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ADULT EDUCATION AS A SOCIAL ACTIVITY

THE problems of man-power and woman-power to which attention has been directed by recent speeches of the Minister of Labour and National Service in view of the growing demands which the War is making upon our resources, have two main aspects, mobilization and utilization. The former is liable to receive more than its due share of attention, and the recent report of the Beveridge Committee on Skilled Men in the Services is a timely reminder that the reservoirs of labour, skilled or unskilled, male or female, are strictly limited. The mobilization of every available man or woman will be insufficient to develop our full fighting and productive powers unless there is wise apportionment of labour between the different fighting services, war production and the essential services, including civil defence, transport, and the like. Equally it will not be developed unless that disposition is made in conditions which call forth from each individual his or her maximum effort, and in which physical, mental and moral vigour can be sustained through whatever days of trial or endeavour lie ahead.

The question of morale is thus of supreme importance, and Mr. Bevin's remarks on management in his recent statement in the House of Commons may arouse misgivings as profound as any of the revelations in the Beveridge Committee's report. The responsibility of management in the maintenance of the conditions which promote industrial efficiency is so fundamental that the failure of the Minister to utilize the powers which he already possesses to deal drastically with inefficient management will recoil severely on his own head if not rectified. The co-operation between management or employer and the worker has two sides, but we cannot complain of lack of response on the part of the worker until the employer —and the Government—have done their utmost to establish the right conditions.

The prescience of Mr. Winant's words in his valedictory report to the International Labour Organisation last year has been attested by much that has happened in Great Britain and in the United States since they were written. The democracies cannot survive unless they achieve effective co-operation between Governments and organizations of employers and workers. Its absence is the primary and fundamental cause of waste of labour, whether in the neglect of personnel management, the failure to establish proper working conditions, to utilize the scientific knowledge acquired so painfully in the field of industrial health, or in the petty misunderstandings over income tax deductions and the like through indifference to psychology and the human element generally.

Mr. Bevin in his speech rightly referred to a great weakness in British industry due to the failure of employers to give the personnel management its proper status. Although over a very wide field of industry that mistake is now being rectified, we still suffer from the long neglect to extend the scientific study of the human side of industry. With adequate

support in the past such bodies as the Industrial Health Research Board and the National Institute of Industrial Psychology could have been ready with a far wider range of experience for the solution of pressing problems. As it is, the reports of the Select Committee on National Expenditure, like the emergency reports of the Medical Research Council, bear melancholy witness to the failure to apply knowledge on hours of work and working conditions generally which were acquired a quarter of a century ago.

There are welcome signs that, in the Services as well as in industry, the scientific use of labour is being attempted on an increasing scale. The appointment of an advisory committee consisting of Dr. C. S. Myers, Prof. J. Drever, Prof. F. C. Bartlett and Prof. C. Burt to assist the Director of Personnel Selection shows that the Army recognizes the value of scientific knowledge in this connexion, and the annual report of the National Institute of Industrial Psychology affords other evidence of the utilization by the Services of scientific men in the training and selection of personnel. The scientific aspect, however, is only one side of the problem. Important as may be scientific selection and training of labour, the use of scientific knowledge to establish the best working conditions, to minimize hazards to health, to eliminate accidents and to reduce friction between management and workers, more is required if production is to reach its maximum efficiency.

Despite the emphasis placed on this subject by the Acting Director of the International Labour Office in his report to the International Labour Organisation Conference at New York last October, and the admirable report on War-time Developments in Government-Employer-Worker Collaboration prepared for consideration at the same Conference, neither in Great Britain nor in the United States can we be said to have reached the heart of the problem. Primarily it is one of education, and the main responsibility for initiative must inevitably lie on the Government. Moreover, it is a question of adult education; not merely of educating the adolescent entering industry for the first time, but rather of enabling the great mass of adult workers to understand what is required of them, to see their own part in relation to the task of the nation, and how their own zeal and efficiency and sacrifice can fortify the national effort and shorten the road to victory.

The vital importance of adult education in this matter has, generally, not been grasped. It completely transcends the scheme for joint consultative and advisory committees consisting of representatives of workers and managements already initiated for the Royal Ordnance Factories by the Director-General, Sir Charles McLaren. These committees are intended to smooth difficulties by arranging the regular exchange of views between management and workers on matters relating to improvement of production and increase of efficiency.

A constitution for Factory Production Committees was signed on February 26 by representatives of the Ministry of Supply and of all the trade unions having members in the Royal Ordnance factories. The functions of the committees are defined as "to consult and advise on matters relating to production and increased efficiency in order that maximum output may be obtained". Meetings will be held fortnightly or as required, but the workers' side is to meet weekly to expedite procedure. A central committee has been set up to ensure immediate and efficient application of the scheme and it will act as a pool for ideas.

This development is essentially an extension of the works council scheme which has been used by progressive firms for a number of years past. The important contribution it should undoubtedly make to efficiency and output should not lead us to overlook the fact that it scarcely touches the wider question of morale. One of the real weaknesses in morale in Great Britain is the lack of understanding and interchange of ideas between those who direct the War and those who are directed. Despite all the efforts of the Prime Minister himself and his great power of interpreting the situation and strategy of the War, this is notably true of industrial and civilian defence workers. Adult education is essentially related to morale in the waging by a democracy of total war.

While, however, the importance of education as a very corner-stone in reconstruction is widely appreciated, the importance of adult education in that respect, and still more in regard to the war effort, is almost completely overlooked or ignored. Adult education, it is true, receives passing mention in a pamphlet "Education for Democracy", by Barbara Drake, recently issued by the British Association for Labour Legislation (London: 1942. Pp. 44. 9*d*.); here the importance of developing systems of adult education as centres of social activity as well as seats of learning is recognized, as well as of encouraging voluntary bodies, organized on democratic lines, which provide suitable courses of adult education. The report referred to above on War-time Developments in Government-Employer-Worker Collaboration, however, does not even mention education.

The truth is that the War will be won and the peace made by the generation of men and women who are grown up now. Unless by adult education we attempt to correct mistakes in their outlook, training and vision, the growing generation may, like its predecessor, find its prospects once again shattered by failure of this grown generation to seize the opportunities opening now before it. Moreover, it should be remembered that the success of the war-time measures of co-operation between workers and employers and the Government is due primarily to the recognition of their validity and purposes both by the trade unions and by management. This recognition was largely due in turn to the need for expedition in settling grievances and to the special care taken to avoid arousing antagonisms by rigid enforcement. There must be some similar recognition and understanding by the mass of the people if they are to take their place in a new and better social order, and this it is a prime function of adult education to supply.

The contrast between the free nations and the totalitarian regimes is nowhere more marked than

in this matter of the methods of democratic collaboration. The value of such collaboration in the formulation and application of a labour policy has been repeatedly demonstrated in dealing with the many problems involved in the allocation of man-power between industry and the Armed Forces, the control of employment, training and apprenticeship, dilution of skilled labour and transfer, and the mobilization of women and other labour reserves. As a recent P E P broadsheet on mobilizing woman-power indicates, it may well be a decisive factor in regard to the use of part-time labour. Tripartite collaboration, through its assistance in safeguarding the interests of workers in the factories, those mobilized for the army, and of seamen, both in the Mercantile Marine and in the Navy, has already made important contributions to the national morale, and has often made important contributions in such matters also as problems of safety, elimination of hazards, prevention of accidents from fatigue, overstrain and tension, and the promotion of industrial hygiene.

The full use of our national resources, whether in time of war or of peace, and the provision of the commodities and services necessary to raise or even maintain general standards of living, involve the full co-operation of employers and workers with the Government at every stage, from the initiation of a policy to its application and enforcement. The educational aspect of such collaboration is, however, often overlooked. National safety and efficiency make it essential, for example, that all groups in the community should understand the aims of certain measures—rationing restrictions, black-out precautions and fire prevention are typical examples. The part which organizations of employers and workers have played and must play in the interpretation of such measures and in carrying back into the local community understanding of the problems at issue and in furnishing explanations of policy is seldom appreciated.

Such educational work—education of the adult in a very practical sense—is one of the most important functions of the machinery of co-operation established during the War. Further, one of the most imperative needs at the present moment, if we are to attain and sustain our maximum productivity, is for a deliberate planned extension of adult education of this type. Without it the fresh sacrifices being demanded of us, the call to more spartan living and strenuous endeavour, may fail of their full effect and purpose through inadequate response, misunderstandings or avoidable friction. As already noted, the poor morale which at present exists in some sections of the people of Great Britain, particularly among industrial and in civil defence workers, is due largely to the lack of interchange of ideas and common principles of understanding between those who direct the War and those who are directed.

The maximum war-effort can only be obtained with the full co-operation of the consciousness of our society, and the lack of co-operative thinking, knowledge and discussion between the two sections of our democracy may be disastrous. We must have leaders who can explain to the members of the Services and the workers the longer-term geographical and historical implications of the War, the tasks before us, the dangers ahead, the principles and practical problems of the post-war era. Moreover, it is just as important that these leaders should listen to complaints as well as talk and interpret.

The recent debates in Parliament have shown how admirably the House of Commons is fulfilling the vital function of interpreting to the Government the mind of the nation. To meet the primary need, the suggestion recently advanced by Mr. Stephen Spender in *The Times* of February 25 of extending the idea of the education officer already found in the Army merits careful exploration. Mr. Spender suggests that there should also be education officers in factories, in civil defence and possibly in civilian life. Their task would be threefold : to assist the people to understand the tasks that face us as a people sharing common aims, principles and opportunities ; to win conscious co-operation in the furthest aims of the War and the ensuing peace ; and to equip the individual to be educated, socially responsible, and imbued with the principles of a less anarchic form of post-war society.

Whether or not some definite organization is required to implement this essential work of education, voluntary effort will still be required if only to fill the gap while some formal scheme is being elaborated. Without vision the people will indeed perish, and on all who have caught some glimpse of the values that are at stake, of science, of art, of religion, of any aspect of that tradition of humanism that has been handed down to us, or who have some understanding of the ultimate purposes for which we are fighting, lies the obligation to share it as widely as possible with their fellows. Scientific workers, many of whom recognized the challenge and threat to our heritage long before the outbreak of war, have a special as well as a general responsibility in this matter. With their responsibility for seeing that science makes its fullest contribution to the national effort, for waging relentless war on any source of technical or administrative inefficiency, lies this further responsibility of helping their fellow-workers, their comrades-in-arms and their fellow-citizens to share that vision of deep purpose and final victory, and, sharing it, to see the part which each must play in the furtherance of that purpose, the winning of that victory and the shaping of the nobler order in which that purpose will be achieved.

THE WAR-TIME SOCIAL SURVEY

A RECENT report of the Select Committee on National Expenditure provides a striking vindication of the War-time Social Survey of the Ministry of Information, which has been the subject of much adverse criticism. The appearance of the report is of special interest at the moment in view of the renewed attention being given to the organization of social research. The Committee is emphatic in its opinion that the War-time Social Survey is an essential service,

performing useful work, and that on the whole the lessons of past experience have been learnt. The report administers a severe and well-deserved rebuke to the attack last summer on the Survey both in the Press and elsewhere, but also provides yet another warning of the way in which sectional interests or prejudices, sometimes inspired by Departments of State, are still able to impede or frustrate action or inquiry desirable in the general interest.

The Survey was established under the auspices of the National Institute of Economic and Social Research, in order to guarantee the scientific status of the personnel and methods used. A member of the professorial staff of the London School of Economics was appointed director, and there was also a committee of scientific advisers who were consulted both about the lines on which an inquiry should be conducted and about the scientific validity of all reports. The Survey was housed in a separate building from the Ministry of Information, the names and addresses of the persons interviewed are never passed on to the Ministry, and not one of the staff of the Survey was a Civil servant.

By June 1940 these arrangements were working well, and although since the autumn of 1940 the work has no longer been carried out under the auspices of the National Institute of Economic and Social Research, the advisory committee has been abolished and the staff has been reduced, the remaining safeguards having been retained. Reports were no longer circulated outside the Ministry of Information, and the Survey was used only for work commissioned by other Departments. As a result of further reorganization in the summer of 1941, the Survey now works under the general supervision of the head of the Home Intelligence Section of the Ministry of Information, under the control of the Director, Home Division. Its present constitution and activities were stated in NATURE of February 21, p. 214.

The Survey interviewers, who are all women, are selected with the greatest care, with particular emphasis on their intelligence, conscientiousness and trustworthiness. They are given careful training as well as exact coaching in the subject to be investigated, and the questionnaires are drawn up with the help of the advisory panel and the Department for which the inquiry is being made. The Ministry of Food and the Board of Trade are the Departments which have made most use of the Survey, the estimated expenditure for which for the current financial year is about £40,000.

The Select Committee is satisfied that the costs are not excessive and comments on the continuous use of the Survey, but it stresses the importance of laying down a carefully considered policy and planning the work. It emphasizes, secondly, the importance of great care in the choice of subjects to be investigated. The Survey should be used for factual inquiries which are necessary to guide a Ministry in some particular policy, and not for inquiries which attempt to assess morale. No inquiry should be begun without careful consideration as to its real necessity. The success or failure of an inquiry depends almost entirely on the interviewers, and no relaxation of the present standards should be entertained. Finally, and somewhat surprisingly and unconvincingly, the Committee recommends that the Survey should not be connected with or controlled by any one Department, but should accordingly be transferred from the Ministry of Information and placed under the direct authority of a member of the War Cabinet, for which purpose the Lord President of the Council is suggested, as being already responsible for scientific matters.

THE PROBLEM OF THE AUTONOMY OF LIFE

Science versus Materialism

By Prof. Reginald O. Kapp. Pp. vi+280. (London: Methuen and Co., Ltd., 1940.) 10*s.* 6*d.* net.

THE title of this book is rather misleading, since its main theme is an exposition of the author's 'philosophy' of vitalism, versus a scientific description of the phenomena of living organisms in terms of the existing concepts and laws of physics and chemistry. In this connexion he appears to be a 'materialist', that is, when he is contrasting the phenomena of life with what he calls the "material Universe", by which he seems to denote inanimate things. His great argument here is that living organisms cannot arise solely from the action of "matter on matter". He admits that the laws of physics and chemistry are operative in living organisms, but holds that they do not fully determine the "pattern" of life. This, according to him, is "doubly determined", that is, determined not only by the laws of physics and chemistry but also by "something else". This something else is "non-material".

Lest the ordinary reader might fall into the error of supposing that this "new light" amounts to a return to the Platonic doctrine of ideal forms, Prof. Kapp is careful to point out that the Platonic forms were applied by Plato to inanimate as well as animate things, whereas he (Prof. Kapp) intends his "immaterial something" to apply only to the "patterns" presented by living organisms. He does not refer to the Aristotelian entelechy. but no doubt that ancient ghost would suffer the same fate as the Platonic form, though Prof. Kapp's immaterial something looks very much like a confused mixture of the Aristotelian "final cause" and "formal cause". So what, according to the author, is his philosophic solution of the age-long problem of life? Being an engineer, he finds his mental haven of rest in one blessed word, "specification". The patterns of life unfold and repeat themselves according to some non-material, pre-determined and pre-conceived "specification". The molecules of matter, according to the author, do not *in this case* "shake down" into positions or states determined solely by their motions and intermolecular forces. No, no—there is always the "specification" to guide them to something better than that, just as the blue-prints of the engineer's drawing office direct the pattern maker, the foundry man, and the machine tool operator. Indeed, Prof. Kapp has no great objection to a living organism being regarded as a sort of machine, for "matter acting on matter could never produce a machine".

This oft-repeated argument against the possibility

of living organisms arising from matter acting on matter rather reminds one of du Nouy's argument concerning the enormous improbability of a living organism arising out of a "material", that is, inanimate system in statistical equilibrium. Nobody with any knowledge of science would ever suppose such a thing. Both Prof. Kapp and Dr. du Nouy have forgotten the potency for producing order residing in the disequilibrium between the 'hot' radiation of the sun's photosphere and the relatively cool surface of this planet, though Schrödinger pointed out a number of years ago that no consideration of the problem of 'living organization' which left out of account the sun's enormous store of 'organized' energy could possess any scientific value. It may be pointed out to the author that the existence and activity of a living organism depend absolutely on the presence in its environment of certain chemical substances which are *not* in equilibrium, this disequilibrium (and consequent potency for producing order) being a direct consequence of the previously mentioned disequilibrium of radiation and matter. It is a curious and instructive fact that, in his yearnings for a "non-material entity", an electrical engineer should have failed to consider the part played by the electro-magnetic field and electro-magnetic radiation.

Prof. Kapp tilts at a number of people whom he calls "biologist-philosophers", among whom one may mention L. Hogben, J. Needham and J. B. S. Haldane. What he particularly dislikes about these biologists is that they *will* persist in the endeavour to describe the phenomena presented by living organisms in terms of the existing concepts and laws of physics and chemistry, that is, they do not invoke the aid of any metaphysical entity, whether entelechy or "specification". Now, Prof. Kapp admits that these biologist-philosophers are quite reasonably good, *qua* biologists. Where they err is in their lack of knowledge of the real nature of physico-chemical science ! They might, however, retort that Prof. Kapp's knowledge of physico-chemical science is rather peculiar, to say the least of it, when he omits all consideration of one very pertinent *non-material* entity, to wit, radiant energy. But they possess a stronger argument even than that, namely, Prof. Kapp's "philosophy" of modern physico-chemical science, which is expounded in his discussion of "The Material Universe". Here one can detect the ominous effect of certain semi-popular expositions of modern physical science on the naïve mind of an engineer. Hearken, please, to the portentous words of warning with which the author introduces Section III (the *author's* version of the "Material Universe"): "if physicists were to describe what they find in Nature instead of what they have invented, they would sum up their observations in the words : Chaos, everywhere chaos". To this one can only say, "Eddington, O Eddington, behold what thou hast done !" Or should one blame the "Paycock" ? For Prof. Kapp, the atoms and molecules represent no "repeated patterns", indeed no objective patterns at all, for they are the inventions of the minds of the physicist and chemists. His primary object in this section is, of course, to demolish the "objective reality" of what he calls the physicists' "material" world, so that he (Prof. Kapp) may be in a position to point out triumphantly to the wicked "biologist-philosophers" that they are trying to construct the "objective reality" of the living organism out of the stuff of pure thought. The elementary mistakes and logical fallacies of this section of the book are very obvious, and are strongly reminiscent of some of the 'popular science' of the Sunday Press.

It would, however, take too much space in a brief review to discuss in detail the author's fantastic views on *his* "Material Universe", or his subsequent demolition of the "philosophy of emergence". He gets fiercer and fiercer as he proceeds : *L'appetit vient en mangeant.* Enough has probably been said to give any potential reader an outline of the "new light" which the author seems to think he has shed on the question of "vitalism". In the opinion of the reviewer, however, he has made no contribution to philosophy or to science.

There does, indeed, exist a problem of the "autonomy of life", a problem which is at least as old as the writings and observations of Aristotle. This is really a part of the epistemological problem of the description of our knowledge. It is quite a wise and practical policy of the wicked "biologist-philosophers" to find how far they can go in describing the phenomena presented by living organisms by means of the existing *and rapidly developing* concepts, methods, and 'laws' of physics and chemistry. But, of course, this does not mean that fundamentally new *scientific* concepts and new logical methods of thought will not be necessary for the ultimate autonomous description of our knowledge of the phenomena of living things. The ancient concept of teleology, for example, with its implied concept of 'purpose', may perhaps be replaced in time by a sort of *teleochronism*, that is, actions at a distance in time, to be described by some new form of mathematics, or at least by integral and integro-differential equations and Volterra's theory of functionals, wherein the nuclei may be historical time-functions, descriptive of an internally determinate pattern of action. The discussions of Niels Bohr on the autonomy of the description of our knowledge of life, especially the application of his principle of "Complementarity" (which is essentially a fundamentally new mode of thought) to this problem, are highly significant and valuable. In any event, the *scientific* description of the "finalism" and pattern-unfolding of life will bear no resemblance to the crude and empty idea of an engineering "specification". Science does not advance by the simple invention of such sonorous substantives (unlike certain forms of philosophy). Indeed, Prof. Kapp's form of "science" reminds one very strongly of the German metaphysical idealism of the romantic Schelling-Hegel period ; and perhaps Goethe might have welcomed it at Weimar ! It was, however, the advance of real science in the nineteenth century which killed the fantastic *Naturphilosophie*, that weaving of imaginary worlds out of sonorous substantives devoid of verifiable meaning.

There are certain incidental errors in the text : Clerk Maxwell, not Clark Maxwell—a curious mistake for an electrical engineer to make ; in several instances, J. S. Haldane and J. B. S. Haldane are comically confused with one another ; it will be news to Dr. E. F. Armstrong that he is "the late E. F. Armstrong"—the author probably means his father, the late Prof. H. E. Armstrong.

In conclusion, when one compares the jaunty word-spinning and dialectical jumble of Prof. Kapp with the mystical verbalisms about time written by another engineer, one is tempted to revive, in modified form, an ancient saw : *Ne faber ultra machinam.*

F. G. DONNAN.

MAGNETOCHEMISTRY

Magnetism in Relation to Chemical Problems

By Dr. K. N. Mathur. (Lucknow University Studies, No. 8.) Pp. vi + 185. (Lucknow: Lucknow University, 1940.)

MAGNETOCHEMISTRY is a branch of chemical physics in which interest has re-awakened of recent years. In no small measure has this been due to the considerable output and variety of work by Indian workers, and more particularly by Sir Shanti S. Bhatnagar and his collaborators. Bhatnagar has not only initiated, directed, and obviously inspired work in this field, but also he collaborated, in 1935, with the author of the monograph under review in writing "Physical Principles and Applications of Magnetochemistry". Several other texts have been published within the last decade, but there is still a large number of physical chemists (or is it, nowadays, chemical physicists ?) who would welcome a compact, clear, and concise account of what may be called post-Pascal magnetochemistry.

The present volume was written to fulfil this need. The first nineteen pages introduce the subject and deal with various methods of measuring magnetic susceptibility. A discussion of diamagnetism follows and occupies seventy pages. Langevin's theory of diamagnetism and van Vleck's quantum-mechanical theory are reviewed. Ionic susceptibilities, their evaluation by various means from experimental data and their calculation, are discussed, but it is questionable if so much space should have been given to Fajans's theories of deformation of ions. The additivity of diamagnetism and constitutive correction factors are next discussed and lead to applications of diamagnetism in valency problems, in liquid mixtures, addition compounds, polymerization, and in solid solutions and mixtures.

Paramagnetism is dealt with in fifty-seven pages (pp. 91–147) under the following headings : Langevin's theory, intrinsic molecular field, paramagnetism and quantum theory, paramagnetic substances and the influence of temperature and crystalline fields on them, iron group and complex salts, including a discussion, rather extended for the size of the monograph, on general theories of valency. A short chapter of six pages on magnetism in relation to chemical equilibria completes the subject-matter.

Then follow thirty-two pages of references, indexes, and advertisement of other works in the same series ; this seems to be an unduly large proportion of space to devote to these matters, particularly as only one reference, out of the 144 given, refers to work published after 1937. Much interesting work has been published since then, and its non-inclusion is one serious defect in the monograph. Unfortunately, there are others. The proof reading has been very badly done, with the result that typographical errors are frequent ; for example, "sudstances", "struture", "alipahtic", "invarient", "hysterisis", "principle quantum number". Much more irritating, and serious, are errors in mathematical expressions, confusion of symbols, omission of integration limits, and incorrect signs.

While the printing is clear and the format convenient, the style is variable and often careless. The frequent omission of the definite or indefinite article jolts the reader. So also does the use of "analysis" as a plural noun and of "maxima" and "minima" usually, but not always, as singular nouns (*vide* p. 87, which bristles with examples). Ungainly constructions need not necessarily convey wrong meanings, but several which do might be quoted from the monograph ; one must suffice : on p. 23 we read "*In case* [my italics] the atom possesses an initial magnetic moment the small value of the diamagnetic susceptibility may be entirely masked. . . ." Finally, the reviewer feels that he will not be alone in wishing that the statement on p. 12, that water is "easily obtainable in a pure form" were, in fact, really true.

Workers in the field of magnetochemistry will find this book insufficiently up-to-date ; to recommend it to students would be inadvisable, if not dangerous.

W. Rogie Angus.

TOPOLOGY

Lectures in Topology

The University of Michigan Conference of 1940. Edited by Raymond L. Wilder and William L. Ayres. Pp. vii+316. (Ann Arbor, Mich. : University of Michigan Press ; London : Oxford University Press, 1941.) 3 dollars.

THERE is an amazing difference of opinion concerning the importance of topology. Some claim that it is a new type of mathematical thinking, which goes to the heart of qualitative spacial relations, makes complicated analysis intuitively simple, throws light on differential and functional equations, opens a new era in dynamics, and is applicable to problems of electric circuits and of the constitution of chemical compounds. Yet others regard it as a highly specialized subject which can be safely ignored even by geometers, and point out that topologists have not yet solved the apparently elementary four-colour map problem which has been discussed for more than a century.

Topology, formerly called *Analysis Situs*, is the theory of such properties of geometrical figures as are unaltered by stretching or bending (without tearing or joining). From this point of view a sphere is equivalent to an ellipsoid, but differs from an anchor ring. The fundamental problem is to find the invariants. One of the oldest results is the Descartes-Euler relation between V, E, F, the number of vertices, edges, and faces respectively of a polyhedron, namely, $V - E + F = 2$. Instead of a polyhedron, we may take V points on an ellipsoid, and by joining them up in pairs by E arcs divide the surface into F polygonal areas. Then $V - E + F$ is a topological invariant called the *characteristic* and has again the value 2. If we replace the ellipsoid by an (unbounded) surface of *genus* p, for example, a sphere with p holes through it, we get $2 - 2p$. Surfaces may also be classified as *orientable*, if a positive sense of rotation can be assigned consistently at all points, or *unorientable*, and for topological equivalence two surfaces must agree in this respect as well as in characteristic.

However, experts regard all this as merely the infancy of topology. The whole outlook was changed by Poincaré (from 1895), whose definitions and methods, particularly those involving matrices, are fundamental in the modern treatment. His work was n-dimensional and highly abstract, and later writers have still further refined it by introducing the postulational treatment of abstract spaces and the theory of aggregates. The contributions of L. E. J. Brouwer (from 1911) are of great importance. For the last twenty years, topological research has been

pursued with enthusiasm in the United States, Poland and the U.S.S.R., but neglected in Great Britain.

The book under review gives the proceedings of the Topology Conference held at the University of Michigan during June 24–July 6, 1940. Twelve lectures are reported in full, and there are summaries of the shorter papers. The first lecture is by Prof. S. Lefschetz, whose well-known book "Topology" is almost indispensable as an introduction to modern work. Other lectures are by R. L. Wilder, N. E. Steenrod, S. Eilenberg, H. Whitney, S. S. Cairns, P. A. Smith, L. Zippin, S. MacLane and V. W. Adkisson, O. G. Harrold, jun., L. W. Cohen, and E. W. Chittenden. They are difficult to summarize for the non-specialist reader, because the subject has made such great progress in America that the problems on which experts are now working are so remote from the simple starting points.

H. T. H. PIAGGIO.

A STEEL-MAKER'S AUTOBIOGRAPHY

Knotted String : Autobiography of a Steel-Maker
By Harry Brearley. Pp. ix+198. (London, New York and Toronto : Longmans, Green and Co. Ltd., 1941.) 10*s*. 6*d*. net.

THE author of this unconventional autobiography is known to many as the inventor of stainless cutlery steel, and to metallurgists as a practical steel maker, a trenchant critic at meetings of the Iron and Steel Institute, and as the writer of several excellent technical books. Those books contain the fruit of long experience in the melting and working of steel and in the conduct of laboratory research, expressed in language of great simplicity and directness, suggesting the hand of a master of English. They have nothing of the aridity of the ordinary text-book. It is therefore interesting to see how a boy, brought up in one of the dreariest parts of industrial Sheffield, came by his peculiar gifts.

The back-to-back houses of Ramsden's Yard must have been unattractive enough ; yet the account of life in them pictures a condition of poverty but not of misery, relieved by much neighbourliness and good humour. Brearley's father being a crucible steel melter, the boy, following various casual occupations for a short time only, and receiving only a bare minimum of schooling, became familiar with the small and grimy workshops in which crucible steel, then the aristocrat of steels, was melted and cast. A cellar boy has leisure to study both technical operations and human nature, and this one was a keen observer of both. By good fortune he became bottle-washer in the laboratory of an analytical chemist, an ascetic who had known great poverty, but had managed to study chemistry at home and abroad. One of the peculiarities of this employer, of whom Brearley always speaks with gratitude, accounts for the strange title of the book. With his encouragement, the young assistant became an enthusiastic student, working at science in a night school and in laboratory hours. How he passed from Sheffield dialect to his limpid English style it is less easy to see. From bottle-washer he advanced to the position of assistant, paying the premium of £50 from his weekly wage of 20s. When this was doubled he married, gave popular lectures on science, became an ardent social reformer, and made his first appearance as a writer of scientific articles.

In 1904 he took up an appointment in Riga, where he stayed for four years, managing a laboratory under difficult conditions and acquiring, by hard experience, much knowledge of the treatment of steel and of human material. The Lettish workmen were ignorant and politically restless, and strikes and the revolution of 1905 added themselves to the technical obstacles which arose. How they could be overcome by good humour, common sense and sympathy can be read between the lines of the narrative. In the last part of the Riga period Brearley acted as manager, and then returned to Sheffield to set up a research laboratory for the firm which employed him.

The Riga experience had shown the advantages of such scientific helps to industry as the thermo-couple, and in the treatment of such special products as naval armour plate and high steel tools there was ample room for more scientific control, in which this laboratory was a pioneer. In the course of experiments on rifle barrels, with the object of lessening erosion, a steel with a high proportion of chromium was prepared and was noticed in the laboratory to be unusually resistant to chemical reagents. The suggestion that it might be suitable for cutlery was not received with enthusiasm, and it was not until 1914 that a Sheffield cutler became interested and together with the inventor worked out the means of making table knives from the new steel, the difficulty being that the process of hardening was radically different from that used for ordinary cutlery, so that in the beginnings there were many failures. No patent had been taken out, and the subsequent negotiations as to the ownership of the invention make a rather sorry story. A lawsuit in the United States established the originality of the invention and involved a visit to America which left pleasant memories.

In consequence of these disagreements, Brearley left his employers and joined the firm with which he has since been associated. Travels in other countries, including Russia, and partial retirement, bring the story to a close, but there are final chapters containing the author's thoughts on many matters, metallurgical and other. One conclusion on which he insists repeatedly is the value of the experience of the practical man. The old steel worker who judges the quality of steel by the appearance of its fracture and by the feeling as it is worked under his hammer cannot express his valuation in quantitative terms, and his expressions may seem crude to the academically trained metallurgist, but he may have the root of the matter in him. Examples are given of specifications hampering industry because certain limits of chemical composition had become a fetish and had been allowed to overrule the experience of those who had to work the steel.

In another book, "Steel Makers", which vividly describes the old crucible process, the author has suggested means for enabling students to gain a practical knowledge of the operations they hope to control, and throughout both books stress is laid on the pleasure which may be felt in the work of one's hands, whether it be in chemical manipulation, in the working of clay, in carpentry, or in the mendi g of boots, all of which are referred to in this narrative. The reader feels that he has made the acquaintance of a skilled craftsman, a lover of good literature, of one who can look back with cheerfulness on his early difficulties, and who through varied experiences has attained to a ripe wisdom which leaves him tolerant of much, but not of social injustice.

C. H. DESCH.

SOME ASPECTS OF ALGAL CHEMISTRY*

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WHEN I first approached this subject now some eight years ago our knowledge of the lipoid constituents of the Algæ, especially the carotenoid pigments and sterols, was exceedingly meagre. A partial survey of the algal pigments had been made by Kylin[1], but in the light of the precise knowledge of the lipochromes of the higher plants the pigments described by him required re-examination, the more so as his method of detection was purely qualitative and it is uncertain whether the carotenoids described represent distinct chemical individuals. As regards the occurrence of sterols among the Algæ no information whatsoever was available. In view of the recognized importance of these lipoids in relation to physiological factors, and bearing in mind the accepted botanical relationship between colour and classification, it seemed of importance to study both classes of compounds in detail.

Although as yet we have been unable to examine the whole field, we have so far investigated Algæ selected from seven of the eleven classes into which Fritsch[2] classifies them. In the interim, contributions from other laboratories have provided information regarding the pigments of some of the remaining classes, with the result that we now have a clear picture both of the occurrence and structures of these algal constituents. At the same time, as will be shown later, considerable progress has been made in our understanding of the physiological role of the carotenoids in relation to sexual reproduction.

Chlorophyceæ

We have now examined nine individuals from various orders of the Chlorophyceæ or Green Algæ, and in every case carotene and leaf-xanthophyll (mainly lutein) have been detected[3]. *Trentepohlia aurea*, a strictly terrestrial alga, requires special mention, as it is one of the richest sources of carotene hitherto described (compare also Tischer[4]). On the other hand, we have found that xanthophyll is only present in this alga in minute amount whereas in other Chlorophyceæ the xanthophyll-carotene ratio is 2–5 : 1, being thus of the same order as in the higher plants[5,6]. Another interesting observation is that Trentepohlia, unlike other Green Algæ, is wholly deficient in sterol, and in this respect resembles members of the Myxophyceæ. Our examination of the yellowish-green alga, *Zygnema pectinatum*, has revealed the presence of fucoxanthin, which pigment is normally confined to the Phæophyceæ. As no abnormality in the life-cycle or habitat of this alga is known, this raises the question as to whether the presence of this unusual xanthophyll is revealing the phylogenetic past or is forecasting some impending change.

Apart from these exceptions our survey of the carotenoids strongly supports the view held by most algologists that the terrestrial plants originated among the more advanced members of the Chlorophyceæ. Additional weight to the above view is provided from the sterol angle, for we now find that sitosterol, the characteristic sterol of the Phanerogams, is also common to the Green Algæ.

* Substance of the Eighth Hugo Müller Lecture delivered to the Chemical Society on October 16, 1941.

Xanthophyceæ

Unfortunately we have only been able to examine one member of these yellow-green Algæ, the common mud-alga *Botrydium granulatum*. β-Carotene has been definitely identified as the main epiphasic pigment, while in the complex hypophasic lipochromes we have observed the presence of a pigment having well-defined absorption maxima at 4750 A. and 4470A. and giving a strong blue colour with 25 per cent hydrochloric acid. The absorption values are in exact agreement with those recorded by Kuhn and Brockmann[7] for flavoxanthin, and it may well be that this pigment is characteristic of all the Xanthophyceæ. In this connexion it is interesting to note that the only information in the literature concerning the 'xanthophyll' of the Xanthophyceæ is the recognition that it gives a blue colour with concentrated hydrochloric acid. This could apply to either violaxanthin or flavoxanthin, but the spectrographic evidence excludes the former. The sterol present in *Botrydium granulatum* has been found to be sitosterol.

Chrysophyceæ, Bacillariophyceæ (Diatoms)

The only representative of the Bacillariophyceæ which we have so far examined is *Nitzschia closterium*. Of the Chrysophyceæ, a mixture of three members has been investigated, *Apistonema Carteri* Anand., *Thallochrysis litoralis* Anand., and *Gloeochrysis maritima* Anand. From both classes carotene, lutein and fucoxanthin have been isolated, and the analogy extends also to the sterols where we have observed only fucosterol[8]. This analysis supports the view that the Bacillariophyceæ and Chrysophyceæ have points of affinity. From the chemical evidence they would also appear to be related to the more primitive orders of the Phæophyceæ (Ectocarpales).

Phæophyceæ

Here the characteristic pigment is fucoxanthin, $C_{40}H_{56}O_6$. Apart from this pigment, Willstätter and Page[5] record the presence of both carotene and xanthophyll in the Phæophyceæ, although the latter was only assessed colorimetrically and never actually isolated. In our investigations of the Phæophyceæ we have extended the survey to include members from various orders and find that, despite the great diversity in the life-cycles of the individual species, all reveal the most marked uniformity of pigmentation, with fucoxanthin as the main hypophasic pigment, lutein only being demonstrated spectrographically in the lower members. Another striking feature of the Phæophyceæ is the universal occurrence of fucosterol and total absence of sitosterol; this, again, sharply differentiates the Phæophyceæ both from other Algæ and from the higher plants.

Rhodophyceæ

In general agreement with Kylin[1] we find the lipoid pigments to be carotene and lutein in all members of the seven orders examined, while the normal sterol appears to be sitosterol. An unexpected abnormality has been observed in the case of *Polysiphonia nigrescens*, an alga of striking red-black colour, which contains both fucoxanthin and fucosterol in addition to carotene and lutein. This abnormality of pigment and sterol is curious, as

Polysiphonia nigrescens is morphologically a perfectly normal diplolbiontic member of the order Ceramiales. The closely related *Polysiphonia fastigiata* is quite regular in pigment and sterol, despite its parasitic habitat on the brown alga, *Ascophyllum nodosum*.

Myxophyceæ (Cyanophyceæ)

These Blue-Green Algæ contain a specific carotenoid for which the name phycoxanthin was originally suggested by Kraus and Millardet in 1866. A more detailed examination of a member of this class (*Calothrix scopulorum*) was made by Kylin who, using his capillary method, qualitatively noted carotene together with three other pigments to which he gave the names myxorhodin-α and -β and calorhodin.

In 1935 my co-workers and I isolated from the terrestrial alga *Rivularia nitida*, in addition to carotene and lutein, another epiphasic carotenoid in crystalline form, for which the name myxoxanthin was suggested[9]. The same pigment was also found in a related marine species, *Rivularia atra*, and later[10] in the freshwater member, *Oscillatoria rubrescens*, from which source a second new pigment, myxoxanthophyll, was also isolated. The quantity of material available has unfortunately precluded a detailed examination of the latter, but analysis has given the formula, $C_{40}H_{56}O_7$, while, from the tenacity with which it is retained by alumina on a column, it obviously contains, like fucoxanthin, a multiplicity of hydroxyl groups. Unlike myxoxanthophyll, myxoxanthin is epiphasic, being a typical carotenoid monoketone having the formula $C_{40}H_{54}O$.

Tischer[11] has independently examined the carotenoids of another blue alga, *Aphanizomenon flos-aquæ*, from which he isolated four pigments, principally an epiphasic lipochrome which he named aphanin and a hypophasic member, aphanizophyll. Of these, aphanin is seemingly isomeric with myxoxanthin, according to Tischer being derived from β-carotene and not from γ-carotene as is the case with myxoxanthin. It is thus clear that the Myxophyceæ synthesize their own typical pigment which differentiates the class quite sharply from other Algæ.

Another striking feature, which we have noted, is the complete absence of sterols ; bearing in mind that there is a total lack of sexuality in this class, the question as to whether any correlation exists between the presence of sterols and sexuality naturally frames itself, and although no definite answer can at this stage be supplied, it opens up an intriguing avenue for further investigation. If any significance is to be attached to sterol content in relation to the physiological phenomenon of reproduction, the question of *Trentepohlia aurea*, of which mention has already been made, comes under review. Whereas, so far as is known, this alga is sexually normal, it nevertheless is now growing in a habitat unusual for a Green Alga and, moreover, the genus is normally tropical. It may be that the disappearance of sterol in both the temperate and terrestrial conditions forecasts an impending loss of sexuality. It is also perhaps not merely coincidence that the bacteria, which are also lacking in sexuality, are likewise totally devoid of sterols.

Euglenineæ

Together with the Green Euglenineæ, members are known which are deep red in colour (for example, *E. sanguinea*), due to the presence of a red pigment for long known to botanists as hæmatochrome. Tischer[12] has recently examined *Euglena heliorubescens*, a rich source of this red pigment which he calls euglenarhodon and which he claims is a tetraketone[13] isomeric with astacene, $C_{40}H_{48}O_4$, the characteristic pigment of the Crustacea. Kuhn, Stene and Sörensen[14] have independently isolated the same pigment from the red spores of the green alga, *Hæmatococcus pluvialis*, and have shown that it is actually identical with astacene. The natural pigment is not, however, astacene, but a closely related ester of a xanthophyll to which the name astaxanthin, $C_{40}H_{52}O_4$, is given, and which readily passes into astacene through aerial oxidation during hydrolysis.

The occurrence of astaxanthin in the Euglenineæ is of especial interest in view of the position occupied by these flagellates in bridging the gap between the vegetable and animal kingdoms. Its presence in *Hæmatococcus pluvialis* is more difficult to comprehend ; it may be noted, however, that the red pigment is apparently not present in the normal green motile Sphærella, but only makes its appearance at the onset of the resting phase or with variation in constitution of its habitat. The occurrence of eye-spots (stigmata) in nearly all motile cells of the Algæ merits attention. These appear as a reddish or brownish-red dot in the superficial layer of the cytoplasm and the pigment has for long been considered by botanists to be hæmatochrome. In view now of our more precise knowledge, there can be little doubt that it is actually either astaxanthin or astacene.

Pigmentation and Sexual Reproduction

This problem has been examined in great detail during the past decade by the botanist F. Moewus[15], first at the Kaiser Wilhelm-Institut für Biologie at Berlin, and later in association with R. Kuhn at Heidelberg. For the purpose of their researches use was made in the first instance of the unicellular green alga *Chlamydomonas eugametos f. simplex*, in which the male and female gametes are morphologically identical (isogamous). As grown on an agar medium the gametes are devoid of cilia, but if they are suspended in distilled water and illuminated, the cilia develop in the course of about three minutes and after irradiation for a further two minutes these begin to oscillate and the cell becomes motile. The same effect can be brought about in the dark, but here oxygen is necessary and the distilled water is replaced by 1 per cent of glucose. It can be induced by the addition of a cell-free filtrate of gametes which has already become motile in light to a suspension of a dark culture even in absence of oxygen. This latter experiment proves that a definite chemical substance has been released into the water by the action of light. This substance has been identified with almost complete certainty as the saffron pigment crocin[16], the digentibiose ester of the carotenoid acid crocetin, $C_{20}H_{24}O_4$, and has been shown to be effective in producing motility at the astonishing dilution of 1 : 250,000,000,000,000.

Even though the gametes have thus become motile, they are still unable to copulate, which property they only acquire on further prolonged illumination. Unlike the first, this second photochemical process is effected only by irradiation with blue or violet light, the active wave-lengths being the two mercury lines at 4358 A. and 4961 A. The period of illumination is specific, being shorter for the female than for the male gametes,

while over-irradiation gives only inactive filtrates. That here, again, definite chemical substances are formed and discharged into the surrounding solution is shown by the fact that it is not essential to irradiate the sexual cells themselves in order to produce the copulatory materials. One can first illuminate a male or female cell suspension activated in the dark with glucose and oxygen, with red light (6463 A.) for one hour and then filter and expose the inactive 'red' filtrate (V) to the further action of short-wave light, when the copulatory substances are again formed. The time required for attainment of 'female properties' by the filtrate is from 20 to 30 minutes ($K_{♀}$); after a longer time it becomes unable to confer on female 'dark' cells ability to copulate. After sixty minutes, however, the filtrate acquires the property of rendering male 'dark' cells active ($K_{♂}$), while after ninety minutes' irradiation the filtrate (K_0) becomes permanently inactive.

All these phenomena can be exactly reproduced if, in place of the filtrate (V), the light-sensitive pigment, *cis*-crocetin dimethyl ester, is employed. Under the influence of light this is converted gradually into the *trans*-form and it has been found that for this particular race of Chlamydomonas the material conferring copulatory activity on the female 'dark' gametes is a mixture of three parts of *cis*- and one part of *trans*-crocetin dimethyl ester. For the male 'dark' gametes the ratio is three parts of the *trans*-isomer and one part of the *cis*-ester. The V-material is perhaps the labile *cis*-crocetin dimethyl ester and the $K_{♀}$ material the *trans*-isomer. The biological limit of activity of both esters is found at a dilution of 1 : 33,000,000,000 which, great as this is, is not comparable with the effect of crocin in bringing about cell-motility.

In a still more recent memoir[17] considerable light is thrown upon the question of control of sex. For this purpose the hermaphroditic green alga *Chlamydomonas eugametos f. synoica* was selected. If this is treated with a filtrate of male gametes of the dicœcious strain all the cells become male, while, conversely, a filtrate of female gametes renders all the cells female. It thus follows that the gametes must also secrete substances (termones) controlling sex. Although the termones in the active filtrates have not so far been isolated, it has been ascertained that the relationship of gynotermone to androtermone is of the type glycoside to aglucone. The fact that, unlike glycosides in general, the female termone is hydrolysed by alkali suggested that it might be picrocrocin, and the physiological activity of this compound was demonstrated. Although the authors consider that safranal is identical with the natural androtermone, the corresponding gynotermone is shown to be a thousand times more active than picrocrocin, and this they attribute to the presence of a sugar residue other than glucose, and possibly gentiobiose. Perhaps the most outstanding feature of this brilliant series of investigations is the remarkable insight it provides of the versatile manner in which Nature utilizes one substance only, the carotenoid crocin (or the as yet undetected protocrocin), to carry out numerous sexual functions. Kuhn[18] has recently announced the existence of an enzyme in male gametes capable of effecting the fission of picrocrocin. This glycoside-splitting ferment is in all probability localized in the cell nucleus, and this he considers may be a fundamental constituent of the chromosomes and, indeed, may be actually identical with the gene M (controlling masculinity).

In *Chlamydomonas eugametos* we have been dealing with a species where sexual reproduction is isogamous, and I now wish to direct attention to the question of oogamous reproduction among Algæ. In this connexion the dicœcious members of the Fucales, such as *Fucus serratus*, are especially convenient as large quantities of both male and female gametes can be obtained in a pure state. The numerous biciliated sperms contain a small yellowish chromatoplast, and the mature antheridia therefore appear orange-yellow, which colour they impart to the entire receptacle. It appeared to my colleague, Mr. P. W. Carter of the Botany Department, Aberystwyth, and myself that an investigation of the nature of this yellow pigment might shed light on the fundamental process of sexual reproduction. At the time this investigation was commenced we were not aware of the researches of Kuhn and Moewus, and in any event the problem is different, as here only the male sperms are motile. Our experiments[19] have been carried out with *Fucus serratus*, *Ascophyllum nodusum* and *Fucus vesiculosus*, and have revealed that the pigment present in the male gametes consists almost entirely of β-carotene. In direct contrast to the results obtained with the male exudate, the examination of the corresponding female exudate has revealed that the colour of the ova is due solely to chlorophyll and fucoxanthin. As β-carotene is to be observed only in the male gametes it may be that this carotenoid is bound up with their motility. Perhaps under the influence of light and in presence of oxygen the hydrocarbon becomes oxidized to crocetin which then acts in a similar manner as with Chlamydomonas. The association of carotene with sexual processes is further suggested by recent work carried out by Emerson and Fox[20], who have observed that in the case of the aquatic fungus Allomyces, the orange colour of the motile male gametes in the sexual phase is due to γ-carotene.

Another problem to be elucidated in connexion with the sexual process in these Fucaceæ is the mechanism whereby the motile male gametes become attracted to the egg. Kuhn and Wallenfels[21] have shown that in the case of the sea-urchin this is brought about by the ova secreting a compound, echinochrome A, into the sea-water. It may be that fucoxanthin plays a similar part in these algal ova or that something akin to echinochrome is secreted. This latter possibility is supported by the fact that we have obtained cell-free extracts of ova of *Fucus serratus* which attract the sperms. It is our intention to investigate these matters in greater detail at a more opportune moment.

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FOUNDATIONS OF THE NEW WORLD ORDER

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POST-WAR economic reconstruction is neither possible nor desirable. We reconstructed after the War of 1914–18. The system wobbled in the world economic crisis of 1929; it has now crashed in the present War. Its doom is deserved. A system which, of set purpose in the interest of a few, limited the production and distribution of food and other necessities of life urgently needed by the vast majority of men, is incompatible with human welfare. With the old economic system goes its superstructure, the international political system under which we have suffered two world wars in one generation. The old world order is in its death throes.

Piecemeal planning for such limited objectives as the restoration of the sovereign rights of small States, the adjustment of political boundaries for a new balance of power or, in the economic field, for new trade agreements and the restitution of trade union rights, on the assumption that after the War things will be pretty much as they were before, is worse than a waste of time. It diverts men's minds from the real task, which is the building of the new world in which all men in all lands will enjoy the freedom from fear and freedom from want promised in the sixth article of the Atlantic Charter.

The old world, which had within it both good and evil, is undergoing a metamorphosis. The good and the evil are struggling for supremacy. The call of the new world is a challenge to the human race. Has man the higher spiritual attributes needed to build it? Has he the intelligence to recognize irreversible changes now taking place in human society and the goodwill to direct these changes along lines calculated to promote human welfare?

An evident irreversible change is the transition to a World State. Science has eliminated distance. To-day, the countries of the world are in closer contact than two adjacent counties in England were a hundred years ago. Phases of a World Government have been evolving rapidly since the time the first steamship crossed the Atlantic. Finance, trade, science and even sport have come under some form of international control, and Governments have united in organizations, such as those for the control of infectious diseases and an international postal system. The last phase will be the organization of a properly constituted Government based on a sound world economic policy with a world police to maintain law and order. This will carry through and complete the task begun half-heartedly when the League of Nations was set up after the War of 1914–18.

The real issue of the War is whether the World Government will be the kind imposed by the Nazis in Europe, which means a throw-back to the more primitive form of social order based on slavery and maintained by brute force, or a democratic Government in which nations will co-operate for their mutual benefit.

The Nazis have an advantage in the struggle because they fully realize they are fighting for world dominion and they have created an enthusiasm among the German youth for their new world in which they will be the *Herrenvolk*. We, on the other hand, while willing to fight to the death to defend ourselves against Nazism, have no clear vision of the future to enthuse our own people and the people of all other lands for an offensive war as a crusade to establish the new and better world. We have not yet even reached agreement on the kind of world we are fighting for.

The only way to reach agreement is to go back to fundamentals. All men of goodwill would agree that the first duty of Government is to provide the necessities of life for the people governed. The material necessities of life are (1) food and (2) shelter, which includes a house, furniture, clothing and warmth. To these must be added (3) work, which is a psychological necessity. The British Commonwealth, the United States, the U.S.S.R., China and all the other nations opposing Nazism could reach agreement on a simple positive programme based on providing the necessities of life for the people.

This may appear a rather meagre programme. As a matter of fact, even in the wealthiest countries, we could not complete this programme in less than ten years. A third of the population in the United Kingdom and about an equal proportion in the United States do not enjoy food and shelter on the standard needed for health. In most other countries, the proportion of the population which has never been adequately fed or adequately housed is even higher. Among native races, for whose welfare Britain is responsible, only a relatively small proportion of the population have reached that economic level.

If every family had a home in which they could live in decency, food on the health standard and a feeling of absolute security that they would never fall below that level, we should have an economic and social foundation upon which we could begin to build a new world which, in time, would provide for a still fuller life.

This simple plan of providing for human needs on a health standard has the great advantage that we know what we are planning for. The needs are known. We can measure them and estimate the time it will take to provide them.

I have outlined elsewhere a national food policy which would fit in with the world plan and would enable post-war food relief for Europe to dovetail smoothly into a permanent policy. The scheme suggested would involve less interference with the freedom and initiative of the farmer and trader than was involved with the pre-war marketing board schemes.

While food can be planned on a world scale, housing varies so much with climate that it is a national problem. In Great Britain the only way to get all families housed in our day is by a temporary housing scheme. In Scotland, after seventeen years of Government housing schemes, during which 280,000 houses were built, there were still 250,000 families needing decent homes. This was the position just before the War. The number needed by the end of the War may be about 400,000. In England it will be more than 2,000,000. These families cannot wait for a home until we have completed plans for the better location of industry and for new towns. A *temporary* housing scheme, providing houses on a minimum standard of whatever material is available, should be undertaken immediately the fighting finishes. An advantage of a temporary scheme is that it would give time to see what industries are likely to be after the War and where they can best be located. Within, say, ten years, these houses

could be replaced by more permanent and better houses. We need not worry about the waste involved in a temporary housing scheme. Our capacity for production after the War will be increased to such an extent that there will be difficulty in getting an outlet for the products. In any event, the waste of human life involved by existing slum conditions is more important than the waste of material.

As Mr. Roosevelt has pointed out, the standard of living of the masses of the people is so low that if we undertook to provide satisfactory homes and adequate food for everybody, there would be work for every man and woman seeking a job. But provision must be made for men temporarily out of employment, and every man, rich or poor, should be made to do some useful work. A National Service Corps would provide for this. The men in the Corps could be employed on national or local government work. Every man should be forced to serve for a year before he reaches twenty-one years of age. After a year's service, a man would be free to leave. He would also be free to return if he wished and could not find employment. After a man had served a number of years calculated to be sufficient to pay for the bare necessities of life on a health standard for himself and his family, he could retire and enjoy these with the same dignity and self-respect as a man drawing an endowment for which he had paid all the premiums.

This plan for adequate food, a decent home and security for every family would bring about a social revolution. Bringing food and housing among the poorest third of the population up to the standard for health would reduce disease and improve national health and physique. Poverty in the old sense of the term would be gone for ever. A great part of our social and public health services and most of our charities would become unnecessary. The unemployment problem would be solved. Every family would have security for a good home. For the first time in history, the common man would enjoy economic freedom and the means of attaining his full physical and spiritual manhood.

This plan would also lay the foundation for agricultural and economic prosperity. It is estimated that in the United States the production of the protective foods, for example, milk, eggs and fruit, would need to be increased from 15 per cent in the case of some to 100 per cent in the case of others. Similar increases are required for Britain and larger increases for most other countries. The production of this additional food would call for a great expansion of agriculture. To enable agriculture to produce the food needed the great majority of farms in Britain would need to be re-equipped. The same is true of almost all other countries, including the United States. The re-equipment of agriculture would provide an outlet for an enormous amount of industrial products. When production had reached a level which would supply human needs there will be a permanent increase in the trade in food and in the commodities exchanged for food. A food policy based on human needs would be the spear-head for agricultural and economic prosperity.

A policy of providing first for human needs, as outlined here, would be so revolutionary and so beneficial that it would be wise to concentrate on it and leave all industries not directly concerned with the necessities of life to the free play of private enterprise. This would provide for the flexibility needed for the adjustment of industry and trade to the advances of science.

This plan for building the new world from the bottom upwards would give expression to our growing spiritual idealism. Every great spiritual awakening calls for sacrifice. This plan involves sacrifice. In Britain those who already enjoy the necessities of life on a health standard—and that includes the well-paid workman—would need to stand back from the national table until those worse off are served. To accomplish the world food plan, the wealthy nations must give to the poor nations food, agricultural equipment and the other things needed to provide the necessities of life, not against a loan which would sink the poorer nations in debt, but on a world-wide lease-lend plan arranged by an international financial organization, the security of which would be guaranteed by all nations, including the poorest. The poorer nations would not be encouraged to pay interest in the form of money or exports which would delay the provision of the necessities of life on a health standard for the whole of their population. When they had reached that level, they could begin to pay their debt in money or in kind. The nations would find their spiritual and economic salvation in this policy of giving.

This may seem Utopian. It is merely the policy of the good neighbour. Any ordinary citizen would give food to a neighbour needing it, demanding nothing in exchange immediately. Until Governments in their dealing with each other reach the moral standard which regulates neighbourly relations, the world will never be free from war.

The adoption of this plan would remove the feeling of uncertainty and apprehension as to what is going to happen after the War. Everyone would know what they were fighting for and working for. The people in the occupied countries in Europe and even in Germany itself would know what our peace aims are. They could be told incessantly, day and night, that when our armies invade Europe they will bring the food ships with them, and that the United Nations will continue to send food and other things needed not merely for post-war relief but until each country, including Germany, is in a position to provide the necessities of life on a health standard for the whole population. We could, in terms which would carry conviction, call upon the people of all countries to join with the armies of the free to carry through the glorious revolution for the destruction of the forces of evil, and the establishment of a new World Order in which the nations will co-operate to bring freedom from the fear of war and freedom from want to all men in all lands.

QUANTUM THEORY AND DIFFUSE X-RAY REFLEXIONS

IN the article by Mr. G. D. Preston which appeared in NATURE of April 4, a descriptive account was given of the theory put forward by Sir C. V. Raman in a series of papers published in the *Proceedings of the Indian Academy of Sciences* to explain the extra spots on Laue and other types of X-ray photographs. We are here adopting a much more critical attitude.

Raman has emphasized the fact that when X-rays are scattered by a vibrating system, the scattered beam contains components of changed frequency. It is not, however, made clear either in the Symposium or in Preston's account of it that this is a consequence

both of classical and of quantum theory. From the classical point of view it is the Doppler effect for the reflexion of X-rays by waves of atomic vibrations; in quantum language it is the transfer of energy from a photon to an acoustical quantum, or vice versa. This frequency shift has long been acknowledged by the thermal theory. Since the frequency changes are much too small to be observed, they are not of practical significance except in so far as they are intimately connected with the incoherence of the scattered rays, which is an essential feature of the phenomenon.

Raman also gives the impression (which is not refuted by Preston) that his theory is a "quantum" theory and that the thermal theory is a "classical" one. The exact opposite is the case. As Preston remarks, Raman's presentation is obscure, but it is clear enough that at no stage (except when he introduces the effect of temperature change) does Raman make use of quantum mechanisms at all. He does not attempt, for example, to calculate the intensity with the help of transition probabilities. The thermal theory, on the other hand, although originally presented, nineteen years ago, in a semi-classical form, has since been given a strictly quantum-mechanical basis. The facts are that Raman's "excited vibrations" must exist (either from a classical or a quantum point of view), but that their contribution to the scattering is extremely small as compared with the effect of the thermal vibrations.

All the experiments described by Raman and his colleagues are in entire accordance with the thermal theory, but experiments on metals and on the "forbidden" reflexions of diamond, which he did not attempt, definitely prove that his theory cannot account for the facts. We have outlined some of our arguments in the following communications (written before we had read Mr. Preston's account) and have elaborated them in papers to be published elsewhere.

M. B.
K. L. and H. S.

Sir C. V. Raman's theory of the extra spots on Laue photographs having now been published in detail, I wish to deal with the theoretical aspect, as I believe it is now possible to show exactly where Raman's statements are incorrect.

(1) Raman assumes that the extra spots are due not to the acoustical (low-frequency) branch of the vibrational spectrum but to *monochromatic infra-red vibrations*.

This assumption contradicts the results of lattice dynamics, which show that the elastic spectrum consists of different branches, each of N vibrations (N number of unit cells), uniformly distributed in reciprocal space (co-ordinates: components of wave vector $\mathbf{q}$). In order to justify this contradiction, Raman points out that lattice theory uses the method of the 'cyclic lattice' (replacing the boundary conditions by the postulate of periodicity in a parallelepiped of N cells), a method which he says is not proved but arbitrarily invented to simplify the mathematical treatment. As a matter of fact, it is not proved, apart from a simple example (chain of equal particles) and a limiting case (continuous medium). These cases show, however, that the cyclic method is not arbitrary, but mathematically reasonable; and it is also well confirmed by its applications (for example, conductivity of metals). As Raman attacks the validity of the method, in particular for the optical branches, I have rigorously solved the problem of a finite di-atomic one-dimensional lattice (chain of two alternating particles); the result is, of course, uniform distribution of the frequencies in both branches and the same law for their dependence on wave number as given by the cyclic method.

The intensity of X-ray scattering of all branches will be incoherent and proportional to N. Raman's contention that the scattering due to an excited infra-red vibration will be coherent and proportional to N^2 has no theoretical justification whatever.

(2) Bisheshwar Dayal attempts to support Raman's assumption of monochromatic infra-red vibrations by calculations about the *specific heat* of metals, which he contends cannot be represented by a Debye function but needs additional terms of the Einstein type. This suggestion is not new; it was given in my book "Dynamik der Kristallgitter", published in 1915 (formula 200, p. 77), where I showed that the optical branches of the lattice oscillations are narrow bands which for the calculation of specific heat can be approximately replaced by one frequency. It is clear that no support for Raman's hypothesis can be obtained from a formula previously derived from lattice dynamics.

(3) Raman considers the *sharpness of the lines* observed in the optical Raman spectrum of crystals as a proof of the monochromatic character of the infra-red vibrations. It is not. Lattice theory explains it as a consequence of the optical selection rule: emission of light waves will not occur for every case of resonance, since the electric moments of the different cells of the crystal are in general out of phase; it is restricted to long waves for which the phases in a large group of cells are equal, and this corresponds to an extremely small region of the reciprocal space near the point $\mathbf{q} = 0$. To each 'optical branch' of frequency there belongs only one sharp 'optical resonance'. (I regret if the term 'optical branch' has led to this misunderstanding; but the facts are clearly stated in several publications.)

(4) Raman's proof that *the acoustical branch cannot produce sharp spots* is, shortly, the following: The scattering is proportional to the mean square of the amplitude of vibration, $\overline{\xi^2}$. On the other hand, the mean potential energy of an oscillator of angular frequency ω, $\frac{1}{2}\omega^2\overline{\xi^2}$, is equal to half the mean total energy $\frac{1}{2}kT$, $(\hbar\omega << kT)$, hence $\overline{\xi^2} = kT/\omega^2$. Raman replaces ω by $2\pi c/\lambda$, where λ is the wave-length of the elastic wave, c the velocity of sound. Thus he obtains the scattering of the acoustical branch proportional to $kT\lambda^2$, which is a smooth function and cannot give rise to spots.

The fallacy of this argument lies in the assumption that c is a constant. It is not. In fact, the relation between λ and ω is involved. ω is a periodic function of the components of the wave vector $\mathbf{q}$ (length $q = 1/\lambda$). Consider as illustration the oscillations of a set of parallel equidistant planes in the lattice (spacing a) which will be roughly the same as that of a chain of equidistant mass points (linear lattice); it is well known that the frequency in this case is $\omega = \omega_0 \,|\sin(\pi a/\lambda)\,| = \omega_0 \,|\sin(\pi q/b)\,|$, where $b = 1/a$ is the lattice constant of the reciprocal lattice. The dynamical theory of the scattering leads to the same result as de Broglie's quantum condition: the intensity is enhanced if the difference of the momentum vectors for the incident and reflected photon is equal to the momentum of the acoustical quantum, or $2Q\sin\delta = q$, where $Q = 1/\Lambda$ is the wave number of the X-ray. (As the left-hand term may have any

value, q cannot be restricted to the domain $0 \leqslant q \leqslant b/2$, or $2a \leqslant \lambda \leqslant \infty$, for which $\omega(q)$ assumes all possible values.) Taking for the mean square amplitude Raman's approximate expression kT/ω^2, the 'scattering power' is proportional to

$$S(q) = \frac{kT}{\omega_0^2 \sin^2(\pi q/b)},$$

and the intensity for the direction δ is $S(2Q \sin \delta)$. $S(q)$ is a periodic distribution in the 'reciprocal space' q; it has sharp peaks (infinities) at the points of the reciprocal lattice $q = 0, b, 2b, 3b, \ldots$. These correspond to the Bragg reflexions; for $2Q \sin \delta = nb$ is the same as $2a \sin \delta = n\Lambda$.

If all possible sets of reflecting planes are simultaneously considered, the formulæ are more involved, but the principal features unaltered: the scattering power $S(\mathbf{q})$ is a function of the three components of the wave vector $\mathbf{q}$, and the scattered intensity due to the vibrations is $S(\mathbf{Q}' - \mathbf{Q})$, where $\mathbf{Q}$ and $\mathbf{Q}'$ are the wave vectors of the incident and scattered beam (of practically equal length). $S(\mathbf{q})$ consists of additive terms each corresponding to one branch of the vibrational spectrum, and these have peaks (infinities) for the acoustical branches in the points of the reciprocal lattices (which correspond to the Laue spots); but the terms for the optical branches are quite smooth functions, as for these $\omega(\mathbf{q})$ does not approach zero.

Hence the correct theory attributes the observed extra spots to the acoustical vibrations—just contrary to Raman—and this is well confirmed by experiments of Lonsdale and Smith on various metals.

The optical branches may give broad but relatively weak intensity maxima halfway between Laue spots because $\omega(\mathbf{q})$ has minima there (in the linear case for $q = \frac{1}{2}b, \frac{3}{2}b, \frac{5}{2}b, \ldots$).

(5) Raman claims that the extra spots are due to a peculiar *new type of quantum effect*. His theory, as now made known, is however completely classical, whereas the so-called 'thermal' theory based on lattice dynamics (which Raman rejects) is developed strictly on quantum principles. The only point where Raman introduces a quantum consideration is in respect of the temperature dependence of scattering produced by his monochromatic infra-red vibrations. With the help of strange reasoning he obtains a formula which is in fact (apart from a factor of 2) identical with the formula for the energy of an oscillator with zero-point energy, according to Planck. Now this quantity determines the intensity also in the theory based on lattice dynamics.

Venkateswaran tried to confirm Raman's assumption by deriving the characteristic frequency in the Planck formula from the observed temperature effect of the extra spots, and to compare it with other determinations of infra-red vibrations (Raman effect). These observations had to be made on extra spots well separated from the corresponding Laue spots and would therefore in any case refer to oscillations of relatively high frequency. All the experiments showed was that for carborundum the oscillations were of higher frequency than those for a soft organic crystal, a result which the theory of lattice dynamics undoubtedly predicts, because of the differences in the quasi-elastic forces in the two substances.

(6) In order to explain the *specific intensity of extra spots* corresponding to different Laue spots, Raman introduces special assumptions about the directions of his monochromatic waves. Lattice dynamics provides the explanation without any assumption, by expressing the scattering power $S(\mathbf{q})$ as a function of the quasi-elastic forces between the atoms. These can be approximately expressed in terms of the elastic constants (Zachariasen, Jahn, Sarginson). Jahn has shown that the elastic anisotropy of cubic crystals leads to a characteristic anisotropic distribution of $S(\mathbf{q})$ around each point of the reciprocal lattice; Lonsdale and Smith have used Jahn's formula very successfully for representing their observations.

The extra spots are not, as Raman assumes, in contradiction to lattice dynamics, but provide a powerful method of checking it in every detail.

University of Edinburgh. MAX BORN.

Prof. Born and Miss Sarginson[1] have pointed out that according to the quantum mechanical calculations of Ott (1935) and also from the point of view of Placzek's quasi-classical theory, the excitation by the X-ray energy of characteristic crystal vibrations (analogous to the Raman effect in light scattering) would only be expected to give X-ray interference effects entirely secondary in importance to those of the thermal vibrations. Ott[2] suggested, however, that in regions where a Bragg reflexion would normally be forbidden, the Raman effect might possibly give an observable reflexion, and questioned whether the 222 reflexion from diamond might not be such an instance.

This suggestion has recently been revived by Sir C. V. Raman[3] (who does not, however, either admit the secondary importance of the excited vibrations or refer to Ott's paper) and has been worked out in quantitative detail by P. Rama Pisharoty[4], on the basis of an excited 1,332 cm.$^{-1}$ oscillation *normal to one set of* (111) *planes only*. This procedure we believe to be incorrect and misleading, since such oscillations, if excited at all, will certainly take place with equal probability normal to all the {111} planes. However, Pisharoty makes the following predictions for a perfect diamond set for reflexion at the Bragg angle appropriate to each plane in turn:

(1) There is no 222 Bragg reflexion, but that there is a 222 extra reflexion (which he alternately calls a modified, quantum or Raman reflexion), the intensity of which is roughly equal to that of the 111 extra reflexion.

(2) There is no 220 extra reflexion, or alternatively, that if there is, it will be *very* much weaker than the 111 extra reflexion. He reports that Dr. Nilakantan has failed to find such a reflexion in spite of many trials.

(3) There is no 200 Bragg reflexion, but that there is a 200 extra reflexion. The intensity of this extra reflexion he estimates to be about one third of the 222 intensity, but in so doing he has neglected to allow for the difference in Bragg angle. Actually, his theory would make them nearly equal.

We have investigated these reflexions with the greatest care, and have fully established the following experimental facts:

(1) The 'forbidden' 222 reflexion is in every respect similar to a Bragg reflexion and has none of the peculiar characteristics of an 'extra' reflexion. It appears sharply at the appropriate Bragg angle (for our $D(2)$ diamond its intensity was about 0·04 of that of the 111 Bragg reflexion), and when the angle of setting is varied it disappears completely even when the exposure given is several times as long as that required to record the 111 extra reflex-

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

NOTICE is hereby given that an ELECTION of JUNIOR FELLOWS to begin work on October 1 will take place in July, 1942. Junior Fellowships are normally of the annual value of £400 for three years; but candidates, younger than those usually elected or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £300 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a Degree in a Faculty of a University in the British Empire or a Medical Diploma registrable in the United Kingdom. Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in Mental Diseases and in the general allotment of Fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates should be received by May 14, though late entries will be accepted up to June 1.

Owing to the disturbance caused by the war, it is necessary for candidates to submit evidence that they could be given accommodation in the departments where they propose to work.

Forms of application and all information may be obtained by letter only addressed to: Professor T. R. Elliott, M.D., F.R.S., Hon. Secretary, Beit Memorial Fellowships for Medical Research, University College Hospital Medical School, University Street, London, W.C.1.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

SOUTH KENSINGTON, LONDON, S.W.7

PHYSICS DEPARTMENT
(Technical Optics Section)

A Course of six Lectures, by Mr. B. K. JOHNSON, D.I.C., on "Microscopy" will be given on Tuesdays and Thursdays at 4 p.m., commencing on Tuesday, April 21, 1942.

An optional course of practical work (consisting of 8 periods of 3 hours each) will also be arranged. These courses will be suitable for those having to use the microscope in technical practice; they will include advanced methods in microscopy, and ultra-violet microscopy.

Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, S.W.7. The fees are £1 1s. for the lectures and £2 2s. for the laboratory work.

UNIVERSITY COLLEGE OF SWANSEA

The Council invites applications for the post of Lecturer in the Department of Mathematics. The salary will be determined according to qualifications and experience, with a minimum of £400 and a maximum of £500 per annum. The appointment will date from October 1, 1942. Further particulars may be obtained from the undersigned, by whom applications must be received on or before Wednesday, April 22, 1942.

EDWIN DREW,
Singleton Park, Swansea. Registrar.

HENRY GEORGE PLIMMER FELLOWSHIP

The Governing Body of the Imperial College invite applications for the Henry George Plimmer Fellowship, vacant from September 1, 1942. The Fellowship was founded in memory of Professor Henry George Plimmer, F.R.S., who held the Chair of Comparative Pathology at the College from 1915-18. It is tenable for one or more years at a recognized institution, and is for research which may include Morbid Anatomy, Histological Anatomy, Chemical Pathology, Protozoology, Bacteriology and allied subjects in either Zoology, Medicine or Botany. The annual value is equal to the income from certain War Stock, approximately £217 per annum. The Fellow shall be considered to be attached to one of the Biological Departments of the Imperial College, and shall work under the general supervision of a Professor of that department.

Applications (by letter only) should be sent before June 1, 1942, to the Rector, Imperial College, Prince Consort Road, London, S.W.7, from whom further particulars can be obtained.

UNIVERSITY OF BIRMINGHAM

FACULTY OF MEDICINE

APPOINTMENT OF LECTURER IN BIOCHEMISTRY IN THE DEPARTMENT OF PHYSIOLOGY

Applications are invited for the post of Lecturer in Biochemistry. Stipend at the rate of £400 per annum.

Qualifications, Honours degree in Chemistry or Physiology. Candidates holding a degree in Chemistry should have studied Physiology or Biology as a subsidiary subject.

Four copies of application, with testimonials, must be sent on or before April 25, to the undersigned from whom further particulars may be obtained.

C. G. BURTON,
The University, Edmund Street, Birmingham, 3. Secretary.
March, 1942.

UNIVERSITY OF BIRMINGHAM

Applications are invited for the Chair of Oil Engineering and Refining (Petroleum Technology) rendered vacant by the death of Professor A. W. Nash. The appointment will date from October 1, 1942, and the salary will be £1,250 per annum.

It is intended to appoint the most outstanding candidate irrespective of the particular branch of the subject in which he has specialised.

Further particulars of the appointment may be obtained from the Secretary, to whom applications (three copies) must be submitted, with the names of three referees, on or before Saturday, 9 May, 1942.

C. G. BURTON,
The University, Edmund Street, Birmingham, 3. Secretary.
March, 1942.

HUDDERSFIELD EDUCATION AUTHORITY

HUDDERSFIELD TECHNICAL COLLEGE

Principal: Dr. J. W. Whitaker, F.I.C.

RESEARCH SCHOLARSHIPS

Applications are invited from graduates or candidates with equivalent qualifications for Research Scholarships tenable for two or more years. The scholarships vary in value from £75 to £150 per annum and are tenable in the Department of Coal Tar Colour Chemistry and/or other departments of the College. The scholarships are open to candidates of either sex. Further particulars may be obtained on application to the Principal.

H. KAY,
Director of Education.

HARPER ADAMS AGRICULTURAL COLLEGE

ASSISTANT LECTURER in BOTANY and ZOOLOGY

Particulars of the above appointment, for which immediate applications are invited, may be obtained from The Principal, H.A.A.C., Newport, Shropshire.—Salary, £250 p.a.

ROYAL HOLLOWAY COLLEGE

(University of London)

Englefield Green, Surrey.

Required student-demonstrator in Botany. The demonstrator will have residence and honorarium and ample time for research. Full particulars from the Principal, to whom applications must be sent by May 1, 1942.

Applications are invited for the post of Assistant Physicist in the Physics Department of the Radiotherapeutic Research Unit of the Medical Research Council at Hammersmith Hospital, W.12. Salary £350 p.a. with yearly increments of £25 to £400, the appointment to commence July 1, 1942. Applications should be sent to the Director of the Unit by April 27.

Assistant Librarian (female) required by firm of Manufacturing Chemists for their Medical Library. A qualification in Pharmacy or Science is essential. Knowledge of foreign languages an advantage.—Box 845, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

Microscope for sale. Box 846, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

Microscopes, second-hand, a large selection of instruments in perfect condition; 8d. stamp for list.—Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

THE fact that goods made of raw materials in short supply owing to war conditions are advertised in this publication should not be taken as an indication that they are necessarily available for export.

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ions with appreciable intensity in positions of equivalent mis-setting. The 222 reflexion was examined in both possible diamond orientations ([1$\bar{1}$0] axis vertical) and no sign whatever was found of the detail that would correspond to intensity spikes along cube directions in reciprocal space (that is, of any effect geometrically analogous to the 111 streaks and triangles).

(2) The {220} planes, in all orientations, do give extra reflexions, both primary and secondary[5], which are at least half as intense as the 111 extra reflexions. We cannot understand Dr. Nilakantan's failure to find them.

(3) There are no reflexions of any kind from the (200) planes, of intensity comparable with that predicted, or even as much as 1 per cent of that value.

We used both direct and monochromatized (copper $K\alpha$) radiation from a 5-kw. tube. In order to avoid all possible errors of setting, we took series of Laue photographs at 0·2° intervals, and also 1° and 5° oscillation photographs. Exposures varied from 5 seconds to 2 hours. Using X-radiation monochromatized by reflexion from the (001) plane of urea nitrate, a weak reflexion was observed in the 200 position; its intensity was about 0·01 of that of the 222 reflexion (exposures of one hour and 30 seconds were required to record the two with comparable intensities) and about 0·0003 of that of the 400 Bragg reflexion. It was certainly due to the 400 reflexion of wave-length $\lambda CuK\alpha/2$. Such 'unwanted' radiation is unavoidable in any monochromatized beam if the monochromatizing plane used has a second-order reflexion, and it sometimes amounts to as much as 1·6 per cent of the λ component[6]; for precise work it should always be estimated and allowed for. (Such a $\lambda/2$ component probably accounts for the doubtful 100 reflexion on a monochromatic photograph of sodium chloride, referred to by C. S. Venkateswaran[7].)

P. Rama Pisharoty and R. V. Subrahmanian[8] observe that the absence of the 111 extra reflexions (of the secondary kind) in type II diamonds[9] is due to the probable mosaic structure of these rare specimens. There are not, they suggest, sufficient cooperating planes in each block for the subsidiary phenomena to appear. In a reply to this suggestion it may be pointed out:

(1) That the 222 reflexion (which they have claimed to have the same origin as the 111 subsidiary reflexions) does appear quite strongly in type II diamonds. The larger value of the 111/222 intensity for such diamonds as compared with that for type I is due to the very much greater 111 intensity, not to a decrease in 222.

(2) That the secondary effects were observed so strongly, with our powerful X-ray equipment, for some type I diamonds, that had the effect for type II diamonds been even 0·01 as intense it would almost certainly have been found.

(3) That the temperature-sensitive diffuse spots (primary extra reflexions) which are certainly due to X-ray diffraction by elastic vibrations, appear equally strongly for both types of diamond. Yet according to Raman[10] and Venkateswaran[11], the relative diffraction effect due to elastic vibrations should, on their theory, vary proportionately to the size of the crystal block, whereas that due to the excited characteristic vibrations should not.

(4) That soft organic crystals and soft metals such as sodium and lead, which are undoubtedly mosaic in structure, show excellent extra reflexions.

Pisharoty and Subramanian suggest that in the diamond orientation we used ([1$\bar{1}$0] vertical), the [001] direction was tangential to the sphere of reflexion, thus accounting for the absence of extra reflexions along that direction for the (220) and (113) planes. A little consideration, however, shows that it was not. The [001] direction was more nearly normal to the sphere of reflexion than either [010] or [100] directions along which 220 extra reflexions *were* found, and only a little less so for the 113 reflexion. We thought it unnecessary in our former communications to stress the fact that the absence of extra reflexions along certain directions for some diamond planes is an intrinsic property of the diamonds and not an effect due to the geometry of the experiments.

Finally, we wish to point out, as an experimental fact proved beyond question[6], that the integrated intensity of a Bragg reflexion is *not* proportional to N^2 (N = number of lattice cells *in the crystal*) as Raman repeatedly implies[12], but to the volume of the crystal, that is, to N. Born's theory gives the integrated intensity of an extra reflexion as also proportional to N. In practice it is always integrated intensities that are compared.

K. LONSDALE.
H. SMITH.

Royal Institution,
21 Albemarle Street, London, W.1.

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OBITUARIES

Dr. George Senter

THE death of Dr. George Senter on March 14 brings to a close an eventful life as man of science and administrator. Let us recall the main events of his history. Born in 1874 at Kildrummy, Aberdeenshire, he was educated at the Universities of London, Leipzig and Göttingen. He obtained his first teaching post in 1904 as lecturer on chemistry at St. Mary's Hospital Medical School, and became head of the Chemistry Department, Birkbeck College, London, in 1913. Five years later, when the outcome of the War of 1914–18 was in the balance, Senter became principal of the College and so inaugurated a period which must be regarded as one of the most important in the history of that institution.

Birkbeck College grew out of the London Mechanics' Institution—founded in 1823 with Dr. George Birkbeck as first president. The College still maintains the honourable and ancient association of poverty and scholarship in that it serves the student who has to pursue learning and earn his living at the same time. Senter was the type of administrator who sees possibilities rather than difficulties and dangers. He grasped boldly and imaginatively the opportunities before him, with the result that when he retired in 1939 the College had become a school of the University of London, and on a fine site in Bloomsbury, next to the Senate House of the University,

the foundations of a new college building were laid. Senter had good cause for happiness in the outstanding success of his principalship. Besides guiding the internal affairs of the College, Senter took a prominent part in the larger world of the University. As an active member of the Senate his shrewd judgment was appreciated and his work on committees and boards earned him the respect and affection of his colleagues.

George Senter possessed one of the rarest and most precious of gifts in a man of science or administrator —the gift of lucid exposition. This he turned to good account in his well-known books, "Outlines of Physical Chemistry" and "Text-book of Inorganic Chemistry," which have delighted and helped a generation of chemists. In view of his fine record in administration there may be a tendency to forget his eminence as a man of science. Senter realized at an early date that kinetic investigations would be necessary for the satisfactory elucidation of the problems connected with the phenomenon of the Walden inversion. He carried out a number of pioneer investigations and had he been able to devote himself to this work there seems little doubt that results of great theoretical interest would have emerged. Actually this early work on chemical kinetics in which he was engaged when he became principal of Birkbeck College is now regarded as fundamental, and after some twenty years forms the basis of one of the most rapidly developing branches of physical chemistry.

Although Senter was a bachelor he was not a self-centred man. He had a true and understanding heart associated with a tolerant mind and a happy gift of humour. For relaxation he turned to the peace and joy of his garden and the countryside. In the minds of the hosts of his friends there will ever remain the remembrance of a shrewd and kindly man who had a sincere desire to serve his fellow-men.

W. WARDLAW.

Dr. J. G. Myers

JOHN GOLDING MYERS was born near Rugby in Warwickshire on October 22, 1897. In 1911 his parents moved to New Zealand. There he did brilliantly at school, winning a scholarship to Victoria University College, Wellington. During the War of 1914–18 he came to Europe with the New Zealand Expeditionary Force. Returning to Wellington he completed his studies and obtained the B.Sc. and M.Sc. degrees.

From 1919 until 1924 Myers was employed as entomologist in the Biological Division of the New Zealand Department of Agriculture, where he did excellent work on the cattle tick and other pests. In 1924 he won the coveted honour of an 1851 Exhibition Scholarship for New Zealand and elected to go to Harvard University. There he worked at the entomological laboratory of the Bussey Institution, eventually obtaining the degree of Sc.D. In 1925 Myers came to England to represent the New Zealand Government at the Second Imperial Entomological Conference. Afterwards he went to France at the request of his Government to study the natural enemies of the pear leaf-curling midge. In the following year he was appointed to the staff of the Imperial Institute of Entomology to organize the breeding of parasites of injurious insects for export to the Dominions and Colonies. He did splendid work on the parasites of the blow-fly and of the timber-infesting wood-wasps, which made possible their export to Australia and New Zealand. Myers next visited Australia to investigate the passage of dried fruit from the vine to the consumer and was successful in tracing the sources of insect infestation. In 1928 he went to Trinidad to study the possibilities of the biological control of sugar cane pests. He travelled all over the West Indies and to Guiana and Surinam in search of parasites, and his report, published by the Empire Marketing Board, is a mine of information not only on insect pests and their parasites but also on the general ecology and agriculture of the countries visited.

Myers' work in the West Indies continued up to 1934, when he joined the staff of the Imperial College of Tropical Agriculture in Trinidad. Here he undertook a number of private expeditions at the request of various planters, collecting and studying the ecology of insect pests in unknown parts of British Guiana, Venezuela and Brazil.

In 1937 Myers was appointed economic botanist to the Government of the Anglo-Egyptian Sudan, his task being to survey the economic possibilities of the southernmost province of Equatoria with a view to its future agricultural development. Only preliminary reports of this work are available, but they cover a great variety of subjects and show the usual thoroughness of his approach and the broadness of his vision. It was fated that this task should not be completed, for he was killed in a motor accident near Amadi, Equatoria Province, on February 3.

Apart from his many papers on biological control, and related topics, Myers produced a large number of works on Hemipterous insects which showed him to be a morphologist and systematist of the highest order. Myers' versatility, broad ecological outlook and great experience in many parts of the world made him the most outstanding economic entomologist of his generation. In his death at the early age of forty-four, applied biological science has lost one of its most brilliant investigators. He leaves a widow and two small daughters in British Guiana.

W. E. CHINA.

Sir William Bragg

QU'IL me soit permis d'apporter un hommage français à la mémoire de Sir William Bragg, dont la mort, suivant de près celle de J. J. Thomson, endeuille aujourd'hui la science anglaise.

J'avais appris à connaître et à admirer l'œuvre de Sir William Bragg, il y a de nombreuses années, alors que je faisais mes premières armes de chercheur au laboratoire de Madame Curie. Son livre sur la Radioactivité avait une place d'honneur dans notre bibliothèque, et le volume, très usé, témoignait de l'utilité de l'ouvrage : il était toujours entre les mains de quelque chercheur ou de quelque étudiant.

J'ai eu l'honneur d'être reçu par Sir William Bragg lorsque je parvins en Grande Bretagne après m'être évadé de France, en juin 1940. Je n'oublierai jamais l'amabilité de son accueil, ni les paroles de sympathie, si directes et si profondément senties, qu'il prononça à l'égard de notre malheureux pays.

Je suis sûr d'être l'interprète de tous les hommes de science français, forcés au silence par leur situation, en priant Sir Lawrence Bragg et la Royal Society d'accepter leurs condoléances émues et le témoignage de leur profond attachement à la mémoire du grand disparu.

A FREE FRENCH SCIENTIST.

NEWS and VIEWS

Gardiner Chair of Chemistry at Glasgow

AFTER a connexion of almost forty years with the chemical department of the University of Glasgow, Prof. T. S. Patterson retires from the Gardiner chair of chemistry at the end of the present session, thus bringing to a close a period of teaching activity which has coincided with a period of great expansion in the University Chemical Department. As a research worker Prof. Patterson's chief interest lay in the subject of optical activity, and more especially in the physico-chemical aspect of the subject. His investigations on the effect of solvent, temperature and wave-length of light on the rotatory power of the derivatives of tartaric acid have produced data which will be of great value to future workers, while his modification of the "characteristic diagram" of Armstrong and Walker has simplified the co-ordination of rotatory dispersion phenomena. But in recent years Prof. Patterson has become more absorbed in the historical aspect of chemistry, and in this field he has found fuller scope for his literary ability than was possible in the mere recording of the results of personal experiment. The results of his researches on the lives and work of the earlier chemists have been embodied in excellent articles contributed to the *Annals of Science* and to *Isis*. He has always taken an interest in student activities and was a constant attendant at meetings of the "Alchemists", a student chemical society the well-being of which he had much at heart.

DR. J. MONTEATH ROBERTSON has been appointed to the Gardiner chair of chemistry in the University of Glasgow as from October 1, 1942, in succession to Prof. T. S. Patterson, whose resignation takes effect then. Dr. Robertson, who is forty-one years of age, was educated at Perth Academy and the University of Glasgow, where he graduated B.Sc. with special distinction in chemistry in 1923 and M.A. in 1925. His post-graduate research work also began there, and he has since received the degrees of Ph.D. and D.Sc. from the University. During the tenure of a Carnegie research fellowship Dr. Robertson worked at the Royal Institution in London under Sir William Bragg. During 1928–30 he was in the United States as a Commonwealth Fund fellow and worked in the University of Michigan and the Gates Chemical Laboratory, Pasadena. On his return he joined the staff of the Davy Faraday Laboratory of the Royal Institution and remained there until his appointment in 1938 as senior lecturer in physical chemistry in the University of Sheffield. He has published many papers dealing with the chemistry of natural products, X-ray diffraction methods, molecular dimensions and structure, etc.

Dr. Robertson is best known for his beautifully finished determinations of the structures of conjugated organic compounds by the X-ray study of minute single crystals. In 1932 he mapped the electron density distribution in anthracene crystals by means of two-dimensional Fourier analyses along three principal directions, and showed that the chemist's structural formula represents with considerable nicety the arrangement of atoms in the plane molecule. By designing an apparatus which would enable an absolute comparison to be made photographically between the intensities of the incident and reflected X-ray beams, and by devising various mechanical methods of speeding up the formidable amount of computational work involved, he was able to make similar studies of many other compounds, including those of the dibenzyl and the phthalocyanine series (partly in collaboration with Miss I. Woodward). He proved that the interatomic distances in these compounds are dependent upon the bond characters, and provided a mass of reliable experimental data for testing theoretical calculations based upon energy relationships. His direct determination of the structures of nickel and platinum phthalocyanines not only gave valuable information concerning the stereochemistry of those metals but also showed that the usual 'trial and error' method of determining phase constants can be dispensed with in special cases. His latest work (in collaboration with Dr. A. R. Ubbelohde) has concerned the lengths of hydrogen and hydroxyl bonds and their changes with crystalline dimorphism, temperature and deuterium substitution. Few present-day scientific men have succeeded in obtaining so much accurate numerical data of fundamental importance to organic chemistry.

Suppression of Culture in Norway

WE are informed that a petition, signed by fifty-two members of the Royal Society of Science and Letters of Göteborg, has been presented to the Swedish Minister for Foreign Affairs asking him to intervene on behalf of three Norwegian members of the Society who have been imprisoned and subjected to severe treatment in Norway. A translation of the petition reads: "Three foreign members of the Royal Society of Science and Letters of Göteborg have already for a considerable time been deprived of their liberty. They are known to us as eminent scientists and scholars and are citizens beyond reproach. As far as we know, none of them has been convicted of any crime against the laws of their country by a legal court of justice or even accused of any criminal offence. To all of us their fate has given great pain. The fact that Prof. Seip (of the University of Oslo), for reasons unknown to us, has been subjected to cruel treatment has further increased our anxiety on their behalf. We members of the Royal Society resident in Göteborg herewith apply to your Excellency to do everything in your power in order to set our fellow-members at liberty and enable them to resume their studies and research." It is to be feared that this petition will be of little avail, though it reflects the views of the men of science of neutral countries, and is much to their credit.

Scientific Research in Sweden

EXTENSIVE research activity is going on in Sweden, in order to find substitutes for products which can no longer be imported owing to the War. One of the most important centres for this research is the Physical-Chemical Institute, Uppsala, headed by Prof. The Svedberg. The Institute has now lost all the foreign research workers who used to study there, with the exception of one Swiss; nevertheless the staff has been doubled. Extensions have in particular been made to departments dealing with the many present supply problems, of which the chemical aspects fall within Prof. Svedberg's own department, namely, the giant molecules. The work with different kinds of synthetic rosins and cellulose-derivatives is now progressing on a large scale. Among other objects of research may be mentioned bread. Experiments are being made to find a means of replacing

imported hard wheat, which was formerly used to improve the baking qualities of bread made from Swedish native soft wheat. Investigations are also being carried out on synthetic rubber. The work has proceeded so far that the product has been evolved in the laboratories of the Institute, although it is too early yet to say whether domestic production can be started and its probable extent.

One of the foremost technical means of research of this Institute is the Svedberg ultra-centrifuge, which has become of the utmost importance to science. The rotor of this centrifuge is given a speed of up to 70,000 revolutions per minute by a number of oil turbines. The Institute also houses such instruments for research as one of the world's largest electro-magnets and a neutron generator, both of which have been made in Sweden. In the bio-chemical section the experiments for locating and cultivating infantile paralysis virus and tuberculine on the basis of a new method for analysing mixtures through molecule splitting are carried on under the direction of Prof. Arne Tiselius, who has devised this method. The object in the first place is to obtain a pure form of virus. The stoppage of the import of apes for these experiments for a while threatened the workers with the loss of indispensable test animals, but it is stated that their replacement with rats has now proved acceptable.

Quality Control in Manufacture

AN article by H. Rissik on "Quality Control in Manufacture" in the *Electrician* of March 27 reviews the principles of the subject with special reference to the use of control charts. The theoretical foundations of the method were laid down originally by Prof. R. A. Fisher, and the technique itself, which was originated in the Bell Telephone Laboratories of the United States, has been applied successfully for more than twelve years throughout the various manufacturing organizations of the Bell system. The technique of quality control is, briefly, one of inspection-cum-production, based on known statistical methods which have been applied successfully in other fields, and it has proved to be a valuable aid to manufacturing concerns engaged on repetition work. Its advantages include reduction in inspection costs and in rejects, attainment of maximum benefits from quantity production and of uniform product quality even though the inspection test be destructive, immediate applicability as part of inspection routine, and utter simplicity of application.

Fundamentally, the problem is one of controlling variability in some directly measurable quality characteristic, for example, dimension, weight, tensile strength, electrical resistance, hardness, etc. In practice this means analysing the variability observed and comparing it with some objective standard. Thus, provided a product is known beforehand to be stable, limits may be assigned within which practically all observed values of the variable quality characteristic are expected to lie. If measurements on a succession of piece-parts, produced supposedly under the same essential conditions, are found to give dimensional values lying outside these limits, then it may be inferred that they were not, in fact, so produced, that is, the production process was not stable in the first place. This leads to the very heart of quality control as a technique enabling preventive action to be taken before trouble develops; and the basis of this is the so-called quality control chart which is, in effect, a continuous graphical record of product quality. The article discusses the use of the control chart and makes reference to the recent British Standards Institution publications, *B.S.* 600–1942 and *B.S.* 1008–1942.

Electrical Instruments

IN his chairman's address to the Meter and Instrument Section of the Institution of Electrical Engineers (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 13, January, 1942), W. Phillips surveys the design and performance of electrical instruments. Development since the 1890's has been twofold: first in widening the limits of measurement, and secondly in accuracy. Switchboard moving-coil instruments are now available to give full-scale deflection for 10 μ amp. or less, and ammeters having a range of 30,000 amp. are in use. In voltage, the range is from a few micro-volts, with apparently no upper limit, the sensitivity of D.C. moving-coil instruments now being limited only by the non-magnetic quality of the moving system. The standardization of frequency at 50 c./s., and its close regulation by supply undertakings, has fostered the design and use of testing apparatus for the measurement of power factor, peak factor, and current; and also of voltage testing sets and similar apparatus for use at fixed frequency. The Electricity Supply (Meters) Act created an immediate demand for standard and sub-standard instruments of all types, large sums being expended by supply authorities in equipping meter-testing stations. Great improvements in wattmeter performance have been made, particularly in the reduction of self-heating error and D.C./A.C. change-over error.

One of the recent major troubles with which instrument makers have had to cope is the almost complete stoppage of supplies of sapphire jewels. An English company now manufactures sapphire jewels from rough boules, but it cannot yet meet the demand. Substitutes are being provided, consisting of nitralloy steel jewels for meters, while for instruments a specially hard glass jewel is available requiring no expensive or elaborate manufacturing plant. The jewels at present being manufactured are mainly for use in miniature instruments, a small number only having been made for larger instruments.

Electric Heating of Premises

MR. W. GILCHRIST, in a paper read recently before the Institution of Electrical Engineers on the above subject, deals with the various methods of applying electricity to space-heating, water-heating and sundry special applications with particular reference to large-scale space- and water-heating installations. The author records the fundamental principles of design and some of the results obtained from certain methods of heat application which do not, in some respects, follow existing practice. The possible economic limits of using electricity for direct heating are related to the capacity of both commercial and domestic buildings, there being a definite limit to the size of such installations both from the consumer's and supplier's points of view. Details are given of certain combinations of radiant and convection heating to achieve maximum comfort conditions at a lower cost to consumer and supplier than other existing methods. Examples are given of installations using a combination of thermal storage, local thermal storage and direct heating, and a method of applying water-heating to large installations is described which considerably improves the

overall efficiency. A domestic electrification policy is outlined with special reference to space- and water-heating for working-class houses, and it is suggested that future policy in the domestic electrification of houses should be based on the use of a proportion of solid fuel for heating and water-heating.

Bee-keeping in War-time

AT a lunch of the Backs to the Land Club held on March 25, Dr. C. G. Butler, of the Rothamsted Experimental Station, gave an address on the place of bee-keeping in the national economy. As Dr. Butler pointed out, it appears to be the common idea that the value of the honey-bee lies in the honey it produces. From the point of view of national economy, however, its function as the pollinator for fruit and seed crops is of prime importance. Honey has not been found to contain any measurable quantity of vitamins, but its invert sugars make it very readily assimilated by the human body. It is therefore of special value in treating cases of shock; also invalids and young children. Dr. Butler stressed the undesirability of too many beginners taking up bee-keeping at the present time. The shortage of supplies, in his opinion, is such that established bee-keepers should have first claim on such supplies, rather than the novice knowing nothing at all about bees. There is evidence that in many places where large orchards, or areas of insect-pollinated seed crops are planted, there are insufficient wild pollinating insects present for full production. Dr. Butler urges that, at the present time, greater efforts should be made to use honey-bees for pollination by making them available by the transfer of stocks to such areas where they are most needed.

Wilhelm August Lampadius (1772–1842)

AT the time when geologists and mining students flocked to the Freiberg Mining Academy in Saxony, and when Gottlob Werner was at the height of his fame, a twenty-year-old chemist because a member of the staff, and from that time onwards for half a century he taught, wrote and experimented with great success. This young chemist was Wilhelm August Lampadius, who in his fourteenth year had been apprenticed to a Göttingen apothecary. Born at Hehlen in Brunswick on August 8, 1772, Lampadius lost his father, a pastor, at an early age. Apprenticed by his mother at Göttingen he devoted his spare time to study and was befriended by the university professors J. F. Gmelin and Lichtenburg. At the age of nineteen he entered the service of the metallurgist Count Sternberg of Bohemia. With the Count he made a journey to Russia and in the Count's laboratory made experiments on electricity and heat. His talents becoming known to Werner, he was given a post at Freiberg and on the death of C. E. Gellert (1713–1795) he was made professor of chemistry. In this situation he assisted German industry in many ways. He spread a knowledge of Lavoisier's discoveries, and made researches connected with mining and metallurgy, chemical manufactures, agriculture and meteorology. Especially important among the books he published was his handbook on smelting. A man of estimable character, respected alike by his friends and colleagues, he died at Freiberg on April 13, 1842) in his seventieth year. His place in the Academy was taken by Karl Friedrich Plattner (1800–1858), the chief of the royal department of assaying and an authority on the use of the blow pipe.

Earthquakes Registered at Kew

DURING February 2–March 5 four large earthquakes were registered on the seismographs at Kew Observatory. The first, on February 2, began recording at 17h. 15m. 28s. U.T., possibly from an epicentral distance of 1,500 km., though long waves were not pronounced and the shock appeared to possess some of the deep-focus characteristics. On February 16 a strong shock began recording at 18h. 27m. 31s. U.T., possibly from an epicentral distance of 13,300 km. It finished recording at 20h. 00m., having lasted some 1h. 32·5m. The third earthquake, on February 21, began recording on all three components with *iP* compressional at 07h. 20m. 14s. The tentative calculated epicentral distance was 9,300 km. The shock appeared to be normal, had a maximum ground amplitude at Kew of 72 μ, and finished recording at 09h. 40m. U.T. The third disturbance, on March 5, began recording near 19h. 59m. 56s. U.T., though the start of *iP* was somewhat confused by microseisms. The epicentral distance may have been near 8,200 km., the long waves were of small amplitude, and the shock finished recording at 21h. 10m. U.T.

Announcements

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the James Alfred Ewing Medal for 1941 has been awarded to Dr. F. W. Lanchester. The Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research.

THE first Sir Joseph J. Thomson Memorial Lecture of the Chemical Society will be given by Lord Rayleigh, in the Lecture Theatre of the Royal Institution on April 16 at 4.30 p.m.

PROF. B. K. MALINOWSKI, University professor of anthropology in the London School of Economics who now holds the position of Bishop Museum visiting professor of anthropology in Yale University, has been appointed professor of cultural anthropology at that University as from July 1.

PROF. EMIL ABDERHALDEN, professor of physiology at Halle and for many years president of the German Academy of Natural Sciences at Halle, has had the latter appointment extended for another ten years.

AT a meeting of the Quekett Microscopical Club, held on March 21, the following officers were elected: *President*, Mr. W. E. Watson Baker; *Hon. Librarian*, Mr. C. Best; *Hon. Curator*, Mr. C. Sidwell; *Hon. Secretary*, Miss C. Arnold.

The following awards in respect of the year 1941 were made at the annual corporate meeting of the Institution of Chemical Engineers on March 27. The Osborne Reynolds Medal, for meritorious work accomplished for the advancement of the Institution during the year, to Dr. A. Parker, honorary editor and recorder of the Institution; the Moulton Medal (in gold), for the best chemical engineering paper of the year, of a mature character, read before the Institution and published in the *Transactions*, to Mr. P. Parrish, for his paper "Modern Developments in the Design of Plant for the Concentration of Sulphuric Acid"; the Junior Moulton Medal for 1941 was not awarded; the William Macnab Medal, for the best set of answers submitted in the associate-membership examination during the year, to Mr. E. W. Pates.

LETTERS TO THE EDITORS

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

Use of Soil Fertilizers in China

BEGINNING in 1935, this Department has been investigating the fertility of the soils of China, with especial reference to the limiting effect of plant food deficiencies, and to the possibility of increasing crop production by the use of fertilizers. The investigation is based in the first place on field experiments, chiefly 'NPK tests', consisting of modern factorial designs at two and/or three levels. The standard rate of application throughout is eight *catties* per *mou* (about 0·5 cwt. per acre) of nitrogen, phosphate and potassium (N, P_2O_5, and K_2O). The experimental crops are rice, wheat, maize, rape-seed, cotton, millet, barley, sugar cane, Irish and sweet potatoes, and mulberries (chiefly the first five). The experiments have been carried out either by this Department directly, or in co-operation with provincial institutes, universities, and other organizations. The field experiments are supplemented by laboratory chemical tests for 'available' nutrients in the soils of the experiments.

The results of more than 170 of these field experiments, widely scattered through fourteen provinces of China, are now available. The work is still continuing, and yield results already obtained are still being analysed, but although the investigation is thus incomplete, it is desired to put the broad results on record, in case the work should be interrupted. It is realized that the number of experiments is not large, in relation to the area covered (a consequence of the difficult conditions which have existed here since 1937), but none the less the general results are quite consistent within the various regions or soil groups, and it is believed that further extension of the work will not greatly alter the picture. It is thought that the findings will have some general interest to agriculturists and geographers, while the implications are important for the future of China.

Eighty-three per cent of the soils tested in the field experiments gave significant responses to one or more nutrients: in other words, soil fertility is likely to be limited by plant food deficiencies in at least four fifths of the soils of China. (Early statements about the high fertility of Chinese soils were usually based on a superficial acquaintance with the rich soils of alluvial plains and deltas; much of interior China consists of relatively poor, hilly, land.) Nitrogen deficiency was most general (74 per cent of the soils); next came phosphate deficiency (38 per cent); potash deficiency was uncommon (12 per cent), probably because of the general use of ashes and local manures. There were clear relationships between the great soil groups and nutrient supply or deficiency, which there is not space here to set out in detail. Briefly, the pedocal soils of north China (J. L. Buck's 'wheat region') were often deficient in nitrogen, but they were generally well supplied with phosphate and potash; the pedalfer soils of central and south China (Buck's 'rice region') were still more deficient in nitrogen, often seriously deficient in phosphate, and sometimes deficient in potash. The red and yellow earths were the most seriously nutrient-deficient soil groups, and those on which fertilizers were most strikingly effective in increasing yields.

Estimates were made of the probable extent to which crop production could be increased in China by using artificial fertilizers in addition to the present supplies of local manures and fertilizers (which cannot be much expanded). If artificial fertilizers were used only on soils where they were likely to be needed (on the soils which gave significant responses in these experiments), it would be possible to increase the total production of crops in China by between one third and one half, using the rates of application mentioned above. (The variability of the estimate depends on the weights to be applied to different crops and regions.) This estimate may be taken as applying to the part of China covered by Buck's "Land Utilization in China", with the exclusion of his 'spring wheat area'. The increase in production would be much greater in the rice region (about one half increase over present production) than in the wheat region (about one fifth increase).

Taking economic factors into consideration, and using the 1937 farm prices in east and north China as a basis, it can be said that if all farmers whose soils needed fertilizers applied what was necessary, at the standard rate, then on the average individual farmers would have a two-to-one chance of making a profit (that is, one farmer out of three would be likely to lose money). If only those farmers applied fertilizers whose soils were likely to give an economic response, on the basis of the field experiments, total crop production in China could still be increased by at least one quarter. Supposing that China developed her own fertilizer industry, and that fertilizers could be sold at prices comparable with those in the United States in 1937, then these estimates would be considerably increased. If all farmers with deficient soils used the necessary fertilizers, then each farmer would have at least a five-to-one chance of making a profit from his expenditure; if only those farmers used fertilizers who were likely to secure an economic response, total crop production in China could be increased by at least one third.

The bearing of these results on the population, food and economic problems of China needs no emphasis. While it may not be possible to take much action on them under present conditions, for the future they are equivalent in increased production to adding four or five new provinces to the seventeen or eighteen provinces for which these estimates may be expected to hold good. In connexion with the reclamation and resettlement of the poor soils of south-west China, too, the use of fertilizers is likely often to make the difference between success and failure.

N. F. CHANG.
H. L. RICHARDSON.

Soils and Fertilisers Department,
National Agricultural Research Bureau,
Chungking.
Jan. 14.

Age Changes in Size of Muscle Fibres of the Marsupial Heart

As we have pointed out elsewhere[1], there is considerable evidence for believing that the conducting systems of mammalian and avian hearts (nodes and Purkinje fibres) are neomorphic developments, evolved

in response to functional requirements in these homoiothermal vertebrates, and not remnants of more extensive tissue of similar structure in lower vertebrate hearts[2,3] or embryonic muscle[4,5].

We have hitherto based our conclusions on histological studies of the hearts of lower vertebrates, in which we have failed to find any nodal or Purkinje tissue. We have now striking corroboration that these tissues are specialized structures and not embryonic remnants from measurements of the fibre-size of various regions of marsupial hearts, *Macropus ruficollis bennetti*, fœtus (pouch state) and adult, and adult *Macropus giganteus*. The accompanying table shows the maximum breadth of the majority of fibres in each region; a small range of variation in size of fibre occurs in each case, but this is in no way comparable in magnitude with those differences between the specialized and ordinary heart muscle to which we have directed attention.

	M. ruficollis (fœtal stage) Fixed—10 per cent formalin. Stain—Van Gieson and iron hæmatoxylin	*M. ruficollis* (adult) Fixed—10 per cent formalin. Stain—Van Gieson and iron hæmatoxylin	*M. giganteus* (adult) Fixed—10 per cent formalin. Stain—Pyridine silver
Sinu-atrial node	8 μ	(Sinu-atrial node not present in block)	10 μ
Atrio-ventricular node	10 μ	10 μ	10 μ
Atrio-ventricular bundle (Bundle of His)	12 μ	36 μ	36 μ
Atria	4 μ	11 μ	16 μ
Ventricles	5 μ	12 μ	18 μ

It will be observed that, whereas the ordinary atrial and ventricular muscle fibres increase markedly in size from the fœtal to the adult stage, the nodal fibres are fully developed in the fœtal stage. This suggests strongly that the nodal fibres are specially developed (for the initiation of the cardiac rhythm), while the size of the ordinary heart muscle increases with the increasing work (against peripheral resistance) which this muscle is called on to perform. The nodal fibres in the fœtus are larger than the ordinary atrial and ventricular fibres, a condition which is reversed in the adult. This suggests that the nodal fibres do not constitute an embryonic stage in the development of ordinary myocardium but attain full specialization for their particular function early in life. The large increase in size of the Purkinje fibres with age can be correlated with the requirement for more rapid conduction of the impulse in the larger heart.

A full account of the conducting systems of these interesting hearts will be published elsewhere.

FRANCIS DAVIES.
ERIC T. B. FRANCIS.

Depts. of Anatomy and Zoology,
University of Sheffield.
March 26.

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[3] Mackenzie, I., *Int. Cong. Med.* Sect., **3**, 121 (1913).
[4] Gaskell, W., *J. Physiol.*, **4**, 43 (1883).
[5] His, W., jun., *Arb. med. Klin. Lpz.*, 14-49 (1893).

Extra Spots in Electron Diffraction Patterns

MANY photographs have recently been published showing extra spots in X-ray diffraction patterns from single crystals. These extra diffractions are ascribed to thermal vibrations of the atoms or molecules in the crystal; they are close to the normal Laue-spot positions and comparable in size with the Laue spots. The close parallelism between the electron and X-ray diffraction phenomena leads us to expect that diffractions of this kind should also occur in electron-diffraction patterns, but although we observed[1] much more diffuse maxima two years before the work of Preston[2] directed attention to the X-ray extra spots, no extra spots of the X-ray type have hitherto been observed in electron diffraction, nor has the diffuse electron type been observed in X-ray patterns. It therefore appeared desirable to discover whether this distinction was of fundamental importance, or simply due to the difference in experimental conditions so far adopted. The absence of the diffuse electron type of maxima in X-ray patterns is apparently due to the experimental conditions[3], but we were unable to explain the lack of such extra spots in electron diffraction.

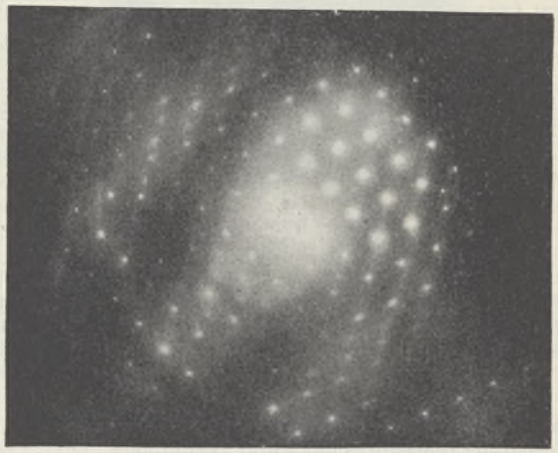

Fig. 1.
ANTHRACENE, SHOWING SHARP LAUE SPOTS, DIFFUSE, SLIGHTLY ELONGATED, EXTRA SPOTS AND DIFFUSE BANDS.

The recent clarification of the X-ray results has led us to re-examine some electron-diffraction patterns in which we had noticed apparently anomalous features. These we now find correspond closely to the X-ray extra spots. Thus, diffuse spots occur in regions where the sharper Laue spots are forbidden, as may be seen clearly in Fig. 1, obtained from anthracene with the electron beam practically parallel to [112]. The diffuse spots correspond to intersections of the sphere of reflexion with the reciprocal-lattice intensity regions, which are enlarged as a result of thermal vibrations in the crystal.

In very anisotropic crystals the intensity regions may become elongated in characteristic directions, and with suitable crystal orientations they may give rise to streaks in the diffraction pattern[4]. In the case of anthracene we have found in many patterns, including several published previously[1], a series of such streaks, the positions and directions of which indicate that the molecules vibrate with maximum amplitude at right angles to their length (Fig. 2).

We have also observed these phenomena in other aromatic compounds, as well as in long-chain hydrocarbons and their derivatives. We therefore conclude

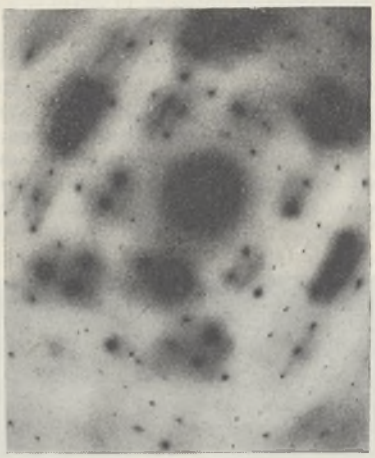

Fig. 2.
ANTHRACENE, SHOWING LAUE SPOT PATTERN, DIFFUSE MAXIMA AND EXTRA DIFFRACTIONS ELONGATED NORMAL TO THE LONG AXIS OF THE MOLECULE.

that the parallelism between the electron and X-ray diffraction phenomena also extends generally to the effects originating from thermal vibrations in crystals.

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March 18.

[1] Finch, G. I., and Wilman, H., *Ergebn. exakt. Naturwiss.*, **16**, 353 (1937); Charlesby, A., Finch, G. I., and Wilman, H., *Proc. Phys Soc.*, **51**, 479 (1939).
[2] Preston, G. D., *Proc. Roy. Soc.*, A, **172**, 116 (1939).
[3] Charlesby, A., note to be published.
[4] Lonsdale, K., Robertson, J. M., and Woodward, I., *Proc. Roy. Soc.*, A, **178**, 43 (1941). Lonsdale, K., and Smith, H., *Proc. Roy. Soc.*, A, **179**, 8 (1941).

Open Packing of Spheres

AT the present time when economy of material is so important, the problem of the open packing of spheres possesses more than theoretical interest. The most open (or least dense) packing is unknown[1]. A number of systems have been described by Heesch and Laves[2] including one with a density of 0·056, which may well be the most open possible under the conditions which they have imposed upon themselves. But if the object be to obtain a homogeneous structure with minimum density, in which each sphere makes contact with three others, and which shall be in equilibrium (though not necessarily in stable equilibrium), then, discarding the condition that the assemblage shall be of the single-parameter type, it is possible to proceed as follows:

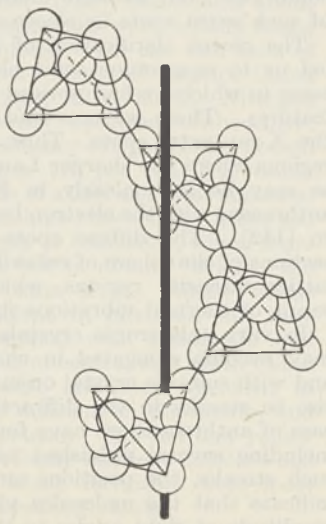

Fig. 1.

Take twelve equal spheres and arrange them in contact with their centres on four opposite edges of a regular tetrahedron. Take quantities of such tetrahedra and arrange them about a tetragonal screw-axis in such a way that a face of a tetrahedron is co-planar with a face of each adjacent tetrahedron, a plane of symmetry perpendicular to these faces being common to the two adjacent tetrahedra (Fig. 1). By extending the process systematically a series of tetragonal screws is developed, alternately right- and left-handed. Part of this tetragonal assemblage as seen from above is shown in Fig. 2. It has a density of 0·042.

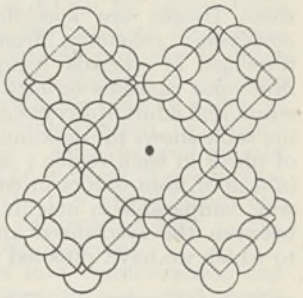

Fig. 2.

The study of a model of the lines of centres of the spheres in this structure, considered as a system of girders, may perhaps commend itself to engineers.

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[1] Nowacki, W., "Homogene Raumteilung und Kristallstruktur", p. 48 (1935).
[2] Heesch, H., and Laves, F., *Z. Krist.*, **85**, 443 (1933).

'Firmness' in Compression and Tension

ATTENTION was directed some time ago[1] to the applicability of Scott-Blair's equation, $\psi = s^{\beta}\sigma^{-1}tk$ (s is shearing stress, σ is strain, t is time, ψ is firmness, k and β are constants) for the 'firmness' of soft materials[2] to tests in tension as well as to tests in compression. This applicability was later extended to tests in torsion[3]. Some actual experimental figures were published showing the comparison between tension and torsion tests results, but no figures have been given for comparative tension and compression tests. These were omitted as no good agreement was obtained, apparently indicating the existence of experimental errors. It is now believed, however, that the apparent anomalies are due to a fundamental cause and not to experimental error.

		Bitumen 2	Bitumen 4	Bitumen 6
k :	extension	0·47	0·82	0·89
	compression ...	—	0·70	0·74
	torsion	0·48	0·85	0·82
log ψ :	extension	8·0	6·3	7·1
	compression ...	—	6·2	6·6
	torsion	7·9	6·6	6·9

A few typical results are given in the accompanying table, whence it is seen that the values for both k and log ψ are higher for tests in tension than in compression. Torsion tests give values not precisely

corresponding with either of the other two methods, but approximating to the tension figures. They are definitely higher than the compression figures.

It has been suggested[4] that the differences may be eradicated by making allowance for the changing cross-sectional area of the specimen during test in the case of the extension tests, as this factor was ignored during early experiments and is automatically counteracted in the particular compression apparatus employed. Such correction may be made in tension experiments by calculating the strain on the extended length of the specimen.

Alternatively, where β is not unity, the correction may be made by using the equation :

$$\log \log \frac{l}{l_0} - \beta \log \frac{l}{l_0} = \beta \log s_0 - \log \psi + k \log t,$$

where s_0 is initial value of stress, and l_0 and l are initial and final lengths of the specimen.

Such correction does not, however, entirely account for the anomalies, and it is suggested that the difference is a fundamental one possibly due to the effect of the inter-molecular forces of attraction and repulsion.

The situation with respect to such factors is very complex and will be affected by the physico-chemical as well as the chemical constitution of the material under test. Thus the shape of the molecules, their orientation, their degree of association and their existence in the form of colloidal micelles will all influence the behaviour of the specimen under different types of deformation. General consideration of these inter-molecular forces would lead us to expect a decrease in ψ and k with increasing stress. This decrease is, in fact, found when a single method of test is employed (for example, either extension or compression). That a comparison of results by the two methods does not fall into this scheme may be due to the fact that in calculating ψ and k certain simplifying assumptions have been made which are not true. In particular, it may be that with these particular materials Poisson's ratio is not 0 : 5 as had been supposed.

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[1] Broome and Bilmes, Nature, **147**, 176 (1941).
[2] Scott Blair and Coppen, *Proc. Roy. Soc.*, B, **128**, 109 (1939).
[3] Broome and Bilmes, *J. Soc. Chem. Ind.*, **60**, 184 (1941).
[4] Lethersich, W., private comm. 1942.

Silica and the Liesegang Phenomenon

The synthesis of a wide range of rhythmic structures, their relationship to naturally occurring forms and the physico-chemical basis common to them have already been studied by one of us (M. C.)[1]. The preliminary experiments outlined in the present note extend the application of the Liesegang phenomenon to silica and its hydrates.

Test-tube experiments with aqueous solutions of commercial waterglass (1 : 1 by volume) carefully covered with an excess of concentrated hydrochloric acid at about 17° led to the immediate formation of a fine network structure which soon became a translucent membrane at the interface of the two liquids. Within 24 hours, 30 white horizontal bands were formed below the membrane. In the course of the next few days the number of bands had greatly increased—occupying more than 80 per cent of the original column of waterglass. The interband spaces increased as the reaction progressed, the 12 bands per cm. below the membrane gradually being reduced to 9 per cm. at the end of the reaction. On standing, the bands, laminated in structure, tended to arrange themselves in groups.

Experiments with more dilute waterglass (3 volumes of water to 1 of waterglass) led to interesting results. The progress of reaction was accelerated and the bands were found to be more closely packed (15 per cm.), aggregating into groups of about four. Above the membrane, in the region originally occupied by hydrochloric acid, a clear jelly-like mass was found (presumably silicic acid gel) equal in volume to about one third that of the waterglass. In some instances, however, the viscous matter exhibited distinct opalescence. Using concentrated waterglass the reaction is slower, the bands are fewer and thicker, being frequently connected by vertical columns of sodium chloride. This is especially the case when hydrogen chloride is the reagent.

In reactions where sulphur dioxide or sulphuric acid had been substituted for hydrochloric acid, certain anomalies were noted, influencing the pattern of depositions. The radial and network structures characterizing the initial stages of membrane- and laminæ-formation were superseded by, or rather modified into, concentric ring forms. With concentrated waterglass the interference to diffusion (probably due to the influence of specific colloid-electrolyte complexes) converted the regular pattern of the laminæ, as viewed from below, into walnut- and pomegranate-like surfaces. These transitions in the pattern development of the laminæ were well demonstrated in beaker and Petri dish experiments, membranes originating in all cases from the periphery of the surface. This dependence of the type of deposition upon the character of the accompanying electrolyte may be of considerable morphological significance.

The fact that the membrane at the interface of the two reacting liquids was at no time distorted by protuberances, particle eruptions or arboreal growth strongly suggests its colloidal character (compare reactions of transitory and permanent colloids as given in earlier publications). Under the experimental conditions used, there was no transition to anhydrous silica, the stratified precipitate remaining in a state of *limited* hydration. The relation of this state to the *unlimited* hydration of silicic acid gel is analogous to that found in the cases of soap curd – soap gel[2] and hydrocalcite – colloidal calcium carbonate[3].

It is intended to use these results as a basis for the synthesis of such minerals as itacolumite (by compression and subsequent dehydration with or without fluxes), opalite, hyalite, etc.

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[1] Copisarow, *J. Chem. Soc.*, **123**, 785 and 796 (1923); 222 (1927). *Koll. Z.*, **44**, 319 (1928); **47**, 60 (1929); **49**, 309 (1929); **54**, 257 (1931). Nature, **129**, 400 (1932). *J. Phys. Chem.*, **36**, 752 (1932). *Science*, **77**, 581 (1933). *Protoplasma*, **30**, 258 (1938).
[2] Laing and McBain, *J. Chem. Soc.*, **118**, 1506 (1920). Marton, McBain and Vold, *J. Amer. Chem. Soc.*, **63**, 1990 (1941).
[3] Copisarow, *J. Chem. Soc.*, **123**, 785 (1923).

RESEARCH ITEMS

Mammalian Arm Arteries

THE Field Museum of Natural History has published a volume of eleven papers in honour of Wilfred Hudson Osgood (Zool. Ser., 27; 1941). Osgood's name is well known to all workers in that subject as a first-class field naturalist and a sound and critical systematist. He joined the staff of the Museum in 1909, and during his term of office as chief curator of zoology that department has made extraordinary progress. The longest memoir in the volume is that by D. Dwight Davis on "The Arteries of the Forearm in Carnivores". The classical work of Zuckerkandl contains accounts of these vessels in sixteen species, but the present paper involved the dissection of thirty-five specimens carefully chosen so that twenty-five genera are represented. The information thus obtained, with that previously recorded, enables an extensive comparative survey to be made. The vessel pattern of the forearm furnishes evidence of the inter-generic and inter-family relationships, although some allowance has to be made for functional specializations. The most primitive pattern is to be found in the Hyænidæ, although they show certain cursorial adaptations. The Canidæ are also primitive but fundamentally different from the other Arctoidea. More investigation in the Viverridæ is required before definite conclusions can be drawn, but apparently they exhibit the least primitive pattern among the Aleuroidea.

Control of Cabbage Caterpillars

TECHNICAL BULLETIN No. 782 of the U.S. Department of Agriculture deals with the control of cabbage caterpillars by means of insecticides. The authors, W. J. Reid, jun., and collaborators, have carried out a large series of experiments specially designed to deal with outbreaks at the time when the crop is being harvested, when there is no opportunity for the natural removal of spray residues. Their recommendations, it may be added, are specially applicable to conditions in the south. They demonstrate that arsenicals should not be applied at any time on that portion of the plants which is to be marketed or consumed as food. The whole problem, therefore, was to discover satisfactory substitutes that would kill the pests concerned without leaving harmful residues. The insects involved were mainly the cabbage looper (*Autographa brassicæ*), the diamond-back moth (*Plutella maculipennis*) and the small cabbage white (*Pieris rapæ*). Practically all the experiments were made with materials used as dusts. Talc, china clay, sulphur, tobacco dust and lime were used as diluents for the insecticidal substances. It appears that derris dusts gave the most uniform performance, and a mixture containing 0·5–1 per cent of rotenone is sufficiently toxic to the three pests named to be of value as a substitute for arsenicals. All other treatments were relatively ineffective against larvæ of the diamond-back moth. In view of the frequent severe damage by cabbage white butterfly larvæ in Britain the results of these experiments are of importance on both sides of the Atlantic Ocean. The tests were made by means of rotary hand dust guns and in most cases were at the rate of 15–20 pounds per acre—the quantities being determined by weighing the dust guns before and after each application.

Salmon Gill Maggots

WHILE the presence of a parasite on the gills of the salmon was reported in Scotland so far back as 1766, and is well known to fishermen, its life-history has been worked out and recorded for the first time by G. F. Friend (*Trans. Roy. Soc. Edin.*, 60, Pt. 2; 1941). The salmon is notoriously difficult to keep in aquaria and so ordinary laboratory culture methods could only be applied to the development of the egg, and the rest of the life-history of the parasitic copepod, *Salmincola salmonea*, had to be followed by examining a large number of fish over a series of years. The author has added much to previous knowledge: the free-swimming larval stage, the attached male and female larvæ and several early stages of the female and the attached male (a rare form since only six were obtained to 4,000 females). A useful diagram of the life-history shows that infection takes place on or near the spawning bed after the return of the salmon from the sea, and so, prior to spawning, no fish was infected. The attached parasite can be carried out to sea and hence the subsequent returns of the salmon serve to spread the infection. The parasite, even when present in numbers up to a hundred on an individual fish, does not appear to harm its host directly but the wounds it makes on the gill filaments by stripping patches may provide points of ingress for pathogenic organisms.

Metasomatic Origin of Granophyre

A 500-FT. sill of dolerite occurring at Hangnest in the Cape Province of South Africa exemplifies very clearly two well-marked features of the thicker Karroo sills: (*a*) very slight crystallization differentiation; and (*b*) marked tendency to react with and mobilize the associated sediments. A petrological and chemical study of this sill and a discussion of the petrogenetic processes involved have been presented by F. Walker and A. Poldervaart (*Geol. Mag.*, 429; 1941). Thick bands of sediment were stoped up from the floor and down from the roof and so became enclosed, together with numerous xenoliths, in the magma. The composition of the sediments was such that they easily underwent mobilization, this being followed by rheomorphic injection into the dolerite, locally with sufficient force to brecciate the contact facies of the sill. Nearer the middle the rheomorphic veins reacted with the partly crystallized dolerite to form a richly micropegmatitic rock. A large xenolithic block of siltstone was metasomatically reconstituted by introductions of soda and small amounts of the cafemic oxides, with production of a granophyric rock of a type which is of widespread occurrence in the Karroo petrographic province. The occurrence recalls the transformation of the Caledonian granodiorite of Newry into granophyre of Tertiary type at the contacts of the former with Tertiary gabbro (D. L. Reynolds, *Proc. Geol. Assoc.*, 265; 1937).

Auto-correlation of Meteorological Time Series

A PAPER by T. E. W. Schumann and W. L. Hofmeyer, entitled "The Problem of Auto-correlation of Meteorological Time Series, illustrated by Examples from South African Stations" was presented at a meeting of the Royal Meteorological Society held on February 18. The main object of the paper was to present a number of characteristic values of the auto-correlation coefficient as actually computed from observed series of temperature and pressure. For this purpose the temperature and pressure

records of some South African stations were selected. In the case of temperatures, it was found that, provided any daily or seasonal fluctuations are first eliminated and the standard deviation is constant, the coefficient of auto-correlation R' has the analytic form $R'=e^{-ky}$, in which k is a constant and y is the time-lag. If, however, there is a marked variation in the standard deviation, such as is nearly always present in hourly values of temperature, R' is a function not only of the time-lag, but also of the actual times marking the beginning and end of the time-lag under consideration. In the case of a series of pressure readings, R' is not a simple exponential function, but may contain one or more damped harmonic terms.

High-Frequency Attenuation

AN improved D.C. substitution method of measuring high-frequency attenuation has been described by H. B. Noyes (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941). In the design of a wire communication system, attenuation data are practically indispensable, and measurements are often made by passing currents of various frequencies over a section of the line, and measuring the input and output with thermocouples, the accuracy obtained depending on the stability and accuracy of the thermocouples. Although this method is satisfactory on long lines, higher accuracy is sometimes needed, particularly when characteristics of short lines are to be determined. The D.C. substitution method has been found to give more precise results on attenuation measurements of this type and has the advantage of using the D.C. value of a resistance as a standard. The accuracy is practically independent of the calibration and stability of the thermocouple, which is used merely to relate the test-line attenuation to a value of an adjustable calibrated resistance in a D.C. circuit. The method requires, however, that either the D.C. and A.C. sensitivities of a thermocouple be identical, or the ratio between the D.C. and A.C. sensitivities of the sending and receiving thermocouples be identical. As a result of this refined technique, insertion losses at frequencies of 12–68 kc. could be determined with a reproducible accuracy or sensitivity of 0·005 db., a much higher precision than has hitherto been attained, contrasting with an error of 0·1–0·2 db. due to thermocouple errors of older methods.

Field Measurements of Insulation

A PAPER on the above subject presented recently by E. A. Burton, J. S. Forrest and T. R. Warren to the Institution of Electrical Engineers deals with the field testing of high-voltage switchgear, busbar and transformer insulation as a means of alleviating insulation failures in service, and describes the apparatus and methods employed by the authors on the Central Electricity Board system. The three main testing techniques, (*a*) measurement of power factor, (*b*) measurement of potential distribution and (*c*) measurement of insulation resistance, are described and practical testing apparatus, designed to make such measurements under the onerous conditions of field use, are described. Three wattmeter types of power-factor measuring apparatus are described, two for 10 kv. tests for bushing sets, and one operating at 50 kv. for tests on busbar systems. Details are given of a bridge specially developed for field testing, and the measurement of potential distribution on bushings in service is discussed, reference being made to an electronic testing set for the measurement of insulation resistance up to 10,000 megohms at 5 kv. The summarized results of more than two thousand tests on installed apparatus are given and special test methods are described to facilitate power-factor measurements on transformer bushings and orifice insulators. Information is also given on the power-factor of oil in service. Methods are suggested of continuously supervising the insulation of important installations in cases where the lower voltage end of the insulators can be isolated from earth, and finally, the merits and demerits of the three main test methods are summarized in order to assist the maintenance engineer in choosing the method or methods best suited to his requirements.

Surface Films of Lupane Derivatives

MANY sterols and triterpenes containing water-attracting groups form stable unimolecular films when spread on water or, in some cases, dilute acid or alkali. Sterols and triterpenes with hydroxyl groups at the extremities of their ring systems form almost incompressible films with limiting areas of 38–42 A.^{2} and 45–50 A.^{2}, respectively. P. Bilham, E. R. H. Jones and R. J. Meakins (*J. Chem. Soc.*, 761 ; 1941) have made surface-film measurements on a number of derivatives of the triterpene alcohol lupane, for which there is lack of information as to the positions of the hydroxyl and *iso*propenyl groups. The small limiting-area values found, particularly with bisnorlupanic acid and ψ-lupenol, and the large area values found with lupenediol and lupenetriol monoacetate, in conjunction with the chemical data found by Heilbron and others, furnish evidence that in lupeol the *iso*propenyl group is situated at the opposite extremity of the ring from the hydroxyl group. The curves for the pressure-area measurements on the films are shown and discussed in detail in the paper, which records an interesting application of a physico-chemical method in studying the structure of a complicated organic molecule.

Exchange Equilibria

IN a paper dealing with exchange and transfer equilibria in mixtures of solvents, R. W. Kingerley and V. K. La Mer (*J. Amer. Chem. Soc.*, 63, 3256 ; 1941) point out that, in a solvent consisting of protium oxide (H_2O) and deuterium oxide (D_2O), in a reaction of the type,

$$\tfrac{1}{2}H_2O + KOD(D_2O) + KBr(H_2O) = \tfrac{1}{2}D_2O + KOH(H_2O) + KBr(D_2O),$$

there is a free energy of exchange when potassium hydroxide is converted into potassium deuterate and also a free energy of transfer of potassium hydroxide and potassium bromide from one solvent to the other. The latter process has not always been correctly treated. In many cases the free energy of exchange is of minor importance. The equilibrium process formulated above was determined from analytical measurements of the process

$$\tfrac{1}{2}HgO + \tfrac{1}{2}Hg + \tfrac{1}{2}H_2O + KBr(H_2O) = \tfrac{1}{2}Hg_2Br_2 + KOH(H_2O)$$

in $H_2O - D_2O$ mixtures and was found to compare favourably with the value calculated indirectly. The solubilities of thallous chloride and calcium hydroxide were determined in the two waters and the exchange coefficient of the base measured in a sample of mixed solvent. The ion product constant of deuterium oxide was calculated indirectly as $1{\cdot}54 \times 10^{-15}$ at 25°, in good agreement with $1{\cdot}6 \times 10^{-15}$ reported by Abel, Bratu and Redlich in 1935.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE first report of the National Institute of Economic and Social Research, which covers the year 1940–41, includes a brief review of the history of the Institute since its formation in 1938. The original research programme of the Institute, which was largely planned upon the basis of a two-year period, was prepared by special committees of the Institute constituted for the following subjects: (1) statistical studies of the national income and changes in its magnitude and distribution; (2) location of industry and the distribution of the industrial population; (3) British commercial policy and the administration of overseas trade; (4) the organization of the credit and capital markets; (5) short-period economic change; (6) economic and administrative problems of unemployment.

The work of 1940 fell into two sections; first, the continuation or completion of pre-war studies, and secondly, the war-time research programme adopted by the Council in December 1939.

In the first section (the national income) inquiry was continued throughout the year under the direction of Prof. A. L. Bowley, and a paper incorporating part of the work has been published in the *Journal of the Royal Statistical Society*. Studies of the location of industry have continued and a study of the social and economic conditions in the Highlands has been completed but not yet published.

A report on some of the results obtained on the location and concentration of industry has already been published, and although the industrial survey of Bristol was suspended in 1940, the results are to be published shortly. A report on part of the results obtained in the fertility studies in Bristol has also been published in the *Journal of the Royal Statistical Society*.

The first and descriptive part of the study of trade regulations and commercial policy in Great Britain has been completed, and work on the remaining part has been suspended. The manuscript is now in the press. A study of the organization of credit and money markets in London has been completed by Dr. Thomas Balogh and awaits publication.

The development of the war-time research programme in 1940 was hindered by the insufficient supply of research workers. Under this programme, grants have been made for studies of the effect of the War on the credit policy and credit mechanism of the City of London; the effect of war on municipal finance, Coventry; economic adjustment to the War in Birmingham; taxation of war wealth; burden of taxation inquiry; studies in Russian economic problems; inquiry into savings and spending and on the social consequences of evacuation in south-west Scotland as well as of juvenile employment in Manchester and in Glasgow, and a study of National Health Insurance by Prof. H. Levy. The programme also includes studies in exchange control by Dr. Thomas Balogh, and a grant has been made for a study of war-time changes in Bristol purchasing power, an investigation substituted for the continuation of work on the industrial survey which was suspended.

Since the heavy air raids on Great Britain in the autumn of 1940, damage to the Institute's premises necessitated alternative temporary accommodation, and hospitality was offered by the Royal Institute of International Affairs. During 1941, the research staff of the Institute was increased and the scope of its work expanded. The initiation of its series of publications was undertaken and arrangements were made with the Cambridge University Press to publish the Institute's researches. The report also refers to the work of the National Service Committee for Social, Economic and Statistical Research and of the Consultative Conference for the Co-ordination of Research in the Economic and Social Sciences in War-time.

In 1941, the greater number of applications were received from individual research workers and fewer from universities and university colleges. A list of studies in 1941 and of publications in 1940–41 is also included.

WHISTLING METEORS

IN an article on "Whistling Meteors" appearing in the November issue of *Electrotechnics*, Chamanlal and K. Venkataraman, of the research department of All-India Radio, discuss the Doppler effect produced by meteors entering the ionosphere.

During observations carried out on short-wave transmitters near the Delhi centre of All-India Radio, it was observed that in certain circumstances when a receiver was tuned to the carrier wave, weak heterodyne whistles of an unusual type were audible. The whistles appear as a high-pitched note which rapidly descends in pitch down to zero frequency where they apparently disappear, or alternatively fade away before reaching zero frequency. The whistles vary in duration from approximately a fifth of a second to several seconds and occur at random time intervals. They are most frequent in the early hours of the morning and are infrequently heard during the day-time, the early morning whistles sometimes occurring very frequently.

A heterodyne whistle which first appears with an initial beat frequency of, say, 3 kc./sec. and, after rapidly descending in pitch, disappears without reappearing on the other side of the fixed carrier wave, can only be explained by the Doppler effect due to interference between the weak carrier wave reaching the receiving centre as a ground wave and a wave returned from a rapidly moving reflecting surface, the latter suffering an apparent change in frequency. Assuming a beat frequency of 3 kc./sec. and that the observation is made on a carrier frequency of 7 mc./sec., the velocity of the moving reflecting surface is found to be about 64 km./sec. The descending pitch of the heterodyne beat note is the result of the moving reflecting surface being rapidly retarded in velocity, and the beat note will reduce to zero frequency if the velocity of the reflecting surface becomes zero. If the beat note disappears before reaching zero, it may be assumed that reflection from the surface has ceased before it has necessarily reached zero velocity.

A consideration of this particular manifestation of the Doppler effect shows that if the reflecting surface is moving towards the point of observation the Doppler effect will appear as a heterodyne whistle on the higher frequency side of the ground-wave from the transmitter. This was confirmed on detuning the receiver slightly from the carrier frequency position. The Doppler effect from a receding

reflecting surface produces a heterodyne whistle on the lower frequency side of the carrier wave.

The only known phenomenon with which sufficiently high velocities are associated and which could cause a Doppler effect of this nature is a meteor entering the earth's upper atmosphere, and confirmation of this was obtained by observations in the early morning hours when the appearance of meteors in the sky coincided with the heterodyne whistle produced in a receiver. The article discusses briefly the number, size, height, and velocity of meteors, the mode of dissipation of meteor energy, and meteor ionization, remarking that the summary provided of some of the known properties of meteors gives ample confirmation of the experimental evidence and deduction that the weak heterodyne whistles observed are due to the Doppler effect caused by the rapidly moving ionized area produced by a meteor. It is evident that, (*a*) the ionization produced by meteors can be sufficient to reflect waves of the frequencies concerned, (*b*) the number of whistles observed is at a maximum in the early morning when the number and velocity of meteors entering the earth's atmosphere is greatest, and (*c*) the velocity of meteors, determined by visual means, is of the same order as that calculated from the Doppler effect observed.

The article concludes with descriptions of the experimental procedure adopted and the results obtained.

NEW DESCRIPTIONS OF SOME INDIAN PLANTS

SOME interesting botanical notes have recently been given by Dr. N. L. Bor, forest botanist, Forest Research Institute, Dehra Dun (*Indian For. Rec.*, Botany, 2, Nos. 2, 3 and 4; Govt. of India Press, Delhi, 1941).

In No. 2 the bamboo *Thyrsostachys Oliveri* Gamble is dealt with. This species, the author writes, flowered in the Katha district, Upper Burma, in 1891. Specimens were sent by J. W. Oliver, conservator of forests, to the late Mr. Gamble, who published a description under the above name in the *Annals of the Royal Botanic Garden*, Calcutta, in 1896. Seeds of the species were also sent and these were planted at Dehra Dun in several places, and also in the Royal Botanic Garden, Calcutta. All those who have known Dehra Dun during the last forty years will remember the magnificent clumps of this bamboo. All the Dehra clumps commenced to flower towards the end of November 1938, the first indication being the fading of the leaves. which soon began to fall off. In the first week of December the flowering shoots, pale purple in colour, were quite evident, and by December 12 the lower sheaths of the flowering shoots were beginning to show the tip of an emerging spikelet. By December 23 two spikelets had completely emerged from each sheath, and the six stamens, pendulous at the ends of long filaments, were visible from each of the three florets of the spikelets. Seed was ripe by January 31, 1939. Dr. Bor says that with fresh material to work upon and unlimited quantities of it, it became evident that the description given by Gamble, prepared from dried material, required modification in several respects.

A lapse of twenty-four hours is quite sufficient for the features of the structure of the delicate palea to be lost, and no amount of boiling will restore them. This fresh material enabled a revised description to be drawn up which corrects some minor inaccuracies in Gamble's description. Two plates portray the details of the inflorescence and spikelets. This reads like a botanical romance, and foresters in Burma and botanists are likely to be equally interested.

For No. 3, Dr. Bor redescribes Dunn's *Vatica Shingkeng*, placing it in the genus Hopea. The original description was based on incomplete material, especially the flowers. I. H. Burkill, who accompanied the expedition into the Arbor Hills of Assam in 1911, discovered the species. He notes: "no general flowering took place during the expedition, and it was with great difficulty that one flowering tree was found". This flowering specimen was not, however, sent to Dunn, who notes in his description "*flores ignoti*".

In No. 4, Dr. Bor describes three flowering plants new to science: *Gleditsia assamica* Bor, *Garnotia puchiparensis* Bor and *Strobilanthes andamensis* Bor. Illustrations are given of each species. Dr. Bor had collected the Gleditsia in the Aga and Naga Hills and Sadiya in Assam without flowers or fruit. He received these collected in Sadiya in March 1938. It is a small deciduous tree about 10 metres in height.

The Garnotia is a grass and was found growing thickly in the clefts of a large rock just west of the Puchipara rest house, Silent Valley, Madras (alt. 3,000 ft.).

The Strobilanthes is a wiry shrub up to 60 cm. tall, gregarious in habit. The species was collected in flower by the sylviculturist of the Dehra Institute during a visit to the Andamans. It was noted that "the species was abundant in regeneration areas on limestone rocks, growing in crowded bushes 1′–2′ high".

DRUG CONTROL IN INDIA

THE problem of drug standardization and drug control in a country of the size and population of India is a vast one. In Great Britain, the United States and other progressive countries a general consciousness of the evils of food and drug adulteration on community health and national well-being was aroused nearly fifty years ago, and the authorities took up the responsibility of safeguarding public health and money by instituting adequate control of the spurious drug trade. In India, on the other hand, although the possible injurious effects of the adulteration of foods were recognized early enough, the seriousness of the situation arising out of the indiscriminate adulteration of drugs and chemicals for the treatment of diseases received comparatively little attention, and India came to be considered the dumping ground of all kinds of substandard, misbranded and poor-quality drugs and pharmaceuticals.

Realizing the need for both legislative and executive action the Drugs Enquiry Committee 1930–31, appointed by the Government of India, recommended that All-India legislation should be passed for the control of the importation, manufacture, sale and distribution of adulterated and under-strength drugs, and that machinery should be established for the regular collection and testing of drugs to ensure conformity to proper standards of purity and strength. It was suggested that for the standardization of drugs a well-equipped central laboratory should be set up with a competent staff of experts

in various branches and that this should be supplemented with provincial laboratories working under the guidance of, and in close liaison with, the central laboratory.

In January 1937 the nucleus of a central laboratory (Biochemical Standardization Laboratory) was established, under the direction of Sir R. N. Chopra, in Calcutta, at the All-India Institute of Hygiene and Public Health. The Laboratory has now made satisfactory progress in the limited number of studies undertaken and has trained adequate personnel and laid sure foundations for future work in this field as evidenced in the triennial report (Report of the Biochemical Standardization Laboratory 1937–40. Government of India Press, Calcutta, pp. 92). During the three years preceding the introduction of the Drugs Bill in February 1940 it was thought that the best course for the Laboratory was to undertake a general survey of the quality of medical drugs in the Indian market and an examination of the specimens of drugs both imported and manufactured in India which were suspected to be of inferior quality.

Many drug manufacturing firms in India do not maintain properly equipped pharmacological laboratories with trained personnel capable of undertaking the standardization of chemotherapeutic preparations, and it was natural that ethical manufacturing concerns interested in the quality of their products should approach the only Government organization available with requests to have their products standardized.

In the initial stages the Laboratory had necessarily to restrict itself to certain definite drugs of comparatively greater importance to the pharmaceutical and medical professions. Routine analytical work was therefore largely concentrated on surveying the quality of tinctures of digitalis, strophanthus and squills, extract of posterior pituitary gland and adrenaline hydrochloride solution. In addition to the routine activities a good deal of interest in research problems on subjects which have a direct or indirect bearing on drug work was consistently maintained. For example, one of the first group of drugs which the laboratory investigated was the cardiac drugs of the digitalis series. Liquid preparations of these drugs deteriorate at a fairly rapid rate when stored under the climatic conditions existing in India, and factors leading to this deterioration and loss of potency have been the subject of investigation. Again, the estimation of the antidiuretic potency of pituitary extract in rats was given an extensive trial and found to be quite reliable and to compare favourably with the results obtained by the oxytocic method. In addition, the Laboratory has the responsibility of acting as the national centre for the maintenance and distribution of certain international biological standards.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Monday, April 13

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Discussion opened by Colonel Sir Charles Arden-Close, F.R.S.: "The Map of the Pacific".

SOCIETY OF CHEMICAL INDUSTRY (JOINT MEETING OF THE YORKSHIRE SECTION AND THE FOOD GROUP) (at the Hotel Metropole, Leeds). Subject: "Colours in Foods". 3 p.m.—Mr. D. J. T. Bagnall: "Comments on Coloured Foods". 3.45 p.m.—Prof. J. W. Cook, F.R.S.: "Physiological Aspects". 5.15 p.m.—Dr. D. A. Harper and Mr. N. Strafford: "The Rapid Spectrographic Determination of Minute Amounts of Arsenic, Lead, Copper, and other Heavy Metals in Food-Stuffs Colours and Medicinals".

Tuesday, April 14

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. D. C. Graham: "Dangers from Rainfall in Urban Areas; Prevention of Flooding of Buildings and of its Insanitary Consequences" (Bossom Gift Lecture).*

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (Joint Meeting with the Institution of Chemical Engineers) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "The Development of New Chemical Processes" to be opened by Mr. H. W. Cremer.

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5 p.m.—Mr. J. N. Aldington: "Fluorescent Light Sources and their Applications".

Wednesday, April 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. C. Dawes: "Making Use of Waste Products".

SOCIETY OF GLASS TECHNOLOGY (at Elmfield, Northumberland Road, Sheffield 10), at 2 p.m.—Annual General Meeting.

INSTITUTE OF CHEMISTRY (LONDON AND SOUTH EASTERN COUNTIES SECTION) (at 30 Russell Square, London, W.C.1), at 6 p.m.—Dr. Hugh Nicol: "What the Plant does with its Materials".

Thursday, April 16

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—"Planning for the Family".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 4.30 p.m.—The Rt. Hon. Lord Rayleigh, F.R.S.: Sir Joseph J. Thomson Memorial Lecture.

Friday, April 17

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on the Pathology of the Hop (Speakers: Dr. W. Ware, Dr. W. G. Keyworth, Dr. A. M. Massee). 2 p.m.—Discussion on the Interpretation of Toxicity Data. (Speakers: Dr. H. Martin, Mr. A. F. P. Parker Rhodes, Dr. C. Potter, Mr. D. J. Finney.)

APPOINTMENTS VACANT

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

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, University College of Swansea, Singleton Park, Swansea (April 22).

HEAD OF THE ENGINEERING DEPARTMENT AND VICE-PRINCIPAL OF THE WEST HARTLEPOOL TECHNICAL COLLEGE—The Chief Education Officer, Education Offices, Park Road, West Hartlepool (endorsed 'T.C.') (April 25).

LECTURER IN BIOCHEMISTRY IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (April 25).

ASSISTANT PHYSICIST in the Physics Department of the Radiotherapeutic Research Unit of the Medical Research Council—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, London, W.12 (April 27).

SKILLED WORKSHOP INSTRUCTOR familiar with modern machine tool practice, at the Medway Technical College, Senior Departments, Gillingham—The District Education Officer, Fort Pitt House, New Road, Rochester.

FEMALE ASSISTANT PHYSICISTS—The Ministry of Labour and National Service, Appointments Department, Section B/E, Sardinia Street, London, W.C.2 (quoting B673E).

FEMALE ASSISTANT CHEMISTS—The Ministry of Labour and National Service, Appointments Department, Section B/E, Sardinia Street, London, W.C.2 (quoting B667E).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Institute of Economic and Social Research. Report for 1940–1941. Pp. 15. (London: National Institute of Economic and Social Research.) [108

Other Countries

Forest Research Institute, Dehra Dun. Forest Leaflet No. 1: Synthetic Tall Oil. By T. P. Ghose and B. S. Verma. Pp. 4. (Dehra Dun: Forest Research Institute.) 2 annas; 3*d*. [33

U.S. Department of Agriculture. Circular No. 606: Observations on the Biology and Control of the Treehopper *Heliria praealta* (Fowler) in Orchards of the Pacific Northwest. By M. A. Yothers and Paul B. Allen, Jr. Pp. 13. (Washington, D.C.: Government Printing Office.) 10 cents. [63

Smithsonian Miscellaneous Collections. Vol. 101, No. 6: Beetles of the Genus Hyperaspis inhabiting the United States. By Th. Dobzhansky. (Thomas Lincoln Casey Fund.) (Publication 3642.) Pp. ii+9+6 plates. (Washington, D.C.: Smithsonian Institution.) [63