, is visiting Sweden to lecture for the British Council on aspects of social medicine and health education in Britain. He will probably also visit Finland. Prof. Mackintosh hopes to obtain in Sweden information for inclusion in a report on housing which he is preparing for the British Government.

LETTERS TO THE EDITORS

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

Presentation of Scientific Data

WORKERS in certain branches of science have to carry in their heads many numerical results and constants, and to read and abstract a vast literature. This becomes even more arduous for those on the borderline between the exact and the descriptive sciences. The difficulties are greatly increased by the less rigorous presentation of borderline results, and by the less stringent editing of journals dealing with a variety of subjects. In chemistry and in physics the symbols and quantities are standardized, but in the applications little regard may be paid to recognized usages. A report drawn up by the Chemical, Faraday and Physical Societies in 1937 listed symbols for thermodynamical and physico-chemical quantities. These were accepted by the Royal Society in 1939. There are, however, many quantities not included in the list. For these, reference to the International Critical Tables or to the Smithsonian Tables is helpful. One major difficulty arises from the fact that the Greek letters and diverse founts of type are lacking on ordinary typewriting machines.

For numerical results it is suggested that, if possible, indices should be avoided, and when used they should refer to the basic unit. Though one may write 17 cm., it is preferable to avoid 17×10^{-4} cm. and to write 17×10^{-6} m., or better, 17 μ. This would be an aid to memory.

It would be a convenient convention if droplet sizes were given as diameters, rendering comparable, for example, the length of a bacillus and the diameter of a coccus with spray droplets. But at present those who measure droplets give diameters and those who carry out mathematical investigations give radii.

It is very confusing when quantities in the same analysis are given in different units. Workers in nutrition are offenders in this. For lack of better, they have to give certain quantities as I.U. (international units), but there is no defence for giving in consecutive lines of a table a vitamin as 19 μ gm./gm. and iron as 1·9 mgm./100 gm., whereas in fact the two quantities are identical. It would appear simpler to give both results in parts per million. Why do they darken understanding by reporting such quantities as per ounce of, say, bread? Surely micrograms are meaningless to workers in ounces, but anyone can understand percentages, parts per thousand and per million. Why write 10^{-8} oz.? It sounds ridiculously small and indefinite, but is actually slightly less than 0·3 μ gm. One may be surprised at detecting a substance "even in a concentration of $1 \times 10^{-10}\,\gamma$ per μ^3", but the feat is more credible when bluntly put as 0·1 gm. per litre.

It is somewhat of a shock to find depths of corrosion pits given in thousandths of an inch (mils) and the thickness of the overlying paint in microns, but to give the application of paint in square feet per gallon (Imperial or U.S.A.) is convenient and logical, with just this drawback, that it renders the determination of film thickness—simple in the metric system—quite complicated. Also one wonders why anyone should be allowed to report permeability "as milligrams of water per day per square centimetre of film area per mil of film thickness", or a liquid for destroying insects in cubic centimetres per 37 cubic feet of air, instead of using the factor 2360 to convert to the same unit of volume and reporting as parts in 87,000, or per 100,000. All the cases instanced have been met with recently. Furthermore, why do physiologists speak of the tension of oxygen, when they mean the pressure—and why, when a paper went to the Chemical Society giving the boiling point of a pure liquid as so many degrees at so many millibars pressure, was it sent back for conversion to millimetres of mercury, though the Meteorological Office publishes the atmospheric pressure in millibars? Could we not be a little more consistent—and spare our memories unnecessary figures? Could we not in technical reports use the metric system universally and translate such quantities as have workshop application into the British system—where necessary? At present there is often a medley of both systems with a vast waste of time in conversion from one unit to another. In measuring light we have even got to the mile-candle. Before autumn one may find candles per acre. After the War, Britain will be poor, so why should we handicap our scientific and technical development by carrying an antiquated system of measurement into new fields? But for those who have to convert, the British Standards Institution Publication 350 (1944) Conversion Factors and Tables is useful.

W. R. G. ATKINS.

Department of General Physiology,
Marine Biological Laboratory,
Plymouth.
Feb. 12.

Sublimation in a Wilson Chamber

As a result of some experiments on the deposition of water vapour at low temperatures, it was found that the liquid phase can frequently exist much further below the freezing-point than was expected. For example, droplets of super-cooled water can be obtained at — 50° C. without difficulty. It appeared also that the number of nuclei in atmospheric air on which water vapour could form ice crystals without the previous formation of droplets was small, and they appear to be active only below about — 40° C. Arrangements were therefore made to repeat Prof. C. T. R. Wilson's classical experiments below the freezing-point, both in thoroughly clean air and in ordinary atmospheric air. The following results were obtained:

Air thoroughly cleaned by repeated expansions. (1) Provided that the lowest temperature after expansion (that is, the temperature when expansion is finished and condensation just starts) does not fall below — 35·0° C., only liquid droplets are formed, however big is the expansion ratio.

(2) If the lowest temperature after expansion falls to — 35·1° C. (± 0·1°) a few ice crystals are formed among a much larger number of droplets. As the minimum temperature falls further below — 35° C., more ice crystals and fewer droplets appear, so that at lower temperatures a fog of ice particles is formed. Whether or not the solid phase appears depends only on the minimum temperature and not at all on the supersaturation.

(3) Provided that the lowest temperature after expansion falls below — 35·0° C., ice crystals are formed although the expansion is below the normal critical ratio.

(4) When the lowest temperature after expansion falls below about — 80° C., the number of particles formed decreases and a few of them change in appearance from transparent ice crystals to much larger grains of soft hail. At about — 100° C. only a few such grains fall down after expansion. Below about — 120° C. no particles are formed. The result does not depend on the expansion ratio, provided it is big enough to make the products visible.

(5) If the air be ionized by X-rays before the expansion, the density of the ice cloud formed is very greatly increased, but the limiting temperatures are not altered.

Ordinary atmospheric air. (1) The limiting temperature of — 35·0° C. found for clean air becomes — 27° C., and varies by ± 0·5° C. from one experiment to another. With air artificially contaminated with tobacco smoke the limiting temperature for the appearance of ice was as high as — 23° C.

(2) At the lower temperatures (— 80° to — 120° C.) the same decrease in the number of particles and the same changes in their appearance occur as in thoroughly clean air.

During the course of experiments, the expansion chamber was surrounded by a cooling bath of different temperatures, all below freezing point. A certain test to indicate the presence of the minutest amount of ice was to have *supercooled* water in the bottom of the expansion chamber. If any ice appeared in the chamber, it could not escape detection. It could not melt because all the surroundings were below freezing point. Within a few seconds, any ice particles which may be formed would seed the super-cooled water either by falling to the bottom or by contact with the film of super-cooled water coating the walls of the chamber. Then the water would freeze.

Some preliminary investigation of the properties of super-cooled water made it possible to use this indicator for initial temperatures of the chamber between 0° C. and — 10° C. Samples of a few cubic centimetres of water which can be easily supercooled were prepared by distillation (without boiling) and then boiling the sample for a few hours. Each sample has its own 'freezing point' which it keeps within 0·1° C. for, at least, a few months. The pressure, up to 100 atmospheres, does not affect the 'freezing point'. Addition of dust raises the 'freezing point'; but crystalline dust is not more active in this respect than amorphous dust. For initial temperatures below — 10° C. a long chamber was used. In such cases the ice particles which are formed high in the chamber grow sufficiently when falling to be observed in the beam of an arc lamp illuminating the bottom of the chamber.

It appears that ice particles formed in thoroughly clean air are formed by sublimation, and that sublimation phenomena due to adiabatic cooling differ essentially from phenomena of condensation since: (*a*) the formation of ice particles seems to depend only on the minimum temperature reached after expansion; (*b*) even in thoroughly clean air they are formed at supersaturations which are far smaller than those necessary to form water droplets. These results would seem to have interesting applications to the formation of clouds in the higher atmosphere.

B. M. CWILONG.

Clarendon Laboratory,
Parks Road,
Oxford.

Explanation of the Joshi Effect

THE interesting experiments of Joshi and co-workers, on what they call the new light effect, relate to the decrease of current flowing in the high-voltage exciting circuit of a Siemen's ozonizer, when radiations fall on the chlorine gas contained within the ozonizer. Alternating voltages of the order of 10 kV. are applied between the inside and outside walls of the ozonizer and the current is measured, its order of magnitude being about 50 microamperes. The experimental arrangement and the description of the effect are given in recent papers by Deo[1] and Joshi[2].

An explanation of this effect seems to be possible from the quantum-mechanical dispersion formula of Kramers, namely:

$$n^2 - 1 = 8\pi B \sum_{l,l'} \frac{\nu(l',l)\,|\,p_0 E(l',l)\,|^2}{h[\nu(l',l)^2 - \nu_0^2]}\, e^{-W_l^0/kT},$$

where $B = \dfrac{N}{\sum_l e^{-W_l^0/kT}}$, n is the refractive index of the gas for the incident light, and ν_0 is the frequency of the atom or molecule corresponding to a transition from an energy-level E (l) of quantum number l to the level $E(l')$ of quantum number l'.

$$\nu = \frac{E(l') - E(l)}{h}.$$

ν is negative if transition takes place from an excited level to a normal level. $p_0 E$ are the unperturbed matrix elements of the components of the electric vector E of the primary beam.

The formula shows that in an excited gas, the refractive index should be less than that for the normal unexcited gas, due to the negative terms in the formula for the excited states. This expectation was experimentally established by Ladenburgh[3] in neon. The equation applies to our case if we put ($n^2 = k$) the dielectric constant and ν_0 is the frequency of the electrical circuit, say, 50 cycles/sec. Hence when radiations fall on the chlorine gas, exciting it to higher vibrational and electronic states, the dielectric constant decreases and so does the dielectric current in the electrical circuit, which is essentially a condenser circuit, the plates of the condenser being the two electrodes of the ozonizer.

That our interpretation is not far from truth can be seen from the following considerations.

1. As the current is only of the order of 50 microamperes, for voltages of the order of 10kV., it shows that it is mostly a dielectric current and not the ordinary ohmic conduction current. For a discharge current the magnitude would be of the order of one milliampere[4]. As a matter of fact, Joshi says in one of his papers that when experimental conditions were such as to get a faint glow in the gas, the light effect decreased. This was due to the conduction part of the current having been increased, with the consequent decrease of the change of dielectric current with radiation, as percentage of the total current.

2. The effect is a maximum in white and violet light compared to that for lower frequencies, whereas chlorine has its maximum absorption in the former. This corresponds to increase of magnitude and the number of the negative dispersion terms. Both these effects make the relative change of current bigger numerically.

3. The maximum of the effect occurs, on the whole, in regions of lower voltages, because the lower the

voltage the more is the current of dielectric or displacement nature.

4. The maximum of the effect occurs at some range of pressures, neither too high (atmospheric) nor too low. At higher pressures, though the number of molecules is higher, the life and hence the relative number of the excited states will be lower on account of greater loss by collisions. Again, with decrease of pressure, the magnitude of the discharge current would increase, making $\Delta i/i$ numerically small. A compromise of all these factors leads to an optimum pressure (of the order of 50 cm. mercury) for particular experimental conditions.

An indirect experimental confirmation of our interpretation is the fact that the dielectric constant of ionized gases is less than unity. An excited molecule and an ionized molecule are different stages in the same direction. There may be other minor points associated with the effect, having different causes, for example, the influence of walls of the ozonizer on $\Delta i/i$, etc., but for the main fact of decrease of current with irradiation the effect of negative dispersion terms seems to be the right cause.

A possible weakness in our interpretation is that the intensity of the excited states is usually regarded as small as compared to the normal state.

Fuller details will be published later on.

R. PARSHAD.

Physics Laboratory,
Punjab University,
Lahore.
Jan. 15.

[1] Deo, P. G., *Ind. J. Phys.*, **18**, 84 (1944).
[2] Joshi, *Nature*, **154**, 147 (1944).
[3] Ladenburgh, *Rev. Mod. Phys.*, **5**, 243 (1933).
[4] Glockler and Lind, "Electrochemistry of Gases and other Dielectrics" (John Wiley and Sons).

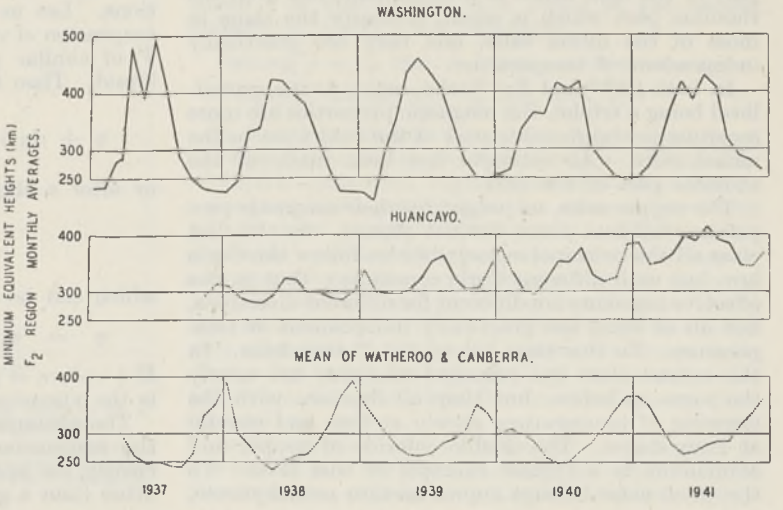
'Anomalous' Behaviour of the F_2 Region of the Ionosphere

IT has been known for some years that the seasonal and diurnal variations, and the geographical distribution of the maximum electron density N in the F_2 layer, the main observable region of the ionosphere, are anomalous in that they do not conform to the simple Chapman theory of ionization production, according to which N should be proportional to $\cos \chi^{1/2}$, where χ is the zenith distance of the sun. For example, in temperate and high latitudes in the northern hemisphere, the noon values of N show a minimum in mid-summer and a maximum in mid-winter, a variation which is exactly out of phase with theory; while in the southern hemisphere in temperate latitudes noon N exhibits maxima near the equinoxes and minima in mid-summer and mid-winter.

Two theories usually are jointly invoked to explain these and other similar anomalies. According to the first, the low values of N in mid-summer are due to a great expansion of the upper atmosphere by solar heating. On the Chapman theory, N is proportional to $T^{-1/2}$, so that such heating, if great enough, might explain the lowering of noon N in mid-summer. This view appears to be supported by the fact that h (max.), the height at which N is found, is some 150 km. greater in summer than in winter. The second theory explains the different type of variation in the northern and southern hemisphere as due to a superposed annual variation of ionization, of unknown origin, which has a maximum throughout the world in December–January and a minimum in June–July. Simple calculation shows that the expansion theory demands a summer value for T of the order ten times greater than the winter value, which is highly improbable on any reasonable theory of radiative equilibrium in the ionosphere, so that it seems desirable to explore other possible explanations of F_2 region anomalies. Evidence in support of an alternative theory is supplied by the data shown in the accompanying graph, which compares the monthly mean minimum equivalent heights h' for north temperate, south temperate and equatorial locations for the period 1937–41. The locations are, respectively, Washington, D.C., the mean of Watheroo and Canberra (Australia) and Huancayo (Peru). The data used were taken from that published regularly in *Terrestrial Magnetism and Atmospheric Electricity* during these years, together with the unpublished records taken at the Commonwealth Solar Observatory, Canberra. The Huancayo graph is drawn as a dotted line when the sun is to the south.

It will be seen from the graphs that the height variations in the northern and southern hemisphere are out of phase, showing a true seasonal variation, with maxima in mid-summer, as the 'heating' theory would predict. On the other hand, it is seen that h' at Huancayo does *not* show maxima when the sun is overhead (that is, in February and October), in disagreement with this theory. Inspection shows, however, that the Huancayo graph parallels that of Washington when the sun is north of Huancayo and parallels that for Australia when it is in the south. (The more complex graphs for N at the same stations, which are not reproduced here, show the same phenomenon.) This behaviour, which is similar to that of the diurnal variation of the magnetic declination at Huancayo, suggests strongly that the variations of h' and N are controlled, as are the magnetic variations, by large-scale tidal movements in the upper air.

Evidence for the existence of such a tide at these levels is presented in a separate communication. The



different seasonal behaviour of N in the two hemispheres is believed to be due to a difference in the seasonal variation of the phase of the tides in the two hemispheres.

D. F. MARTYN.
Council for Scientific and Industrial Research
and Commonwealth Observatory,
Canberra.

Magnetic Properties of some Paramagnetic Crystals at Low Temperatures

MEASUREMENTS have been made on the principal magnetic susceptibilities of single crystals of a large number of paramagnetic salts of the iron group, from room temperature down to about 80° K. A detailed discussion of the results on the basis of the crystalline field theory will shortly be published elsewhere. According to this theory, the deviations from the simple behaviour to be expected of the free ions are attributed to the Stark splitting of the energy-levels of the paramagnetic ion under the influence of the strong and generally asymmetric electric field that occurs in the neighbourhood of the paramagnetic ions in these crystals, due to the negatively charged atoms that surround these ions. The following are some of the main results obtained.

In manganous and ferric salts in which the paramagnetic ion is in the S-state, the anisotropies are negligibly small, and the temperature variation of the susceptibility almost exactly follows the Curie law $\chi = C/T$.

In chromic salts also this is so, even though the Cr^{+++} ion is not in the S-state. This is due to the fact that the lowest level in the Stark pattern of Cr^{+++} is a singlet, and it is widely separated from the upper levels; the singlet level, however, has a $(2s + 1)$-fold spin-degeneracy.

The nickel salts are very similar to the chromic salts in their magnetic behaviour, except that the spin-orbit coupling in Ni^{++} is much greater than in Cr^{+++}, and this conduces to a much larger deviation from the S-state behaviour than in Cr^{+++}; in other words, it leads to an appreciable magnetic anisotropy and deviation from the Curie law. These deviations are utilized to calculate the crystal field constants, and it is found that not only the cubic part of the field which is predominant, but even the rhombic part which is small, is nearly the same in most of the nickel salts, and they are practically independent of temperature.

In both Co^{++} and Fe^{++} salts, owing to the ground-level being a triplet, the magnetic properties are more sensitive to the rhombic part of the field than in the nickel salts. An estimate has been made of the rhombic part of the field.

The copper salts, as judged by their magnetic properties, fall into three distinct classes. In the first class all the principal susceptibilities follow the Curie law, but with different Curie constants; that is, the effective moments are different for different directions, but all of them are practically independent of temperature. To this class belong the Tutton salts. In the second class the principal moments are nearly the same as before, but they all decrease with the lowering of temperature, slowly at first and rapidly at later stages. The double chloride of copper and ammonium is a typical example of this class. To the third class belongs cupric acetate monohydrate, in which the principal moments are all very low even at room temperature and decrease rapidly as the temperature is lowered. The three classes correspond to the non-cubic part of the crystalline field, being very different, lowest in the first class and highest in the third.

The influence of covalent binding on the strength of the electric field, and ultimately on the breaking of the Russell-Saunders coupling not only between the spin and orbital moments, but also between the spins of the different electrons of the ion, and its effect on the magnetic properties of the ion, have been discussed.

Though in the majority of the crystals the magnetic axes do not change their directions in the range of temperatures studied, the change is appreciable in some crystals, the largest change observed being 7°.

There is an axis of magnetic symmetry in nickel and ferrous salts, even though the crystal structure does not lead to it.

My thanks are due to Prof. K. S. Krishnan for his interest in this work, and to the Indian Association for the Cultivation of Science, Calcutta, for facilities for carrying out the experiments.

BHAGAWATI CHARAN GUHA.
20 Larmini Street,
P.O. Wari,
Dacca.
Jan. 15.

Theory of Viscosity of Concentrated Suspensions

FOR infinitely diluted suspensions of rigid spheres, Einstein[1] derived on a rigorously theoretical basis the formula

$$\eta = \eta_0 (1 + kc), \quad . \quad . \quad . \quad (1)$$

where η is the viscosity of the suspension, η_0 is the viscosity of the pure solvent, c is the concentration by volume and $k = 2{\cdot}5$ is a constant. It has been shown that (1) is also valid for non-spherical particles, the factor k being a function of their shape, rigidity and Brownian movement. For elongated rigid particles, $k > 2{\cdot}5$.

If it is assumed that the suspension behaves hydrodynamically with respect to an additional particle as a homogeneous medium, it is possible to derive a theoretical viscosity formula for higher concentrations. Let us add a particle of a volume dV to a suspension of viscosity η, containing already a volume V of similar particles in a volume A of the pure liquid. Then the increase of the viscosity should be

$$\eta + d\eta = \eta\left(1 + k\frac{dV}{A + V}\right), \quad . \quad . \quad . \quad (2)$$

or after a slight rearrangement

$$\frac{d\eta}{\eta} = k\frac{dV}{A + V}, \quad . \quad . \quad . \quad (3)$$

which can be easily integrated, giving

$$\eta = \eta_0 (1 + V/A)^k = \eta_0 (1 - c)^{-k} \quad . \quad (4)$$

If $c = 0$, $\eta = \eta_0$, so that the integration constant η_0 is the viscosity of the pure liquid.

The assumption of hydrodynamical homogeneity of the suspension holds only if the particles are sufficiently far apart, so that their mutual interactions other than a general increase of viscosity are negli-

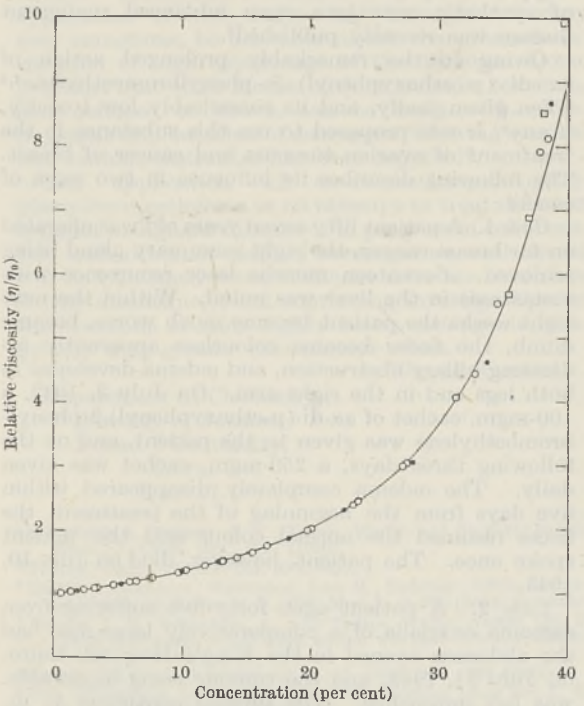
ible. However, under the shearing motion of the liquid the particles move relative to each other and collisions occur. These do not resemble collisions in a gas, the particles rolling round each other, until they reach such positions that a disengagement through further shear takes place.

It can be shown for suspensions of rigid spheres that each sphere is in collision for an average fraction of time proportional to the concentration c. During this time the colliding pair increases the viscosity more than a separated pair, due to a combination of several effects. The most important effect is caused by a certain volume of liquid being immobilized around the point of contact. This volume is proportional to the volume of the spheres. The total immobilized volume qVc, where q is a proportionality constant, should be thus subtracted from A and added to V in equation (4). Whence

$$\eta = \eta_0[1 + (V + qVc)/(A - qVc)]^k = \eta_0 (1 - c - qc^2)^{-k}. \quad (5)$$

The constant q was calculated by an approximate method to be not far from unity for rigid spheres, and it is expected to be much less, if the spheres are soft, as there will be less liquid immobilized around the point of contact. The shape factor k should also change slightly with concentration, as two colliding spheres behave as one non-spherical particle; but this effect is negligible compared with the effect of the immobilized liquid.

As there are no accurate viscosity data available for concentrated suspensions of rigid spheres, measurements of Eirich, Bunzl and Margaretha[2] extending only up to about 20 per cent, measurements of suspensions of glass spheres were made to test the formula (5). The glass spheres of 0·013 cm. diameter were kindly loaned by Dr. F. Eirich, being the same as those in his investigations. The spheres were suspended in a saturated solution of zinc iodide in water and glycerine which has the same density as glass and a high viscosity of 80 centipoises at 20° C.; this made corrections for inertia effects of the spheres unnecessary.



RELATIVE VISCOSITY OF SUSPENSIONS OF GLASS SPHERES AS A FUNCTION OF CONCENTRATION BY VOLUME.
Ostwald viscometer measurements, capillary diameter 0·23 cm., ●; capillary diameter 0·38 cm., ○; Couette viscometer measurements, □. Theoretical curve calculated from the formula (5) with $k = 2·5$, $q = 1·16$, full line.

Measurements were made in two Ostwald viscometers, having diameters of the capillary 0·23 cm. and 0·38 cm., and in a Couette apparatus with diameter of the inside cylinder 1·264 cm., of the outside cylinder 3·6 cm. The uncorrected measurements from different viscometers were in disagreement with each other, but after being corrected for the wall effects they agreed surprisingly well, as can be seen from the accompanying graph, where the corrected results from different instruments are plotted against concentration. The full curve represents formula (5) with values of $k = 2·5$ and $q = 1·16$, which are the values fitting best the measurements. The agreement of the measurements with the formula (5) is well within the experimental error up to a concentration of 37 per cent.

Above this concentration, suspensions subjected to shear are no longer isotropic and exhibit different viscosities in different directions; the rate of shear ceases to be proportional to the shearing stress and depends on the previous history of shears.

I wish to express my thanks to Dr. F. Eirich for the loan of the spheres. Detailed results will be reported elsewhere.

V. VAND.

Research Laboratories,
Lever Brothers and Unilever Limited,
Port Sunlight,
Cheshire.

[1] Einstein, A., *Ann. Phys.*, iv, 19, 289 (1906); 34, 591 (1911).
[2] Eirich, F., Bunzl and Margaretha, *Koll.-Z.*, 74, 276 (1936).

Fluidity and Molecular Structure

IT was pointed out by Porter[1] that, for mercury and water, the logarithm of the viscosity is a linear function of the logarithm of the vapour pressure. I propose a modified relationship introducing the critical pressure p_c, namely,

$$\log \varphi = a \log p/p_c + d,$$

where φ is the fluidity of a liquid at the vapour pressure p, a and d are constants.

Putting $p = p_c$, then $d = \log \varphi_c$, and we can write:

$$\log \varphi/\varphi_c = a \log p/p_c \text{ or } \varphi/\varphi_c = (p/p_c)^a \quad (1)$$

It has been found that, with the exception of associated substances, and apparently a small number of liquids possessing highly symmetrical molecules, a does not differ greatly from the mean value of 0·24 for all pure compounds examined. Equation (1) expresses an interesting extension of the theory of corresponding states, for it implies that, at the same reduced pressure, non-associated liquids have nearly the same reduced fluidities. Furthermore, as a rough approximation, such liquids possess the same value of $d = \log \varphi_c$, and so the fluidity or viscosity of a substance depends primarily on its 'distance' from the critical state.

In the simple Porter equation, $\log \varphi = a \log p + b$, b is the value of $\log \varphi$ at some arbitrary unit pressure; for example, expressing p in standard atmosphere

units, b becomes $\log \varphi_B$, the logarithm of the fluidity at the boiling point under 760 mm. of mercury pressure.

For substances examined having a approximately 0·24, it has been found that the function $M \log \varphi_B$, where M is the molecular weight, can be evaluated from a list of atomic and structural constants, and the fluidity of a given non-associated liquid at its boiling point be calculated with an average error of 3 per cent.

Work on these lines is now in progress together with an examination of the above relationships as applied to liquid solutions. Full details will be published as soon as possible.

L. H. THOMAS.

Department of Chemical Engineering,
School of Mines and Technology,
Treforest.
Feb. 5.

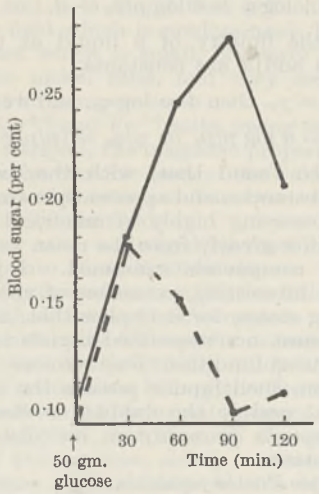
[1] *Phil. Mag.*, 23, 458 (1912).

Effect of Electrically Induced Convulsions on the Sugar Tolerance of Psychotic Patients

IN this Hospital, investigations are being made on the sugar tolerance curves of a number of psychotic patients. Abnormal curves in such patients have been found by workers in the past[1,2].

As progress is comparatively rapid during electric convulsion therapy, it was felt that possible changes in these curves during treatment might be present and this was in fact found to be so. Patients suffering from depressive and manic depressive insanity show the greatest abnormality in their sugar tolerance and also the greatest change in this during treatment. The typical curve before treatment is shown in the accompanying graph. The fasting level is normal or slightly raised, there is a rapid rise to heights well above physiological limits followed by a sharp descent, but not reaching the original level in two hours.

After two to six convulsions, although the mental condition improves, the curves show increasing abnormality. Thus, in most cases the fasting level is raised and the maximum reached in half or one hour is in the region of 0·4 gm. per cent. Gradually, after the mental condition has been normal for many weeks, the curves become normal too.



SUGAR TOLERANCE CURVE
Full line, patients; broken line, average normal.

In all cases of depression the first effects of electric convulsion therapy on the sugar-tolerance curve is to raise both the fasting level and the maximum.

This profound physiological disturbance described above is of great significance since it shows, at least for some mental disorders, a relationship between metabolism and the so-called functional disorders.

This investigation is being continued.

A. GLYNN.

County Mental Hospital,
Lancaster.
Jan. 23.

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Œstrogenic Substances showing Anti-tumour Action

CONTRARY to the general impression (due to publications attributing carcinogenic properties to œstrogens when administered to both sexes of different animals; also the œstrogenic activity, although notably weak, of many carcinogens), I have during my researches[1,2] on œstrogens come to believe that these compounds are not carcinogenic, and that they will most probably show at least some curative influence in the case of tumour diseases. I submitted a detailed report on "Œstrogens as Anti-tumour Compounds" to the Ministry of Public Health in Egypt on May 30, 1944. An account of the influence of synthetic œstrogens upon advanced malignant disease was recently published[3].

Owing to the remarkably prolonged action of αα - di - (*p* - ethoxyphenyl) - β - phenylbromoethylene[4,5] when given orally, and its remarkably low toxicity, if any[6], it was proposed to use this substance in the treatment of ovarian tumours and cancer of breast. The following describes its influence in two cases of cancer:

Case 1. A patient fifty-seven years old was operated on for breast cancer, the right mammary gland being removed. Seventeen months later recurrence with metastases in the liver was noted. Within the next eight weeks the patient became much worse, became dumb, the fæces became colourless apparently indicating biliary obstruction, and œdema developed in both legs and in the right arm. On July 3, 1943, a 100-mgm. cachet of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene was given to the patient, and on the following three days, a 250-mgm. cachet was given daily. The œdema completely disappeared within five days from the beginning of the treatment, the fæces resumed the normal colour and the patient spoke once. The patient, however, died on July 10, 1943.

Case 2. A patient aged forty-five suffering from sarcoma ovarialis of a comparatively large size had the abdomen opened in the King's Hospital, Cairo, on July 31, 1943, and the tumour being inoperable, was left untouched. The tumour continued to increase in size, filling the abdomen and pressing against the different abdominal organs. Treatment with αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene began on August 23, 1944, the œstrogen being administered

orally (6–8 gm. monthly, in 200-mgm. cachets, once, twice or thrice daily with intermittent intervals of 2–3 days every 3–5 days). A considerable improvement took place. Dr. Hamed Mohamed El Dewany, the private physician of this patient, states: "the patient suffered from sarcoma ovarialis. Surgeons and radiotherapists, who were consulted, considered the case hopeless. With the administration of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene proposed by Dr. Wadie Tadros, the tumour softened and decreased in size, and the patient was relieved from pain". The tumour, although at a slower rate, is at present continually regressing.

It is remarkable to note the drop of temperature almost to normal within 3–4 days after the administration of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene to cancer patients with temperature above normal. When tested *in vitro*, however, it was reported[7] that it had no anti-bacterial action.

Robson and Ansari[8] noted that the fate of this substance was, in some respects, very different from that of the œstrogens so far studied. Unlike the natural œstrogens, which are rapidly inactivated (chiefly by the liver), and stilbœstrol, which is rapidly eliminated from the body after absorption, it is stored in the body tissues to an appreciable extent and is eliminated comparatively slowly.

Although the administration of œstrogens in attempting to treat malignant diseases gave in many cases beneficial effects, it is to be noted that in dealing with the problem of these diseases, many factors, apparently interrelated, have to be taken into consideration. Among these may be mentioned the anæmia prior to or after the development of the malignant disease, secondary infections, degree of malignancy and toxæmia due to necrosis of tumour tissues. Moreover, it seems likely that controlled application of both radio- and œstrogenic-therapy may sometimes be desirable rather than the administration of high overdosage of the œstrogen alone, provided that other factors such as anæmia, toxæmia, etc., referred to above, can be dealt with. Prophylactic implantation of œstrogens following surgical and radium castration has been reported[9].

The application of αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene in an attempt to treat different types of malignant diseases is in progress in collaboration with different medical investigators, and results will be published when sufficient data are available. In the meantime, I am continuing investigations on the synthesis of more highly active œstrogenic compounds with greater anti-tumour effect.

WADIE TADROS.

Department of Chemistry,
Faculty of Science,
Fouad I University,
Cairo.
Dec. 17.

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Foot Rot (*Phoma* sp.) of Flax

FOOT rot disease of flax caused by a species of *Phoma* was first recorded in Ireland by Pethybridge *et al.*[1] in 1921. Since then it has been noted to occur consistently in the Northern Ireland crop although the responsible species of the parasite still awaits identification. A review of the literature indicates that *Phoma* has been reported as attacking the flax crop on the Continent of Europe since the 1890's, and, more recently, in Australia[2], the causal organism being variously referred to as *P. exigua*, *P. herbarum* and *P. linicola*.

Foot rot first becomes readily noticeable during mid-season when odd plants here and there in the crop show a wilted appearance. On pulling affected plants, pycnidia of *Phoma* will normally be found to occur in profusion along the basal portions of the stems (see photo.). The plants die prematurely and turn brown while the remainder of the crop is still green. Although foot rot is the phase usually encountered, the fungus can attack and kill the plants in the seedling stages (see photo.); the nature of the attack and the symptoms produced are largely determined by seasonal growth conditions.

The disease may be found if searched for in almost any season, but, until 1944, it was seldom found attacking more than a few straws in any crop, and it was for this reason that Pethybridge and Lafferty included it in the group of less important flax straw diseases referred to collectively as causing 'dead stalks' in the crop. That the disease may be of a serious nature and of epidemic importance was revealed in 1944 when some crops in Northern Ireland, Scotland and Wales were seriously affected; this epidemic outbreak was quite unexpected and, until then, no such cases had been recorded.

The pathogenicity of *Phoma* towards flax is well known, and has been confirmed by our experiments. Until now, however, it has been generally assumed that the parasite is normally soil-borne and that infection is most likely to occur through the medium of the soil. This may be so, but evidence accumulated during the past few years shows that the parasite may be seed-borne and indicates that the seed may be a more effective means for transmission than the soil. Seed produced in the more northerly and westerly parts of the United Kingdom is much more likely to be contaminated with the parasite than that produced in the south and east. This is due, no doubt, to climatic conditions and to the greater difficulty of harvesting non-weathered crops in the north and west. There is also a tendency towards a building up of seed contamination when seed is successively saved from crops grown in areas liable to favour the incidence of the disease and when a succession of poor seasons is experienced. It has been found possible to use the Ulster method[3] for determining the extent of seed contamination and this has proved most useful in the separation of clean from contaminated seed.

The fact that the parasite may be seed-borne raises the question of the efficacy of seed disinfection in clearing it from a seed sample. Using the same technique as that devised for *Colletotrichum linicola* and *Polyspora Lini*[4], we have carried out a large number of laboratory tests with the following results. 'Nomersan' (10 per cent tetra-methyl-thiuram disulphide), which has proved effective for the control of *C. linicola* and *P. Lini*[5,6], did not give very satisfactory results in the case of *Phoma*; repeated trials indicate it to be about 50 per cent effective when

LEFT, FLAX STEM (× 6) SHOWING PYCNIDIA OF *Phoma* SP.; RIGHT, FLAX SEEDLINGS ATTACKED BY *Phoma* SP.

used at the rate of 12 oz. per cwt. of seed. The short wet method of seed treatment using an 8 per cent solution of 'Ceresan U.564' at 0·9 gall. per cwt., although more effective than treatment with 'Nomersan', still did not provide adequate control. Further trials have been made using 'Arasan' (50 per cent tetra-methyl-thiuram disulphide), 'New Improved Ceresan' (5 per cent ethyl-mercury-phosphate), 'Fermate' (ferric dimethyldithiocarbamate) and 'Spergon' (98 per cent tetrachloro-*para*-benzoquinone). Of these materials promising results have been given by 'New Improved Ceresan' and 'Arasan'. Using 'New Improved Ceresan' at the rates of 12 oz. and 9 oz. per cwt. of seed, the contamination of a seed sample was reduced from 32·6 to 2·0 per cent and 5·5 per cent respectively. 'Arasan' used at the same rates reduced contamination to 10·8 per cent and 14·5 per cent. In the case of 'Arasan' it is of interest to note that the duration of the test had to be extended from seven to twelve days as this disinfectant exerts an inhibiting effect upon the fungus. No such effect was noted in the case of 'New Improved Ceresan' which appears to be more directly toxic. Whereas 'New Improved Ceresan' showed generally powerful fungicidal and bactericidal activity, the same selectivity was noted in the case of 'Arasan' as with other disinfectants with tetra-methyl-thiuram disulphide as the active constituent: in the case of bacteria and some fungi these materials have little or no effect.

Although it has not yet been possible to arrange for field trials with these materials, the high degree of correlation obtained between the results from laboratory and field trials in the case of *C. linicola* and *P. Lini*[7] suggest that results obtained in the laboratory should also be closely applicable in the field in the case of *Phoma*. It is proposed to adopt the use of both 'Arasan' and 'New Improved Ceresan' on a commercial scale during 1945. Of all the disinfectants tested for flax, 'New Improved Ceresan' offers the greatest promise for seed-borne diseases generally, its only drawback being its poisonous nature when compared with 'Arasan' and 'Nomersan'.

Tests made with samples of seed treated with 'Arasan' or 'New Improved Ceresan' at the rate of 12 oz. per cwt. have shown that such treatment has no effect upon germination. No adverse effects upon germination have been observed after treated seed has been stored for eight weeks either in small packets in the laboratory or in hundredweight lots subject to ordinary storage conditions. In all cases the moisture content of the seed used was below 10 per cent.

A. E. MUSKETT.
J. COLHOUN.

Plant Disease Division,
Ministry of Agriculture (N.I.),
The Queen's University,
Belfast. Jan. 19.

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A Method of Estimating the Activity of Spermatozoa

IN view of the absence of any satisfactory method for the quantitative estimation of the motility of spermatozoa, it is believed that the following method, evolved in relation to work on human semen, may prove of interest.

The semen is diluted with warm phosphate-glucose solution[1] (one in twenty gives a satisfactory dilution for semen containing 70–200 million sperm per c.c.). The dilution is thoroughly mixed by bubbling air through it with a pipette. One drop of fluid is placed on each of two Thoma counting slides. Over one drop is inverted a small straight-sided glass capsule lined with filter paper moistened with 2 per cent osmic acid. The osmic vapour permanently immobilizes all the sperm in about ten seconds. The capsule is removed, and cover slips are placed on both drops, taking the usual precautions to avoid running over. If the capsule is kept upside down on a glass plate, one drop of osmic acid will last about six hours.

The slides are put aside to allow the sperm to settle, that with the motile sperm being placed on a warmed microscope stage. After five minutes this slide is examined and a count made of the immobile, and of the feebly moving but non-progressive sperm in 160 small squares. The two figures thus obtained may be stated as x and y respectively. The actively moving sperm are ignored. A count is then made on the osmicated slide of all the sperm in 160 small squares, giving a figure z. Subtraction of $x + y$ from z gives the number of active sperm in the suspension corresponding to a total number of sperm z, and a volume of fluid contained in 160 small squares.

Sperm which have been cold for an hour or longer do not all become active immediately when mixed with warm diluting fluid, and maximum motility may not be reached until the dilution has been kept at 37° C. for an hour.

When repeated estimations of motility are required during the course of an experiment, it is essential to take two drops for comparison each time, as clumping or disintegration may cause a progressive reduction in the total number of sperm in the suspension.

This work has been assisted by a research grant from the Family Planning Association.

CLARE HARVEY.

Zoology Department,
University College,
Exeter. Jan. 5.

[1] Chang, M. and Walton, A., *Proc. Roy. Soc.*, B, **129**, 517 (1940).

MEAT IN GREAT BRITAIN

THE British consumer recognizes very clearly that war conditions have brought about marked changes in the kind as well as the quantity of meats we eat. The British farmer realizes the changes that have taken place under war controls in the methods of marketing the meat products of his farm. The former may long for the freer choice of kind, quality and price of pre-war times; the latter may wonder how far the present marketing systems foreshadow post-war schemes. Both are in doubt as to the supplies which may be available, and probably neither completely comprehends the broad complexity of the home supply-distribution situation, as it affects the home-market position. Moreover, meat is, in normal times, a foodstuff in which individual preferences for quality, as well as of purpose and price, are allowed wide play. The pie or the pot, the stew or the roast, an 'r' or no 'r' in the month—while such preferences can be signs of the housewife's whim, or her purse, they can also be factors affecting supply and distribution.

At a meeting of the British Society of Animal Production, held on February 21, the meat situation in Great Britain was reviewed from three main aspects, the leading papers being: on supplies, by Major W. H. Warman and Mr. R. W. Pomeroy; on carcass quality and grading, by Dr. E. H. Callow; and on the marketing and distribution of home-produced meat and livestock, by Mr. T. J. Shaw.

Before the War, Great Britain consumed, in addition to her own production, about 90–95 per cent of the world's exported surplus of meat. Advances in processing techniques have given us chilled, frozen, boned and canned meats. Whatever the country of origin of the imported meat, its production, processing, grading, transport and distribution were organized towards meeting fairly specific consumer demands, which formed only part of the home-consumption market. In contrast, British home production was all absorbed here in its wide variety of kinds, weights, qualities and prices. Again, owing to, or coincident with, the canalization of the whole industry in exporting countries, the treatment and utilization of edible and inedible offals have become highly developed and contribute to the efficiency and economy of the processing system. In contrast there were, before the War, just over 16½ thousand slaughter-houses, private and municipal, handling roughly 17½ million carcasses which formed the home supply of Great Britain. Further, within Great Britain we have fairly well defined importing and exporting areas; for example, the populous conurbations, as against Scotland and the south-west of England, respectively. So far as stock movements are concerned, there were frequent changes in ownership, not necessarily connected with changes in the condition of the stock; for example, store stock could change hands several times as stores, and partly fattened animals pass from one owner to another without progressing much towards the 'finished' slaughter stage. Also, the question of the effect of movement of fat stock on the quality of the carcass still needs investigation; for the best results and the most efficient supply service, should finished stock be slaughtered in the producing areas or in the consuming areas?

In relation to consumer's preferences the general trends up to 1939 were towards youth rather than to age, to tenderness rather than flavour, and to lighter weights rather than large cuts. Geographical variations complicated the situation; thus while the Midlands and the north preferred large pork and bacon carcasses, London and the south favoured pork of about 60–80 lb. weight. Moreover, even with the wide use of feeding-stuffs imported from overseas, there were marked seasonal fluctuations in the kinds of meat produced here: stall-fed winter beef, autumn grass-fed beef, lamb from the arable flocks of the south in spring, hill lambs and ewe mutton later in the year, and older lambs bred on the hills but fattened on root grounds still later, and on into the first months of the year. Also, in spite of these trends we consumed—we had to, though Lancashire liked to—considerable quantities of cow beef, thereby absorbing the high wastage in our milk-producing herds.

War economy has imposed severe changes on this general structure. The emphasis is on quantity—weight rather than quality. The exclusion of imported feeding-stuffs has placed reliance on home-grown fodders, and revealed a 10 per cent fluctuation in autumn weights between good grazing seasons and bad. Fat stock pass into control at local collecting centres at which the basis of payment is fixed according to grading schedules. Local consumption, apart from supplies originating overseas, is closely related to local production.

The results of these measures of control were soon manifest in all classes of meat, but in one respect the harvest is still to appear—the emphasis on dairy stock which attends the priority given to milk production is judged to lead, with herd wastage still high, to a relative increase in the beasts with inferior capacity to give good beef. Yet nuclei of good beef-breeding types remain, and our presently diminished pig and sheep stocks still contain those types upon which, by appropriate use and from suitable combinations in cross-breeding, the British meat-producing industry could be rebuilt in its multiplicity of kinds and qualities.

If the post-war rehabilitation and form of the meat-producing industry of Britain are to be grossly influenced by the use of imported feeding-stuffs, the questions of available shipping and of available exchange will be prominent. Also, but by no means independent of these, there is the long-term trend for many of those countries which have in the past exported feeding-stuffs to prefer to convert those feeds to carcasses at home, and thus to export, for example, their cereal grains as meat, of higher cash value per unit weight. Behind all, there lie the possible and prospective changes in methods of production and local consumption and demand in the areas from which our meat imports were derived.

This review only touches upon some of the major topics which emerged in the general discussion; it may indicate how the problems are interlaced and the need for much further precise information. Fortunately, there has been a steady accumulation of data which tend to resolve the elusive problems of meat quality and to elucidate the relationships of growth, fattening and food values. In this direction, at least, the scientific principles on which the characteristics of the consumers' demands can be interpreted back to the producer are becoming revealed, and the exposition of the results of recent work in this field at the Low Temperature Research Station at Cambridge made a valuable contribution to the proceedings.

It is hoped that a full report will shortly be published by the Society. J. E. NICHOLS.

A COLTSFOOT PROBLEM

By RICHARD MORSE

SOME time ago, when I was carrying out some investigations concerning the behaviour of plants, I came across the statement, in Sir J. E. Smith's "English Flora" (1829), that the flowers of the coltsfoot (*Tussilago farfara*) are "drooping in the bud". The statement surprised me because, although I had been observing the behaviour of this plant fairly closely over a number of years, both in its wild state and under controlled conditions, I had never once seen it produce flower buds that could in any sense be called drooping. As it was inconceivable that the coltsfoot had changed its behaviour since 1829 I could only conclude that the great botanist was in error; and there the matter was allowed to rest.

Recently, however, I have had occasion to inquire into the subject again, and have been amazed at the number of authors who have, in one form or another, repeated Sir J. E. Smith's statement—a statement which I still believe to be wholly untenable.

In Richard Deakin's monumental "Florigraphia Britannica" (1847), for example, the coltsfoot is described as having "the bud drooping, erect when in flower". Yet Deakin was, presumably, a careful worker with an extensive knowledge of British plants, for we are assured in his fourth volume that the entire series of illustrations, numbering well over 1,600, "are accurate facsimiles engraved from original drawings, made by the Author from the Plants themselves, and carefully coloured after nature".

Again, in the third volume of the five which Anne Pratt devoted to "The Flowering Plants and Ferns of Great Britain" (1856), reference is made to "the drooping unexpanded flower-buds" of this plant; in Hooker's famous "Student's Flora" (1884) appear the words "drooping in bud"; in Johns' "Flowers of the Field" (1919) the phrase takes the form of "drooping before expansion"; in Babington's "Manual of British Botany" (1922) the heads are spoken of as being "erect in blossom and seed, drooping before and after flowering"; and in Macgregor Skene's "A Flower Book for the Pocket" (1935) occurs the similar statement that "the head droops in the bud and again after flowering".

The above books, it will be observed, cover the period 1829–1935, so that, during more than a hundred years, students of British botany have been asked to accept, in regard to one of our commonest native plants, a statement which, so far as my experience goes, has no foundation in fact, and yet which, so far as I know, has never been discussed or corrected—save for one brief reference that I myself made to it in a broadcast talk some years ago.

What makes the problem stranger still is the fact that several of the books I have mentioned have passed through more than one edition, without, so far as one can tell, any query being raised as to the correctness of the assertions made. Thus my quotations are taken from the second edition of Smith's "Flora", the third edition of Hooker's, the tenth of Babington's "Manual" (edited by A. J. Wilmott), and the thirty-fourth of Johns' "Flowers of the Field" (revised by G. S. Boulger).

Allusions to the coltsfoot's alleged habit of drooping its flower buds, moreover, are by no means confined to books of the more scientific *flora* type. They have crept also into our agricultural, educational and 'popular' botanical literature.

Thus in the Ministry of Agriculture's "Collected Leaflets on Weeds", second edition, 1923, we are told that "at first the flower heads droop, but when they open out they are erect"; and H. C. Long, in his "Weeds of Arable Land" (1929), uses precisely the same words.

Similarly, Prof. F. Cavers, in his "Life Histories of Common Plants" (1913)—a book intended chiefly for student teachers—tells us that each flower head "at first droops, but later becomes straight"; and in his more advanced work entitled "Botany for Matriculation", revised by L. C. Fox in 1931, those exact words are repeated.

In books of a less scientific character, written chiefly for the general public, the alleged drooping buds of the coltsfoot have been mentioned time and again, for although nutant flower buds are common enough in Nature, this particular story seems to have caught the popular imagination. In James Cundall's "Everyday Book of Natural History" (1866), for example, we read that "at first the flower bud is pendulous, and is thus protected from the rain; as soon, however, as the bloom is ready to unfold to the sun, the flower stalk becomes erect".

John J. Ward, in his "Life Histories of Familiar Plants" (1908), is even more explicit. "The coltsfoot," he says, "guards its pollen almost as a bird does its eggs. When at first the flower stem peeps above the soil, its head droops while the stem elongates. Then, suddenly, the head becomes erect and the florets are exposed."

Again, G. Clark Nuttall, in his fascinating seven-volume work entitled "Wild Flowers as they Grow" (1912), tells us that, in February, the coltsfoot's "hard, thick stem with drooping head pushes up through the earth"; while Edward Step, in his "Spring Flowers of the Wild" (1927), says that "until the female florets are ready to open, the stem is bent, so that the head droops".

I must confess that I am much puzzled by the above and other similar references to what I believe to be a wholly fictitious phenomenon. At the time of writing I have no access to floras of a date earlier than Sir J. E. Smith's, so I am unable to say whether the belief in the coltsfoot's drooping flower buds goes back beyond his day or not.

Two possible explanations of the prevalence of the belief occur to me. One is that, after someone's original blunder, author has copied author through all these years without ever referring to the plant itself; and the other is that the closed fruit heads have been mistaken for unopened flower heads. The fruit heads do, of course, droop for a time after fertilization has taken place. They are, however, so markedly different in appearance from the flower buds that it seems almost incredible that even the veriest amateur could mistake one for the other.

But there is also, of course, the further possibility that my own observations of the plant are at fault. On that point, however, I must leave readers to judge for themselves.

Perhaps I should say, in conclusion, that the omission of several well-known floras from the above list must not be taken to mean that they have not been consulted, but simply that I have not yet found one that controverts the statement made by Sir J. E. Smith. There is no reference to the matter, for example, in Withering's "Arrangement of British Plants" (1830), or in Hooker and Arnott's "British Flora" (1850), or in Grindon's "British and Garden

Botany" (1864), or in Bentham's famous "Handbook" (1924), or in Bonnier's "British Flora" (1925) or in any similar work to which I have access. Brimble, in his "Flowers in Britain" (1944), does not query Smith's statement; but, though he refers to the flower heads being "borne at the ends of thick, erect stalks with hairy bracts", he does not state that the flower buds droop. Furthermore, an illustration shows an erect flower bud.

THE BROAD TAPEWORMS OF MAN, CORMORANTS AND GULLS

J. B. DUGUID and E. M. Sheppard (*J. Path. and Bact.*, **56**, 73; 1944. See also *Nature*, **154**, 185; 1944) described their discovery of plerocercoids of a Diphyllobothriid tapeworm in freshwater trout and sticklebacks in a South Wales reservoir and their work on its life-history. M. D. Hickey and J. R. Harris (*Brit. Med. J.*, 310, Sept. 2, 1944) also found Diphyllobothriid plerocercoids in trout in the Dublin area, and a Diphyllobothriid adult tapeworm in seagulls and cormorants there (see also M. D. Hickey, *Brit. Med. J.*, 482, Oct. 7, 1944, and K. Unsworth, *ibid.*, 385, Sept. 16, 1944). K. Unsworth (*Ann. Trop. Med. and Parasit.*, **38**, 213; 1944) has now published the results of his work on the life-history of the South Wales species.

Starting with a rat infested by Duguid and Sheppard, Unsworth was able to confirm the results obtained by them. He successfully infested the copepods *Cyclops strenuus* and *Diaptomus gracilis*, which Duguid and Sheppard also used, but found that the former was the best first intermediate host. The nauplius larva of Cyclops readily ate the coracidia, which were fully developed by the time that the later copepod stages were reached. After 16–20 days of development in Cyclops, which Unsworth describes, the Cyclops were fed to sticklebacks, in which plerocercoids were obtained, chiefly in cysts on the serous surface of the stomach, under the peritoneum and under the liver capsule. When these sticklebacks were fed to one pike, which is known to be a second intermediate host of *Diphyllobothrium latum* of man, one plerocercoid was obtained from the pike. When plerocercoids from both the infested sticklebacks and the pike were fed to puppies aged 2–3½ months, the adult tapeworm developed in the puppies, which passed eggs in their fæces. Coracidia from these eggs infested Cyclops. Unsworth makes the interesting and epidemiologically important suggestion that the overwhelming infestation of the trout in so large an expanse of water in South Wales (100 per cent) was due to the fact that the trout ate sticklebacks which had already infested themselves by eating infested copepods. He supports this suggestion by the observation that the commoner fish hosts which harbour plerocercoids of Diphyllobothriid species (for example, perch, pike, wall-eyed pike, trout and burbot) are all fish-eating species, while the less common fish hosts of these plerocercoids (for example, grayling and pollan) eat fish only at times. Unsworth was unable to identify the species of Diphyllobothrium with which he was dealing, because he obtained only the scolex and immature anterior segments of the adult from the puppies which he experimentally infested; but, from these, he concluded that the South Wales species studied by him was too small to be *D. latum* of man. He was also able to infest puppies with plerocercoids sent to him by Hickey from the Dublin area, so that this Dublin species can apparently develop to maturity both in a mammal and in birds (gulls, herring gulls and cormorants). Unsworth concluded that the Irish species is not *Diphyllobothrium latum* of man. The immature stages are not, however, enough for the identification of species of *Diphyllobothrium*.

All these workers sent specimens of the adult tapeworms obtained by them to H. A. Baylis of the British Museum, who concludes (*Brit. Med. J.*, 868, Dec. 30, 1944) that all the tapeworms obtained from the gulls represented one species, and all those from the cormorants another. Comparison of the worms obtained from the experimental mammalian hosts by all the workers led Baylis to conclude that all the workers were dealing in their experiments with a single species, which is probably the old but little-known species *D. dendriticum* (Nitzsch, 1824). In experimental mammalian hosts this species showed slight differences from species found in gulls, probably because the mammal is an abnormal host.

The question raised in the *Lancet* (475, April 8, 1944) that the species found in South Wales might possibly be *D. latum* of man, which does occur in the west of Ireland (see below) and might possibly have been brought to Britain by Polish and Norwegian refugees, as it has been established endemically in North America by immigrants, would seem to have been negatived by Baylis's decision. The whole question, however, requires further investigation, for T. E. Gibson (*Brit. Med. J.*, 200, Feb. 10, 1945) records yet another infestation of trout in a Northamptonshire reservoir with plerocercoids morphologically similar to those described by Duguid and Sheppard. These failed to infest a guinea pig, but they did infest three rats, which finally threw off the infestation spontaneously, as Unsworth's puppies did. Gibson also found plerocercoids "of a smaller type" in 40 per cent of "smaller fish" in the same reservoir, but attempts to infest rats with these have so far failed (see also T. Hare, *Brit. Med. J.*, 347, March 10, 1945). In addition to this, Dr. Peterson of Yell informed Duguid and Sheppard that a species of *Diphyllobothrium* is also endemic among freshwater trout in some of the Shetland Islands.

With regard to the occurrence of *Diphyllobothrium latum* in man in west Ireland, N. O'Connor (*Brit. Med. J.*, 737, Dec. 2, 1944), discussing multiple infestation of man with two types of tapeworm, states that the existence in Ireland of *D. latum* of man was first recorded by O'Farrell (*Lancet*, i, 466, 1916; i, 570, 1918; and *Irish J. Med. Sci.*, vi, 95; 1929). Another case was reported by O'Kelly (*Irish J. Med. Sci.*, vi, 188; 1935). The first case of multiple infestation was recorded by O'Farrell (*Irish J. Med. Sci.*, vi, 542; 1930). All these cases came from the Shannon area. O'Connor (*loc. cit.*) himself records the infestation of a husband and wife with *D. latum* in the River Erne area, near lakes not connected with the River Shannon, the wife's infestation being multiple and combined with infestation with *Taenia saginata*. Both ate perch, pike and eels, but no trout; the wife often ate undercooked meat and raw pork. The husband had never been abroad; the wife was born of Irish parents in Glasgow, which town she had visited only twice within the last twenty-three years. G. W. S. Andrews and A. C. Ogilvie (*Brit. Med. J.*, 772, June 3, 1944) record a case of multiple infestation with *Taenia saginata*.

G. LAPAGE.

FORTHCOMING EVENTS

Saturday, March 24

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, N.W.1), at 10 a.m.—Tenth Annual General Meeting; at 10.30 a.m.—Dr. C. F. A. Pantin, F.R.S.: "The Interrelationship of Biology Teaching in Schools and Universities"; at 2 p.m.—Dr. Stanley Kemp, F.R.S.: "Marine Investigations"; at 2.45 p.m.—Dr. S. A. Neave: "The Work of the Zoological Society"; at 3.30 p.m.—Mr. J. C. F. Fryer: "Zoological Interests of the Agricultural Research Council"; at 4.15 p.m.—Dr. E. B. Worthington: "Freshwater Investigations".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. H. Ridley: "An Experimental Approach to Time Lapse Cinematography".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION of the ROYAL INSTITUTE OF CHEMISTRY) (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Dr. U. R. Evans: "The Principles governing Corrosion Resistance in Metals and Alloys".

Monday, March 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Dr. S. E. Hollingworth: "Zones of Rock Flow and Resulting Land Forms".

ROYAL INSTITUTE OF CHEMISTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Dr. Harold Moore: "Industrial Non-Ferrous Alloys".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Future of Synthetic and Thermoplastic Insulated Cables" (to be opened by Mr. T. R. Scott).

Tuesday, March 27

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting. Discussion on "The Social Aspects of Television" (to be opened by Capt. C. H. Cazaly).

Thursday, March 29

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 5.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

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

CHIEF METALLURGIST by Midland firm to take control under the General Management of the metallurgical side of the production of cold rolled mild, alloy and carbon steel strip—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3759.XA) (March 28).

LECTURER IN THE ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT of the Coventry Technical College—The Director of Education, Education Offices, Coventry (March 29).

ASSISTANT ENTOMOLOGIST (temporary)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (March 31).

ASSISTANT LECTURER (well-qualified Graduate) FOR MATHEMATICS AND PHYSICS, at the Norwich City College and Art School—The Director of Education, City Hall, Norwich (April 3).

CHAIR OF AGRICULTURAL CHEMISTRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (April 6).

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING of the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (April 7).

METALLURGIST GRADUATE for development work in large Steel Foundry in South Midlands—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2119.XA) (April 9).

CHEMIST on the staff of the WATER POLLUTION RESEARCH LABORATORY, Watford—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3403.A) (April 10).

FOOD CHEMIST in the Research Department of a well-known London firm to carry out the analysis of a wide range of food materials packed in metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2722.XA) (April 14).

LECTURER IN GENERAL ENGINEERING SUBJECTS, and a LECTURER mainly for ENGINEERING MATHEMATICS—The Registrar, Merchant Venturers Technical College, Bristol 1 (April 15).

WORKS PROCESS CHEMIST for new factory in India—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3705.XA) (April 17).

Senior Post as RUBBER RESEARCH CHEMIST with a large Company in the North of England engaged in rubber manufacture—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3360.XA) (April 17).

METEOROLOGICAL OFFICER CADETS, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (April 20).

ENGINEER FOR THE POSTS AND TELEGRAPHS DEPARTMENT of the Government of Nigeria—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D.971.A.) (April 21).

SENIOR LECTURER (ungraded) IN HISTOLOGY—The Registrar, The University, Liverpool (May 31).

UNIVERSITY CHAIR OF BACTERIOLOGY, tenable at University College Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (June 25).

HIGH-GRADE TECHNICIAN (male) for laboratory concerned with the construction of moulded applicators individually fitted to patients—The General Superintendent, Christie Hospital and Holt Radium Institute, Withington, Manchester 20.

TELECOMMUNICATIONS ENGINEER by S.E. London engineering firm—The Ministry of Labour and National Service, Appointments Department A.3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. QS.91).

ASSISTANT SECRETARY—The Royal Photographic Society, 16 Prince's Gate, London, S.W.7 (endorsed 'Assistant Secretary').

SPEECH THERAPIST—The Director of Education, Education Offices, Moss Street, Bury, Lancs.

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 3, December 1943. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Kueneman. Pp. iv+159–238. (London: H.M. Stationery Office, 1944.) 4*s.* 6*d.* net. [152

Glasgow Art Gallery and Museums. Report for Year ending 30th June 1944. Pp. 24. (Glasgow: Glasgow Art Gallery and Museums, 1945.) [162

British Coal Utilisation Research Association: Steam Engineering Department. Progress Report for Year ending April 1944, and Programme for Year commencing May 1944. Pp. 14. (London: British Coal Utilisation Research Association, 1944.) [202

A.Sc.W. Facts. Pp. 20. (London: Association of Scientific Workers, 1944.) 3*d.* [202

University of Leeds. Report of the Librarian for the Session 1943–44. Pp. 5. (Leeds: The University, 1945.) [222

National Smoke Abatement Society. Fifteenth Annual Report for the Year ended December 31st, 1944. Pp. 16. (London: National Smoke Abatement Society, 1945.) 2*d.* [222

Tools for the Next Job: a Policy of Progress through Productivity. (Published for the Tory Reform Committee.) Pp. 64. (London: Europa Publications, Ltd., 1945.) 2*s.* 6*d.* [272

Some Notes on the History and Principles of the Shepherd System of Air Disinfection. Pp. 12. (London: Shepherd's Bactericidal Aerosols, Ltd., 1945.) [272

Ministry of Health. Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations and Points of Interpretation. Mental Nurses S.C. Notes, No. 2. Pp. 6. (London: H.M. Stationery Office, 1945.) 1*d.* net. [272

Imperial Forestry Institute: University of Oxford. Twentieth Annual Report, 1943–44. Pp. 12. (Oxford: Imperial Forestry Institute, 1944.) [272

Other Countries

Nutrition Problems in Relief and Rehabilitation: Planning for the Post-War Area. By Moses Schonfeld. Pp. vii+30. (New York: American Chapter, Religious Emergency Council of the Chief Rabbi of the British Empire, 1944.) 75 cents. [52

Newfoundland Government. Research Bulletin No. 14: A Biological and Economic Study of Cod (*Gadus callarius*, L.) in the Newfoundland Area, including Labrador. By Dr. Harold Thompson. Pp. 160. (St. John's: Department of Natural Resources, 1943.) [72

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 31: The Effect of Storage under certain Specified Conditions on the Quality of Indian Cottons. By Dr. Nazir Ahmad and A. N. Gulati. Pp. 21. (Bombay: Indian Central Cotton Committee, 1944.) 1 rupee. [72

South Australia: Institute of Medical and Veterinary Science. Sixth Annual Report of the Council, July 1943—June 1944. Pp. 12. (Adelaide: Institute of Medical and Veterinary Science, 1944.) [72

U.S. Office of Education: Federal Security Agency. Misc. No. 7: FM for Education: Suggestions for Planning, Licensing and Utilizing Educational FM Radio Stations Owned and Operated by School Systems, Colleges and Universities. By William Dow Boutwell, assisted by Ronald R. Lowdenmilk and Gertrude G. Roderick. Pp. ii+54. (Washington, D.C.: Government Printing Office, 1944.) 20 cents. [122

Ministry of Finance, Egypt: Survey Department. Geodesy in Egypt. By J. H. Cole. Pp. x+164. (Cairo: Government Press, 1944.) P.T. 50. [202

Colony of Mauritius: Department of Agriculture. Fourteenth Annual Report of the Sugarcane Research Station, 1943. Pp. ii+17. (Mauritius: Government Printer, Port Louis, 1944.) 50 cents. [202

Anuario del Observatorio Astronómico de Madrid para 1945. Pp. 374. (Madrid: Instituto Geográfico, 1944.) [202

Publicaciones de la Facultad de Ciencias matematicas, Fisico-quimicas y naturales, Aplicadas a la Industria, de la Universidad Nacional del Litoral. Serie Conferencias y Textos, Publicación No. 21: Teoria general de las magnitudes físicas. Por Prof. Walter S. Hill. Pp. 112. 4 dollars. Serie Tecnico cientifica, Publicación No. 22: Combustion nuclear. Por Prof. Walter S. Hill. Pp. 72. 3.50 dollars. (Montevideo: Instituto de Fisica, 1941.) [202