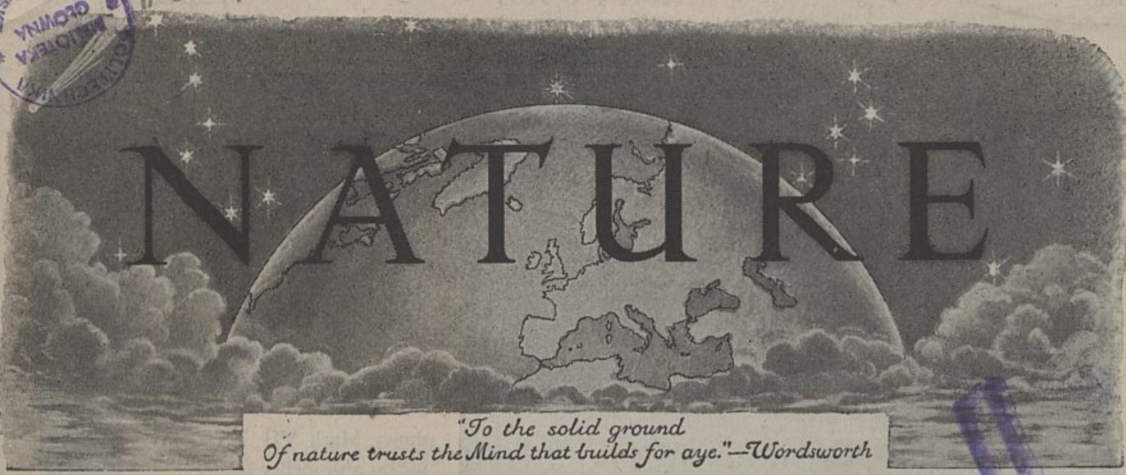

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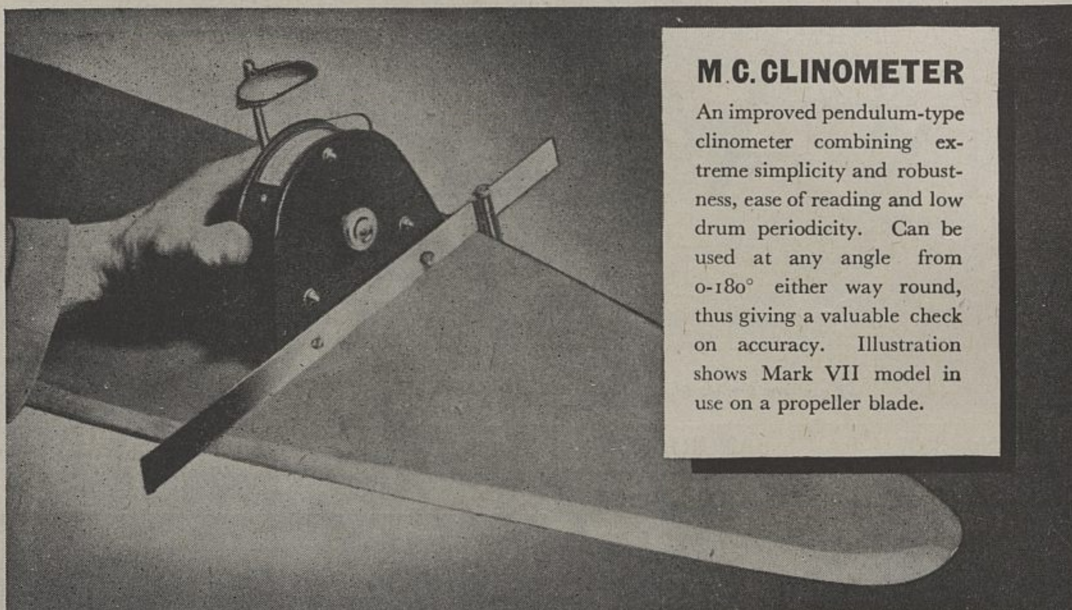

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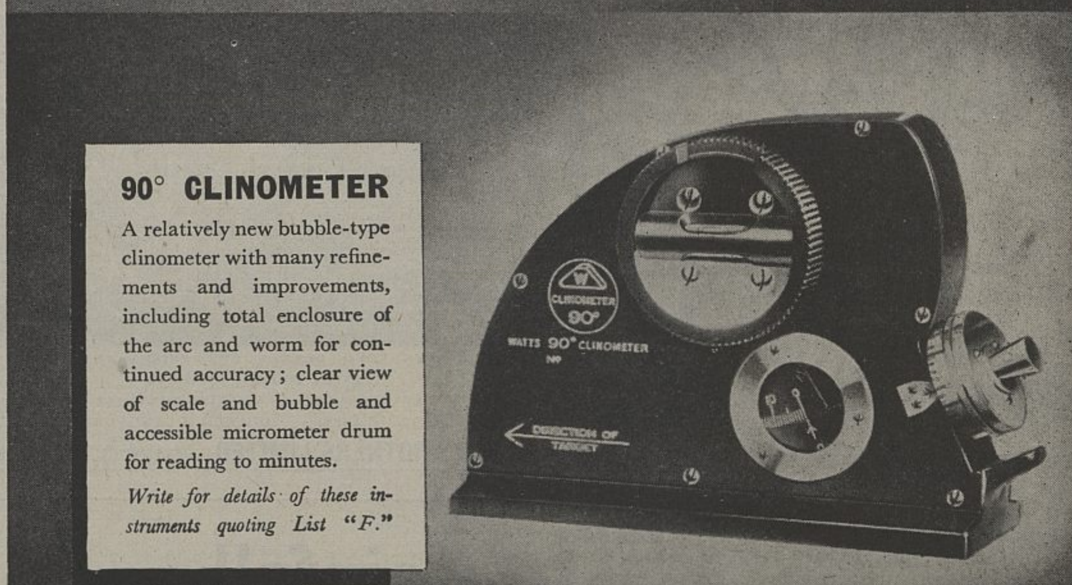

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NATURE

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POST-WAR AGRICULTURAL EDUCATION

NEARLY two years ago the Minister of Agriculture appointed a committee under the chairmanship of Lord Justice Luxmoore to examine the present system of agricultural education in England and Wales and to make recommendations for improving and developing it after the War. Both the need and the magnitude of the task are evident from that Committee's report, which has now been issued*. The Committee interpreted 'agricultural education' as covering the bringing up, training and instruction of adolescents and adults in the sciences applicable to agriculture; the art and practice of the various branches of animal and crop husbandry, including horticulture; the provision of advisory services and the organization of general instructional work by means of lectures and demonstrations.

So long ago as 1668 Abraham Cowley directed attention to the neglect by landowners in not providing suitable tutors for their children to instruct them in the nature and improvements of the land they would inherit. He suggested that one college in each university should be erected for the study of agriculture. It was not until 220 years later that the first university college provided facilities for the study of agriculture, though the Royal Agricultural College was established in 1845. The early days of organized agricultural education were more directly associated with the other cultural branches of education than has been the case more recently, being fostered by the Board of Education through the activities of the local education authorities. Many of the ideas which now prevail concerning 'rural bias' were appreciated in the early years of the present century. It is a singular fact, however, that farmers themselves have long held the idea that education of any kind produced an attitude of mind inimical to manual work, whereas in point of fact it is largely an economic one.

Since 1911 the Board (now Ministry) of Agriculture has been the prime mover in matters affecting agricultural education, operating through grants to local education authorities in the counties and to the governing bodies of universities and colleges. This has resulted in considerable developments and in some cases notable results have been achieved, but invariably in proportion to the means available for the purpose. Unfortunately the application of schemes for advancing agricultural education has been very uneven in character, due in a large measure to unsatisfactory methods of rendering financial aid and the lack of authority in regard to development work.

The present War had not been long in progress when it was realized that food is a vital munition. The agricultural education staffs in the counties were diverted to the direct task of organizing the food production effort. Considerable powers were entrusted to the War Agricultural Executive Committees, but it is of more than ordinary interest that it

* Report of the Committee on Post-war Agricultural Education (Cmd. 6433.) Pp. 92. (London: H.M. Stationery Office, 1943.) 1*s*. 6*d*. net.

is being recognized increasingly by farmers and their workers that an intensification of educational work is the quickest way of making progress. It is no longer necessary to convince the average farmer that practice by itself will not reach the goal of maximum efficiency. The ideal is that combination of 'practice with science' which was adopted as the motto of the Royal Agricultural Society of England so long ago as 1840. Into this happy atmosphere the Luxmoore Report has been born.

As a record of the position obtaining at the present time the Report is valuable. Attention is directed to past and present weaknesses. It is perhaps unfortunate that the background of war-time needs and methods has largely affected the trend of ideas, and it is by no means certain that these views will obtain for any length of time on the conclusion of hostilities. It becomes necessary to stress this fact, for though inquests are very necessary, it is by no means true that the pre-war agricultural education system of Great Britain was so completely moribund that only a revolutionary replacement of the old system can achieve results which everyone wishes to see realized. The absence of uniformity is not necessarily a defect. It is one of the strong features of democratic government. In fact, one may go so far as to say that uniformity in any branch of college or university education is undesirable. In agricultural education, however, where the need has been greatest the means for rectifying this position have been totally inadequate.

It is accepted as a preliminary necessity that agriculture should be made sufficiently attractive to induce young people to enter it. A solid foundation of general education is stressed. A prevailing tendency in some agricultural circles at the moment is to suggest the introduction of vocational training in the ordinary school curricula. The Committee rightly decides against this proposal, but agrees with compulsory school attendance until fifteen and part-time continuation education until eighteen, in which both cultural and vocational training would be given, and in the latter connexion the Young Farmers' Clubs movement is commended. Up to this stage the Board of Education will be in control.

The main defects of the present system are considered to be due to the absence of any controlling authority responsible for the organization of agricultural education; the number of different authorities providing agricultural education; and the diversity of the sources and means of finance. To remedy this, it is proposed that a central statutory authority, to be called the National Council for Agricultural Education, should be set up. This Council is to be so constituted that it is outside the Ministry of Agriculture, but under the control of the Minister (an extraordinary proposal in view of the average life of a pre-war minister), and to be responsible for providing, at the cost of the national exchequer, for the different branches of agricultural education. At first sight, this cuts across previously recognized systems by removing agricultural education completely from the control of local authorities. One can scarcely imagine that the suggestion will be accepted without question, and indeed one member of the Committee presented a minority report on this very subject. While it will be generally agreed that local authorities have not always functioned satisfactorily, a different attitude would probably have been adopted with more specific guidance and the availability of adequate means, but again it should not be forgotten that the War has given a new complexion to ideas even in relation to reforms in local government.

The Committee considers that farm institutes should be established in practically every county, with the object of providing training for those who are to become small farmers or to occupy posts of responsibility as agricultural workers. The type of training in these institutes is outlined, and the proposals are based on the successful experience of some of the existing centres. Attention is directed to the necessity for avoiding extravagance in the lay-out of farm institutes, and this is particularly necessary judging from some of the pre-war efforts in this direction. Farming and educational opinion generally will support the extension of farm institutes, for their usefulness will also serve some of the needs of vocational education in the counties through short courses in rural subjects for members of the teaching profession, thus necessitating contact with the Board of Education. It is to be hoped, however, that such courses as are given to teachers will be more on broad principles than on specific topics.

So far as the roles of agricultural colleges are concerned, these are regarded as essential for supplying opportunities at a higher standard than that provided by farm institutes, but below the scientific standard required for a university degree. Hitherto, colleges have had to compete with each other and with other centres providing agricultural education, and by reason of financial uncertainties courses of a very varied character have been provided. The South Eastern Agricultural College at Wye is within the University of London, and a similar relationship exists between the Royal Agricultural College, Cirencester, and the University of Bristol. The Midland Agricultural College, Sutton Bonington, which started at University College, Nottingham, is about to rejoin the parent stock. Cold water is poured on a widespread development of this trend, but the opinions of the Committee are not consistent. They suggest that for agriculture "the whole of any course leading to a degree should be taken in the University itself so that the benefit of contact with teachers and students engaged in other subjects should not be lost". Yet for horticulture it insists that "every effort should be made to induce more of the Universities to offer courses leading to degrees as well as graduate courses leading to diplomas in the same subject. They should be given in a separate department, but there must be contact between it and the science departments and the department of agriculture where it exists". It is difficult to understand that what is right for horticultural graduates is wrong for agriculture. One criticism made concerning the farms attached to some of the colleges is that they do not, either in farming or equipment, reach a sufficiently high standard. It is difficult to understand how the Committee found it possible to examine this aspect carefully, and it would have been fairer if the criticism had been qualified. Indeed, more definite criticism of the college farms is essential, if any important development can be expected to accrue.

By contrast it is interesting to note the restrained references to the university departments of agriculture ; but their functions are more specifically defined than in the case of the colleges. Suggestions are made for the avoidance of competition with centres providing lower-grade courses, and a very strong point is made of the need for providing an increasing number of candidates who have had a university training for technical and other posts. No one will disagree with this suggestion. People of independent thinking will be inclined to appreciate the autonomous character of the universities as centres of education, by comparison with the very tight reins by which other forms of agricultural education are to be controlled. The demand for university courses has increased considerably in recent years. Young people who would have been satisfied previously with a diploma course are now advised in their own interests to read for a degree, especially when they wish to enter the technical service. A criticism of many degrees, however, is that candidates can qualify without having had any satisfactory experience of practical agriculture, and it is in this deficiency that practical agriculturists have had most cause for complaint. The suggestion is made that in the case of students who ultimately wish to make the closest contact with farmers, adequate farming experience should be acquired before entry upon the university course. At the present, Leeds is alone in requiring evidence of this pre-university practical training. The suggestion put forward by the British Association Committee on Post-War University Education that all university students should spend at least one year in extra-mural pursuits (see NATURE, Dec. 19, 1942, p. 718) should do much towards meeting this criticism.

A re-casting and re-grouping of the advisory services for the whole range of agriculture is recommended. The Committee has appreciated the difficulties that belong to the present system, where the control is often ill-defined, the facilities at the provincial advisory centres very inadequate and the co-operation with the county services not always as close as it might be. The new proposals tend to result from the organization of technical services operating for the purposes of the war-time food production campaign. Already in most counties the Ministry of Agriculture has taken over the county agricultural staffs, while counties have been subdivided into districts of convenient size with technical officers in each district. This arrangement is regarded as a satisfactory one, though it should be observed that the staffs concerned work under the control of county executive committees that are constituted on a non-democratic basis. Some continuation of this control is envisaged after the War, though probably the method of appointment will harmonize more closely with traditional British ideals. The proposed county organization is to be linked directly with the specialist advisory service, which will operate from a provincial centre or sub-station. At the present time there are thirteen provinces in England and Wales, each university department and major agricultural college acting as a provincial centre. The new proposals suggest larger provinces, numbering six in all, with headquarters located in a university city, though not necessarily part of the university. The proposed centres of the provincial organization are Leeds, Birmingham, Cambridge, Reading, Bristol and Aberystwyth. It is proposed to appoint a chief advisory officer at each provincial centre, his duties being to co-ordinate the work of the specialist staff. Similarly from the provincial centre a chief provincial organizer will direct and co-ordinate the work of the county organizers and their staffs throughout the province, while a provincial administrator will be the administrative head of both branches in the province.

These proposals are logical, but they suffer from several fundamental weaknesses, the chief of which is that no provision is made for the direct contact which now exists with the centres of higher agricultural education, while the new provinces are unwieldy in size and in certain cases eliminate strong county loyalties. If the present teaching centres are to be divorced from their contact with advisory specialists, the student life of the country will be very much the poorer, and it is to be hoped that reconsideration by the implementing authorities will be given to these points. It may be urged that when a better standard of education obtains among the rural community and advantage is taken of the facilities to be created for technical training that less responsibility will be shouldered by the specialized advisory staffs. Many of the problems confronting county organizers to-day result from the lack of fundamental knowledge of the rules of good husbandry and the application of scientific knowledge. Even a highly qualified race of advisers will not restore prosperity to an industry that depends for its well-being to a great extent on the skill and craftsmanship of the agricultural worker. The farmer of the future must be equipped to lead and direct his men. The Committee recognizes that two types of advisers are necessary : one highly qualified and scientifically trained, who will be presented with opportunities that compare favourably with other professions ; the other who will command respect by reason of technical qualifications that are combined with a sound knowledge of agricultural practice.

Even though complete unanimity is unlikely to result from the various proposals put forward, it is necessary that steps should be taken to overhaul the pre-war organization and control. That questions of finance have been at the root of many previous deficiencies is strengthened by the suggestion that the implementation of the Luxmoore proposals will involve an annual expenditure of £2,500,000 and a capital expenditure of £3,500,000, compared with a total expenditure of £606,385 in 1938–39. It is as true of agricultural education as of farming itself, that its efficiency is dependent on the availability of adequate financial resources to provide the men and equipment necessary for the work.

MODERN VIEWS ON EMULSIONS

The Theory of Emulsions and their Technical Treatment

By Dr. William Clayton. Fourth edition. Pp. vii+492. (London: J. and A. Churchill, Ltd., 1943.) 42*s*.

THE problem of bringing the results of fundamental research to bear upon industrial practice represents one of our present-day difficulties, and one which is likely to be accentuated in the future. Dr. Clayton has therefore performed a very useful service in providing us with an account of emulsions which will undoubtedly interest both practical industrial chemists and also those concerned with elucidating the basic principles of these complex systems.

Regarding industrial emulsions, the author has wisely restricted his attention to certain types, and used these to illustrate the broad physico-chemical principles involved; so that, of nearly 500 pages, more than half is devoted to discussions on the wide range of relevant fundamental principles.

Within recent years, considerable understanding of these underlying principles has been acquired from the study of adsorbed and insoluble films at the air/water and oil/water interfaces, and in this edition the first two chapters now introduce these newer investigations. The major points discussed are surface and interfacial tension, the Gibbs theorem in relation to adsorption, foaming and insoluble monolayers, and an outline is given of the techniques available for the study of interfacial films.

Approaching emulsions from a rather different point of view, Chapter 3 deals with dilute emulsions as examples of oil hydrosols, in particular with the electrical double layer and its bearing upon emulsion stability.

Then follows an account of the various types of emulsifying agents, and methods of assessing their efficiency, succeeded by a chapter on emulsion properties such as viscosity, electrical conductivity, and optical. It is a pity that Pickering's oft-repeated statement, that 99 per cent oil-in-water emulsions can be obtained, is still given prominence, although this was disproved by Lawrence some years ago. A similar criticism can be made of the work of Newman, quoted on p. 228.

The numerous theories of emulsions which have been proposed are reviewed at some length in Chapter 4, and this leads naturally to the question of dual emulsions and of inversion of emulsion type. It is in these fields that considerable advances have been made in recent years.

The remaining chapters, with the exception of the last, are concerned essentially with biological and technical aspects of emulsions, and the author's acquaintance with the latter is well shown by his excellent treatment of these topics. The importance of emulsions in biology, particularly in relation to fat metabolism, needs no emphasis.

After the final chapter, outlining such physical measurements as surface and interfacial tension, determination of emulsion type, and size-frequency analysis, there follow two appendixes, the first concerned with the separation of technical emulsions, the second a summary of the important patents since 1934 in which emulsions are involved.

The references throughout the book appear to be extremely complete, and due recognition is given to all the innumerable workers in this most diverse and fascinating field. In the opinion of the reviewer, however, a more critical, even if necessarily more biased, attitude might well have been taken in dealing with the more controversial of the fundamental questions, since due appreciation of the various, and often apparently conflicting, theories can scarcely be expected from the non-specialist.

The paper on which the book is printed is unusually good for these days, and the printing excellent, although a rather large number of small typographical errors were noted during perusal of the book. It is a pity that this, like the majority of war-time publications, is so expensive, particularly in view of the wide field which it covers and its consequent interest to so many.

A. E. Alexander.

THE BEHAVIOUR OF BIRDS

Bird Display

An Introduction to the Study of Bird Psychology. By Edward A. Armstrong. Pp. xvi+381+22 plates. (Cambridge: At the University Press, 1942.) 21*s*. net.

THE somewhat supercilious attitude of the laboratory zoologist to the study of birds, if less prevalent than formerly, is not entirely a thing of the past. The notion that to study a dead bird in a laboratory is a permissible occupation for a serious zoologist (though to study some more deserving kind of animal such as a protozoon or an echinoderm would be better), but that to study living birds in the field is mere dilettantism unworthy of a real man of science, dies hard. This kind of attitude is, in fact, only a particular example of the gulf between the laboratory and museum zoologist and the field worker which is happily being more and more effectively bridged at the present time. So far as the study of birds is concerned, the ornithologists themselves, or some of them, have afforded a certain excuse for the old sneer, but the work under review provides a very good illustration of the contribution which modern field ornithology is making to general biology.

It is in the field of behaviour in the wide sense that the study of birds has probably most to offer to the general biologist, and in recent times the critical study of the behaviour of wild birds has occupied the attention of biologists of first-rate ability, such as Huxley, Lorenz, and a number of others. The scientific investigation of bird behaviour centres very largely around those formalized activities which are embraced under the general term of display, and in this connexion the possibilities of mutually advantageous liaison between field and laboratory studies are happily exemplified in the relation, now well established, between the displays of birds and the physiological processes of reproduction.

In addition to the contributions of trained biologists in the realms of both fact and interpretation, a great number of intelligent amateurs have given careful accounts of display activities which they have observed, and these records are scattered through many journals and other ornithological works in a number of languages. The result is that a very considerable, though widely dispersed, body of material is now available for analysis and synthesis. On the purely descriptive side the known facts about the display behaviour of individual species of British birds have been summarized fairly fully for the first time in the recent "Handbook of British Birds"; but a sound general work on the whole subject was very much needed. This Mr. Armstrong has now provided.

The magnitude of the advance since Darwin made the first scientific approach to the subject in his presentation of the theory of sexual selection may be gauged by the mass of observational data existing to-day in contrast to the meagre material available to him. There are many points of detail and some of larger import which remain obscure or imperfectly understood, but at least a coherent general picture (differing a good deal from Darwin's conception) is emerging, thanks to the labours of the pioneers already referred to. Broadly speaking, the striking and frequently spectacular manifestations of avian display are not generally concerned so much with the choice of a particular mate as with the proper synchronization of the reproductive rhythms of mated pairs or with the maintenance of an effective 'emotional bond' between them. As regards the former function, it may be remarked that the importance of visual and other exteroceptive factors in influencing reproductive processes is now widely realized and has been especially stressed by Marshall, but for a proper approach to an understanding of display in birds it must be viewed against a wider psychological as well as physiological background.

Mr. Armstrong has a wide knowledge of comparative psychology, and, as indicated by the sub-title of his book, it is on the psychological and behavioural aspects of display that the main emphasis is laid, though not to the exclusion of others. Though the subject presents a wide field for further productive research, the time was ripe for a survey of progress up to date by a single author, and in the main Mr. Armstrong has carried out his task very adequately. The result is a highly interesting and stimulating book, and the author has been markedly successful in the way in which he has worked into the general picture a wealth of illustrative examples from published sources and original observations. As an ornithologist he has the right combination of field experience and grasp of the literature, and his interest in animal and human psychology enables him to draw some instructive parallels from other groups, and sometimes to point out suggestive similarities in the basic emotional make-up and 'ceremonial' behaviour of man and the lower vertebrates. The concluding chapter on physiological aspects of display shows that he has studied the specialized literature of this subject not only on birds but, so far as relevant, on other vertebrates with considerable care. It may be observed in parenthesis, however, that it is a pity that the unqualified statement that Rowan's crows with gonads enlarged to the spring condition in winter went north when released, "fulfilling the spring migratory impulse", goes on being copied into books. It is true that there was considerable circumstantial evidence that a majority of the treated birds did go northwards, but in fact the numbers of actual recoveries from north and south respectively were identical, and Rowan himself has not claimed that the results were conclusive.

Discussions on the related phenomena of song, territory, nest-building, social behaviour and so on serve to emphasize that display has inter-relations with almost the whole range of bird behaviour. In a few instances the ornithological specialist will detect minor slips or cases where an isolated observation has been a little incautiously generalized, but these are not serious. Nor is it other than natural if experienced students are inclined to differ from the author on theoretical points here and there. What is much more important is that the intelligent field observer, who may not have time or facilities to study the original sources in detail, and the general biologist who wants to know something of the subject, have at last a single work from which they can obtain a sound and trustworthy account of facts and theories about bird display, and from which, thanks to an extensive bibliography, they can readily proceed to more advanced study if they wish.

B. W. TUCKER.

THE BRITISH TRADITION

The British Way

1: A Comment on British Democracy. By Sir Hector Hetherington. Pp. 48. 2: The Temper of British Ideals. By Prof. John Laird. Pp. 51. 3: The British Method of Government. By A. K. White. Pp. 63. 4: British Political Institutions. By Prof. Andrew Browning. Pp. 52. 5: The British Way in World Trade. By Dr. Alec L. Macfie. Pp. 64. (Glasgow: Craig and Silson, Ltd., 1943.) 1s. each.

ONE of the reasons commonly advanced in pressing for a statement of Allied war aims is that such a statement contributes powerfully to the stimulation of the maximum war effort by its effect on morale. It would be unwise to discount that effort unduly, and the Prime Minister's recent broadcast speech is at least in part an admission of its importance. A no less potent source of inspiration for the war effort is, however, to be drawn from the British achievement in the past. We are slowly becoming aware that our habit of self-depreciation is apt to have untoward consequences. To say the least, it does not promote understanding and smooth co-operation with others of the United Nations, particularly with the U.S.S.R. or even with the United States. Persistently to understate our effort and capacity is to play into the hands of our opponents and present them with opportunities for suggesting that our contribution to the common cause is negligible, or that we are allowing our allies to bear more than their share of the burden.

There have been welcome signs of late that this danger has been realized. The right note has been struck in the speeches not only of Mr. Churchill, General Smuts and others but also in the Press—an admirable article, "The British Achievement—No Apologies" in the *Round Table* for December, is an excellent example. Mr. E. F. M. Durbin's "What Have We to Defend?" and Sir John Orr's "Fighting For What?" are other notable instances of a spirited defence of the British tradition, which is as stimulating to ourselves as it is destructive of the attempt to foment misunderstanding. The series of pamphlets, "The British Way", are well calculated to further this work. Without being narrowly nationalistic, those before us give an admirable interpretation of the British heritage, our outlook and way of life and the contribution we can make to the building of the post-war world. They are equally calculated, if these first five can be taken as a fair sample, to stimulate some of the creative thinking required if we are to reshape our institutions to serve our own ends as well as those of the world.

The pamphlets are naturally enough not all of equal merit. Sir Hector Hetherington gives the series a fine start with "A Comment on British Democracy", which goes right to the heart of those questions of the machinery of government and the relations between industry and the State on which many minds are now exercised. The dual function of government is well put: to manage as efficiently as may be the public business of a society; and to manage it also in such a way as to define, protect and enlarge the rights of the ordinary man and woman who are subject to its rule. For these functions to be discharged under a democratic system, which offers to ordinary citizens the opportunity of genuine participation in the business of government, there are three essential conditions: first, an effective arrangement for enforcing the responsibility of the government to public opinion; secondly, the maintenance of genuine opportunities of creating a public opinion; and thirdly, the government should be prevented from acting directly upon any citizen subject to its authority.

Sir Hector points out that these three basic principles have been established by British experience, and that we have produced a reasonably good working model of a democratic society. But whether the instruments we have shaped in government, industry and education are to survive depends on the quality of mind and will of our citizens, and especially of our leaders—whether we recognize widely and wisely the duties that are the counterparts of our rights and liberties and learn to use our freedom to make a community where we may live as a sensitive, creative and happy people should live. Whatever our past achievements, no democratic society can endure except in so far as its citizens learn that no man has a title to benefits unless, according to his power, he pays the cost.

Prof. John Laird's "The Temper of British Ideals" strikes the same note. The fundamental assumption of democracy is that the essentials of living and acting together are and should be a matter in which everyone should be a responsible participant. He places timely emphasis on the way in which we have achieved a very great freedom for speaking our mind about public affairs and for equipping our minds in such a way that, speaking them, we have the chance to speak sense, and he hints at the problem still before us in establishing the freedom and proper use of the air. Over our system of education, of justice, our religious toleration, our Colonial administration, Prof. Laird passes with calm appraisal, and emphasizes that both Great Britain and the United States have shown and are showing that British ideas can be adapted to the ideas of peoples who think upon their own lines and not upon ours.

Mr. A. K. White's discussion of the British method of government, by debate and discussion, is both penetrating and realistic. He does not conceal the difficulties or dangers inherent in this method, but his analysis of the group discussion method is highly pertinent to many of the problems confronting us in reconstruction, in industry and elsewhere. The real issues are laid bare and the fundamental conditions defined firmly and with precision. Discussion, he points out, is a co-operative undertaking as well as a natural political instrument and an educational method. Unlike force, it is a dynamic method, but it is helpless when interests are too opposed and prejudices too stubbornly held. Accordingly the democracies must face the facts of the great society and harness them to their own purposes.

Suggesting that the democracies should now make deliberate use of suggestion to cultivate the necessary and desirable measure of solidarity in the people, he urges, besides greater opportunities for personal contacts between all grades of society, and machinery for a fuller exchange of views and interests between them, that the need for instruction in discussion should be met by establishing, in normal times as well as in war, a central bureau or Ministry of Information to act for the Government as a whole as public relations officers now act for separate Government departments. Mr. White is not blind to the dangers of such a suggestion. The duties of such a Ministry in a democracy are in direct contrast with the functions of a totalitarian Ministry of Propaganda. It would ensure that the public interest overlay discussion and thus secure the essential condition for successful Party government. Enlisting suggestion in support of discussion at the point where the latter method is in most need of assistance, it would help to solve the fundamental problem of enabling the mass of the people to discuss politics intelligently and share intelligently in government.

Mr. White is concerned less with the past than with the present and future—he has wise words on planning and discussion and representative government. The onus, he reminds us, is on the planners to show that there is a satisfactory substitute for the Party system and responsible government in general. If, however, he is provocative, he is also constructive, and scientific workers may well find his essay one of the most stimulating in this admirable series.

The natural counterpart to Mr. White's essay is that of Prof. A. Browning on "British Political Institutions". This concise and lucid analysis of the three elements in our constitution and the problems arising out of them, such as those of the headship of the State, the representative body, and of the relation between the State and the individual, stresses the capacity of the British constitution to adjust itself to meet the changing needs of changing times. An equally important factor in its success is the fidelity with which it reflects the outlook and genius of the British people. Its stability illustrates the national dislike of unnecessary change. Its adaptability reflects the equally strong national consciousness that stagnation is fatal. Its essentially practical character and failure to conform to any logical scheme of political organization reflect the national distaste for theories, and the tendency to judge everything solely by its results.

Dr. A. L. Macfie's pamphlet in some ways is the least happy of the five. Somehow his summary of the growth of the British system of free trade in the hundred years after Waterloo, of the collapse to anarchy and of the position of trade in a democratic world, for all its merits, just fails to demonstrate exactly the British contribution. His touch is surer in delineating the future and the British opportunity and responsibility. The sanity and constructive suggestions, including that for an international investment board, in the concluding sections of his pamphlet, amply earn it a place in a series of pamphlets, which should meet a real need in Great Britain and which might well be utilized elsewhere by the British Council.

R. BRIGHTMAN.

SEEING EVER-SMALLER WORLDS*

By SIR LAWRENCE BRAGG, O.B.E., F.R.S.

THE limit to microscopic resolution is set by the wave-length of light. The degree of indistinctness of an object when seen under high magnification can be estimated if we picture the light which is traversing the instrument reversed in its direction. Instead of light waves scattered by the object passing on to build up the image, suppose corresponding light waves to start from the image and proceed towards the object. The pattern which they build up in the object plane will be, on a very reduced scale, what is actually seen when looking through the microscope, and since the local ether storms which they produce must be at least about a wave-length in each dimension, all sharp edges or fine detail in the object must be blurred to this extent. It is as if we were trying to paint a picture with a brush which gives a broad line, the breadth being the wave-length of light. Detail on a finer scale than a brush mark must escape its coarse stroke. Using the shortest ultra-violet waves for which transparent lenses are available, and transparent media of high refractive index in which to immerse the object, the limit of resolution cannot be pushed beyond 1000 A. (10^{-5} cm. or $1/10\,\mu$). As Abbe pointed out in his treatment of the microscope, this is an absolute barrier set by Nature, and if it is to be surpassed it must be by employing some quite new principle.

All bodies cease to be transparent for ultra-violet light more than an octave beyond the end of the visible spectrum. It is not until we reach the X-ray region that waves are again able to traverse matter to an appreciable extent. This opens up the possibility, which has been exploited in X-ray analysis, of getting information about the form of a body by observing the way it scatters X-rays. Convenient X-ray wave-lengths range from 2·0 to 0·5 A., and so lie in a region 4,000 times smaller than that of light waves. Resolution is correspondingly increased, and is in fact sufficient not only to separate atoms in a solid but even to give considerable information about the distribution of scattering matter in an atom. We have, however, to pay a heavy price for this gain in resolving power. We cannot form an image of an object illuminated by X-rays. Even if the technical difficulties of designing some type of reflecting lens capable of focusing X-rays could be overcome, the amount of scattered X-ray energy is inadequate. Consider, for example, a minute object, about 1000 A. each way, illuminated by ordinary light. Under intense illumination the amount of light scattered by such a body is sufficient for photographic recording but is nearing the limit. Yet such a body contains 30 million atoms, and when it is remembered that the most intense X-ray beam has far less energy than we are able to get in a light beam, it will be realized that even if the X-rays scattered by single atoms could be focused, the energy would be far too small to be observable.

It is therefore not possible to bring the X-rays from each point of the object to corresponding points of an image and so make direct use of their resolving power. It is only possible to observe the intensity of X-radiation scattered in any given direction by the object, and to get all the information we can about the object by interpreting such observations. This limitation decides the peculiar nature of X-ray analysis. In the first place, an object of irregular form gives a most complicated distribution of scattered rays. It is only when the object is a regular repetition of a unit of pattern that the scattered rays are diverted to certain directions, and that it is possible to associate in a simple way the strength of the scattered rays with the form of the unit. Hence X-ray analysis finds its most ready application to the examination of crystal structures where such regular patterns exist. Further, since we can only measure the intensities of the scattered beams, vital information about the form of the object is lost. When an object is viewed by the microscope, light is scattered in different directions by its various parts. These light waves pass through the instrument, and interfere in the image plane to build up a light distribution which corresponds, within its limit of resolution, with the object. The form of the image is determined, not only by the amplitudes of the waves scattered in different directions, but also by their relative phases, since the interference depends on these phases. In X-ray analysis, we can measure the amplitudes of the waves scattered in different directions, but their relative phases are not observable. Hence we have not got enough information to reconstruct the object. An infinity of objects, deduced by assigning any arbitrary phases to the scattered waves, would account for any one set of X-ray results.

The interpretation of X-ray diffraction is therefore like that of solving a cross-word puzzle. We cannot proceed directly; we must guess, and test whether we have guessed correctly. We know that the actual object, a crystal structure, consists of a regular array of certain groups of atoms. We know how much each atom scatters X-rays, and experience with other analyses teaches us much about the probable configuration of the atomic groups, what distance apart they are likely to be, and which are likely to be neighbours. Armed with such experience, possible configurations are tested to see whether they explain all the X-ray results, until one is found which satisfies every check. X-ray analysis has proceeded, as experience has accumulated, from simple structures where the alternatives are few to highly complex ones.

There is a simple optical experiment which illustrates the difficulty of X-ray analysis, and makes a striking demonstration. A cross-grating pattern, with about fifty repetitions of the unit to a centimetre each way, is illuminated by parallel monochromatic light and viewed by a microscope. A convenient object is a series of circular transparent holes, made as a print from the type of process plate used in half-tone reproduction. When the microscope is accurately focused, these holes are seen in their true form. Now the light message received by the microscope under these conditions is a series of parallel beams, the cross-grating spectra. The intensities and directions of these beams remain the same whatever the distance of the objective from the cross-grating. These beams therefore continue to build up an image when the objective is moved away from or towards the object, out of the focused position. The only variation when the objective is moved is in the relative phases of the parallel beams, which on passing through the instrument build up the image. The racking of the microscope out of focus affects the path-lengths of the beams to a different extent. We therefore see a different image for every position of

* Friday evening discourse delivered at the Royal Institution on March 12.

the objective. The image may be regarded as built up of a two-dimensional Fourier series of fringes, and these fringes become very obvious when so thrown out of phase that they no longer build up the true image. If the source of illumination is a mercury vapour lamp, the various wave-lengths build up image patterns of considerable beauty, which resemble a brilliant series of tartan patterns. Every image is realistic, and we cannot focus the microscope unless we know what we ought to be seeing—in this case, a series of round holes. In a precisely similar way, the phases are uncertain in X-ray analysis, and we can only 'focus' because we know we ought to be seeing atoms.

In contrasting X-rays and light, we see therefore that X-ray analysis attains very great resolving power, but is difficult to apply except to structures which are regular repetitions of a simple unit. In the case of light, the complexity of the 'geography' of the specimen presents no difficulty because we can form images, but there is a serious limitation to the resolving power. To what extent has the gap been filled ?

X-ray analysis has been extended to ever more complex structures. A classic example is the work of J. M. Robertson on organic molecules. If by getting a first rough approximation to a structure we can determine the phases of the scattered X-ray beams, we can then use the measured intensities to determine the amplitudes of these beams, and so get complete information about the form of the object. The problem is considerably simplified by the fact that in most crystals the unit of pattern has a centre of symmetry when projected on certain planes. The phase is then positive or negative. To put this more precisely, the wave scattered by the unit of pattern as a whole must by symmetry be either in the same phase as, or opposite phase to, that scattered by a point at its centre. By amplitude is meant the amplitude of the resultant wave as compared with that scattered by a pattern of single electrons at the centres. By summing a double Fourier series with these phases and amplitudes, a map of the electron density in the crystal is obtained which is a true 'X-ray image' of the structure projected on a chosen plane.

X-ray analysis is being extended, however, to even more complex fields. Crystals of certain proteins give X-ray diffraction pictures which show that they are extremely regular. Bernal first obtained such pictures, and the work has been carried on by Fankuchen, Mrs. Hodgkin, Perutz and others. The X-ray pictures show a wide array of very fine spots ; and if only one could deduce the phases, the intensities of the spots could be used, as in Robertson's work on organic molecules, to build up an X-ray image of a protein. The difficulty of guessing these phases is formidable. A molecule of hæmoglobin, studied by Perutz, has a molecular weight of about 70,000. There are encouraging signs, however, that progress is not impossible. Perutz has discovered a method of making the crystal structure shrink without distortion of the hæmoglobin molecules, which in the fully expanded crystal are separated by sheets of the liquid bathing the crystal. Now if we had a complete plot of the scattering power of a centro-symmetrical molecule for different directions of scattering, we could deduce the phases. They are either positive or negative, and as the direction varies the scattering power must go through a zero value in passing from one to the other. Hence the positive and negative regions of scattering are separated by nodes as in a vibration problem, and with the whole picture before us we could take the central region to be positive, and proceeding outwards change the sign every time we pass through a node. Ordinarily this is not possible, because the molecular scattering factor is sampled only at certain points, namely, the spectra determined by the grating constants of the crystal. When the grating constant itself can be varied, however, as in the case of hæmoglobin, the spectra sweep through the molecular scattering distribution and fall to zero in traversing the nodes. In this way Perutz has been able to trace a number of the nodes, and has reduced the problem of deciding between positive and negative for the inner spots to a few alternatives. Only one of these alternatives turns out to give a reasonable answer. Hence Perutz has been able to get an X-ray image of the protein molecule. This image is still very imperfect, corresponding to a resolving power of about 7 A., but the molecule is beginning to take shape and the process can be extended.

Another example of larger scale structures attacked by X-ray analysis is afforded by the studies of more or less regular fluctuations of the perfect crystal array such as occur in certain alloy structures. Preston's work on age-hardening, Bradley's work on the permanent magnet alloys, and the study by Lipson and others of 'sidebands' are cases in point. When an optical grating is ruled by a faulty engine, so that periodic disturbances of its regularity are produced, the result is a series of false lines or 'ghosts' in the neighbourhood of each spectral line. Similarly, when a crystal lattice is distorted in a harmonic way, each X-ray diffraction beam has ghost beams in its neighbourhood. The separation between the main line and the ghost is a measure of the period of fluctuation. Such fluctuations occur in alloys in a metastable state, when full separation into phases has not been attained. Periods of the order of 100 A. have been studied in this way.

The electron microscope, which has been developed in recent years, is of such absorbing interest because it fills in the wide gap between analysis by light and by X-rays. Experiments in the development of the instrument were begun by Knoll and Ruskin in Germany in 1932. An account of its principles will be found in an address given to the Royal Institution in May 1940 by Prof. L. C. Martin (see NATURE, August 31, 1940, p. 288). The electron microscope forms images like the ordinary microscope, while its resolving power is about forty times as great. It owes this power to two factors. In the first place, the Abbe limit, or limit to resolving power due to wave-length, is extremely small. The wave-length of 60 kilovolt electrons is $0 \cdot 5 \times 10^{-9}$ cm. as compared with $0 \cdot 5 \times 10^{-4}$ cm. for yellow light. A corresponding increase in resolving power is not attained, because the numerical aperture of the magnetic or electrostatic lenses employed by the electron microscope has to be made extremely small to avoid aberrations. However, even with the small apertures ordinarily used, the Abbe limit of the instrument is about 10^{-7} cm. or 10 A. Certain imperfections limit the resolving power of the best instruments yet constructed to 30–40 A., which approaches the Abbe value. Causes of imperfection are the aberrations and not completely symmetrical fields of the lenses and the fluctuations in voltage at the electron source. A resolving power of 100 A. is attained without serious difficulty. This high resolving power would by itself not be of service, were it not for another fortunate factor. The intensity of illumination by the electron beam is immensely greater than that for the brightest possible light source. Gabor estimates it as being in common practice 10^6 times as great as the intensity of the sun's image. Hence extremely small masses of matter containing a few thousand atoms scatter sufficient energy to produce an impression on a photographic plate.

The principle of the instrument is very simple. A co-axial magnetic or electric field acts as a lens for a beam of electrons of given velocity. By suitable design the focal length of such lenses can be reduced to a few millimetres. A first condenser lens concentrates 50,000-volt electrons on the object. After traversing it, they pass through an objective lens which forms an image magnified 100 or 200 times. This is viewed in a fluorescent screen with a fine hole at its centre, and a chosen portion of the image is brought over the hole. This portion is again magnified to a similar extent by a final lens, and viewed on a screen or photographed.

The objects must be extremely thin, less than 1,000 A. in thickness, and are of course in a vacuum. They may be deposited on a very fine pellicule of collodion which is laid on a plate pierced with fine holes. Focusing is achieved by adjusting the current in the magnetic lens. It is impossible to view the surface of a solid directly, since transmission must be used. It is possible, however, to examine the contours of a surface, such as that of an etched metal, by spreading a fine film of collodion over the surface and stripping it off, when it retains an impression of the hollows and ridges.

The War has retarded the applications of this instrument which would undoubtedly have otherwise been made, and we can confidently expect that it will open up fascinating new fields in future. On one hand, it gives greater definition to objects that can be seen under the microscope, and on the other it attains a resolving power in the 100 A. region, which is of the same order as that of the larger-scale structures studied by X-rays, so that we now have instruments capable of use in the whole range between the visible and atomic dimensions.

PRESENTATION OF SCIENCE TO A GENERAL PUBLIC*

By DR. ARNOLD RAESTAD

Formerly Minister of Foreign Affairs to the Norwegian Government

ALTHOUGH I am not a scientific man myself, it has fallen to my lot to be connected with certain aspects of the problem of the exposition of science. I have been engaged in examining the problem of how to organize better the presentation of the methods and results of science throughout the world or, in other words, the international dissemination of science. After three or four years of preparatory work, in 1938, the League of Nations, through the International Institute of Intellectual Co-operation in Paris, appointed a committee of scientific men, presided over by myself, to report on the matter. Before I say more about the committee and its work, it may be instructive to record, very briefly, the preliminary inquiries which led to its appointment.

The Assembly of the League of Nations had interested itself, in a couple of resolutions, in the use of broadcasting to promote the cause of peace and to familiarize nations with the culture of other nations. In 1936, an international convention for the use of broadcasting in the interest of peace was concluded. Later, the Institute of Intellectual Co-operation asked me to consider what subjects it might most appropriately pick out for an organized effort in this connexion. The Institute referred more particularly to the cause of peace and the work of the League, and to literature and culture generally, as promising objects for an internationally organized effort. I had to report that, in my opinion, neither the peace work of the League of Nations nor the knowledge of the literature of other peoples lent themselves very well to such a co-ordinated international effort.

But there was another field in which the practical broadcaster knew there was something to be done—science. For some reason or other, the attention of the statesmen of the League had not been focused on the need to disseminate more perfectly a knowledge of science—to publicize science. In most countries of Western Europe, despite the vastly increased effectiveness of the common media of information, the information at the disposal of the general public is less adequate, both as regards the progress of science and as regards current topics involving the existence of a scientific problem, than was the case thirty or forty years ago. The Press, filling its public to the saturation point with news and political views, has only a languid interest in the results and methods of science. The documentary film and the radio have not, in actual practice, filled the gap. As for the radio, it has no doubt rendered great services here, for listeners are easily attracted by great scientific names or fascinated by discoveries in biology or astronomy. But generally speaking, according to reports from many countries, the radio has not given what might have been expected, for a number of reasons. Outstanding men of science very rarely combine the qualities which make a good and attractive speaker on the radio; further, no single country has at its disposal first-rate men in all branches of science.

The Institute of Intellectual Co-operation, in view of the preliminary reports thus gathered, appointed in 1938 a committee of scientific men to consider means of improving, by organizational measures, the way in which the results and methods of science are now presented to a general public. The members of the committee were Dr. Julian Huxley, M. Henri Laugier, Dr. Clarence C. Little, my compatriot the late Prof. Sem Saeland, a Swiss, a Dutch and a Belgian man of science. All modern media of current presentation were considered in turn—lectures, Press, films, exhibitions, radio. The problem was approached from the point of view of science as well as from that of society, and from the point of view of the individual scientific worker as well as from that of organized and collective science. The committee was unanimous in stating as its opinion that the situation called for reforms of an organizational character, that these reforms would have to be carried out, if at all, by existing scientific bodies, and that the organization involved would have to be international in its scope and conceptions.

* Substance of a paper read on March 20 before the Division for the Social and International Relations of Science of the British Association at the Conference on "Science and the Citizen".

As for the content of the reforms, the committee, still unanimous, recommended the creation of an International Centre for scientific information, the efforts of which would have two main objectives: first, a continuous recording of the progress of science; and, secondly, the mobilization, as need and demand arise, of information on any scientific point of current interest. The material produced would, in principle, take the form of data, leaving the elaboration and the linguistic form to the journalist, the speaker, the film producer, the organizer of exhibitions, etc.

For its full achievement, therefore, a more satisfactory presentation of science to a general public will require the co-operation of three agents: the scientific specialist working to perfect his branch of knowledge and using the symbols peculiar to it, mostly mathematical; the intermediary man of science competent to grasp the symbolisms of a number of sciences and to assess the value of theorems and proofs offered by the specialists; and finally, the popularizer. Now and again, a specialist, and somewhat more often, the intermediary scientific worker, may also be a good popularizer; but the committee was unanimous in emphasizing that the great and urgent need of our time in this domain is for the development of a class of intermediary scientific worker having a very definite role in the life of science, a role important for science and for society alike.

A draft organization for the proposed International Centre was worked out. Besides the central secretariat, which might be reduced to modest dimensions to start with, there would be regional representatives of the Centre, and in each country, the academy of science or association for the advancement of science or corresponding body would appoint individual men of science or groups to carry on collaboration and correspondence with the Centre and its regional representatives and take initiatives. Otherwise, the initiatives would, to a great extent, come from the interested popular agencies themselves—Press, radio, film, theatres, etc.—as well as from the national bodies and authorities engaged in the work of spreading throughout the nation the knowledge and spirit embodied in organized science. Neither the central organization nor its regional or local subdivisions should constitute a barrier between the Press, the radio and other popular agencies and their direct access to scientific men. The news, comments and publications of the new organization should, on the contrary, be an additional help to them. The new organization being conceived as part of the house of science itself, there is no danger that it would develop intolerance and try to exercise a sort of birth-control of scientific ideas.

In 1938, the Rockefeller Foundation had instituted an investigation into the same problems in the United States. Conditions there differ to some extent from those in Europe; for example, greater efforts have been made to spread 'science news' in the Press, and to organize the production of documentary films. On the other hand, peculiarities of the broadcasting service react unfavourably on the attitude of the public to the news about science presented there. The first Rockefeller conference on Science and the Citizen in 1938 was followed by a second one in the summer of 1939. At that time, efforts were being made to formulate a practical programme that might be put before the leading scientific bodies of the world. The War interrupted these efforts. But in the light of recent experience, our aims of those days seem to me now to carry a more urgent appeal than ever.

To prepare for a lasting peace is to believe that we can have a new spiritual world. But there is no new spiritual world making for peace and progress unless it be centred in a greater proportion of willingness, and even habit, in high and low, to submit one's own judgment to the control of facts and to respect, in others, the supreme freedom to ascertain and assess facts. This submission to the control of measurement, and this respect for the truth of any assertion, constitute, if I am not mistaken, the spirit of science. When organizing the world, the United Nations have no more fundamental task, and no more urgent one, than to implement properly international co-operation for an adequate presentation to every people of the results and methods of science. In this co-operation, I do not propose to include nations subordinating scientific research to racial or other prejudices. Under the proposals put forward by the League of Nations Committee, international co-operation is automatically limited to such nations as respect the freedom of scientific thought and expression; and I believe it is best so.

I know that in Great Britain the better dissemination of scientific news by the Press and other popular agencies, and the establishment of a central organization to deal with the numerous international questions which inevitably arise, have frequently been discussed. Now that the United Nations are taking stock of their opportunities and their obligations, the opportunity should be grasped to make the realization of these purposes part and parcel of a remodelled and strengthened international co-operation.

SCIENCE IN INDIA*

By D. N. WADIA

Minerals in War

A GEOLOGIST'S work during war-time consists largely in mobilizing all mineral resources in his own limited sphere for munitions purposes. Free international movement of minerals having ceased, every country has to produce the full quota from its domestic mineral resources. Far-reaching questions will arise in the near future, if indeed some have not already arisen, as to how long minerals from accessible depths of the earth will be able to sustain man's wars.

Man's advancement to civilization from the hunter and peasant stage is due to his mastery over metals and minerals, but this advance has caused serious inroads on the world's stock of minerals and especially of metals. During the century and a quarter between the Napoleonic wars and the present War, the consumption of minerals has been more than a hundredfold of that consumed during the entire history of man on earth, and, so far as metals are concerned, man has used up between 1914 and to-day, between the two German wars, more metals than during any previous period of history. Metals such as tin have almost reached depletion stage, silver is being made to stand substitute for tin, while the extractable stocks of platinum, silver and gold left within manageable depth for the future needs of the world will be very meagre. The consumption of fossil fuels, coal and petroleum, has been at a far more serious

* General presidential address to the thirtieth Indian Science Congress meeting at Calcutta during January 2–4.

rate, so serious that the world's known reserves of mineral oil at the present rate of production will be exhausted in a few decades. The total world coal reserves are larger, but they will last only a few decades longer, if the present acceleration of production and consumption of coal and its use for the ever-lengthening catalogue of by-products continues in the future at the same rate.

So far no checks have been devised for this alarming depletion of the world's underground wealth and this robbing of the earth by the living generation at the expense of future generations. Metals and minerals are a rapidly wasting asset of a country, for which there is no renewal or replacement. Agricultural and forest resources of a land can be rejuvenated by suitable measures and manures, but no fertilizer can revive one exhausted mine, for geological processes require hundreds of thousands of years to form a vein of metallic ore or a bed of coal.

There are some 1,500 distinct species of minerals known ; of these about two hundred find application in commerce and industry and are considered economic minerals. Among these again there is a rapidly mounting list of metals and minerals which are of vital use in the manufacture of munitions of war and of highly specialized commodities of strategic use. In the defence programme of a nation under present-day conditions of totalitarian warfare, the metallurgical industry and its ancillary mining of minerals yielding the ferrous and alloy metals, fluxes, refractories and accessory minerals are of essential importance. A significant feature of the distribution of these minerals is the concentration of their production and manufacture in a comparatively few countries in the world, happily nearly three fourths of these being centred in, or controlled by, the United Nations as against the Axis group. Of the total annual mineral production of the world in pre-war years, so much as 85 per cent came from North America and Western Europe; of these the United States, Great Britain and Germany, and latterly the U.S.S.R., contributed more than 75 per cent.

This, however, does not mean that Nature has endowed these countries to this unequal extent with valuable minerals ; it is rather an index of the country's industrial and technical development and the energy of the people. The three successive five-year plans of the U.S.S.R. are an example of this. Industrial progress of other parts of the world may materially change this condition. For example, China's vast reserves of coal, hitherto untapped for lack of economic employment, may, in the not distant future, be put to use in metallurgy, or in the production of heat energy or other profitable channels. India's resources in iron ore are of a magnitude quite out of proportion to the two million tons of pig iron per year it has only recently begun to produce. Only in a few districts of Bihar and the Eastern States Agency, the high-grade iron-ore reserves are calculated to be of the order of 4,000 million tons. Large reserves of aluminium ore are still only potential assets. The minerals of South America and Africa are yet in an early stage of development, while Australia's store of mineral wealth is yet unknown over wide tracts of that region. When these untouched reserves enter production stage, the apparent inequalities will diminish and the countries bordering the North Atlantic basin will not occupy the dominating position in strategic minerals they do at present.

But even so, when the whole world's mineral resources are fully known and mobilized, the stock will not last many generations, if it is made to feed the waste of recurring wars on the scale of magnitude and frequency of the last two world wars. If the supply and free movement of a few ferro-alloys and a few strategic key minerals for non-industrial uses is controlled by some central world organization, the demon of totalitarian war can be banished and other wars shorn of the insane waste involved in military as well as non-military devastations. Then the wreckage of tanks and armour plate can be beaten back into ploughshares and its superior steel released for beneficent uses in peace.

It is no exaggeration to say that half the later wars of history have been directly or indirectly motivated through the desire of gaining access to stores of strategic mineral products, ores, fuels, salts, alloy metals and essential industrial minerals. The international mineral situation during pre-war years was in a chaotic state. While the United Nations were in a state of 'vacuous unawareness' about it, the Axis powers grabbed as much of the indispensable munitions minerals as they wanted, and the War has been waged by them on the stores of hoarded minerals and metals.

Only the adoption of a wise and justly planned international mineral policy framed by an international directorate can preserve peace and goodwill among countries unequally endowed by Nature with mineral wealth. No country in the world, however well supplied it be, is self-sufficient in mineral requirements, nor is any so situated that it can regard its mineral resources as purely domestic or national. Embargoes, tariffs, patent rights and transport controls imposed for political reasons do not offer a solution, but by hindering free movement of minerals become powerful contributive factors in precipitating world wars. Unequal geographical distribution of minerals being an unalterable fact, planned international economy should devise means not only to eliminate this cause of inter-country friction but also to increase the interdependence of nations on each other for their vital trades and industrial needs, and so make minerals a rallying point for international co-operation and goodwill.

The preliminary recommendations of the Conference on "Mineral Resources and the Atlantic Charter", convened by the British Association's Division for the Social and International Relations of Science last July, appear to be on the right lines, but they will not go far enough if their implications are meant to safeguard the interests of the British Empire only, or even of the whole United Nations' group. They should embrace all the free countries and should call for sacrifice from all participating nations of part of their national and natural advantages for the ultimate benefit of all and the future security of the peoples of the world. The main resolution of this Conference reads as follows :

"This Conference, having specifically dealt with mineral resources, submits that, as a first step, the Council [of the Association] should initiate forthwith consultations with appropriate scientific and technical organizations, to secure an understanding on the principles involved. The Conference would further urge that a scientific review of mineral resources, using and supplementing all existing data, should be among the first tasks of any international organization for the social applications of science, such as was envisaged at the recent Conference on Science and World Order. To this end, the Conference recommends that the Council should consider how it might help to promote the establishment of an International Resources Organization, as a fact-finding and advisory body for Governments, as a contribution to world stability, and in the spirit of the Atlantic Charter."

The fourth article of the Atlantic Charter postulates access for all States on equal terms to the raw materials of the world. But if the Atlantic Charter does not unreservedly provide for all peace-loving nations of the earth, whatever oceans bound them, its fulfilment in a partial degree will not achieve the goal of post-war mineral allocation, nor succeed in removing a focal infection point in the body politic of the world.

The position of mineral affairs to-day being what it is, it behoves us as non-Utopian science workers to ask : What is India's place in the world's mineral map ? The mineral outlook of the Indian region is on the whole satisfactory both for war- and peace-time requirements. India's resources in minerals of strategic importance, minerals for munitions and defence armaments, base metals, alloys, fluxes, refractories and accessory minerals can be regarded as adequate, in several but not all of them. India is deficient in tin, tungsten, lead, zinc, nickel, graphite and liquid fuels. But in the basic metals, iron, manganese, aluminium and chromium, the country is well supplied, in the case of the former three, in large excess. Our neighbour, Burma, has abundant stocks of the munition metals of which India is in defect, while her oil resources must yet be regarded as considerable. Ceylon has reserves of the world's finest graphite, a mineral indispensable in metallurgy, and of a magnitude sufficient to last a long period. Ancillary minerals such as asbestos, cement, fertilizers, clays, mica, sulphur, various salts, ores and other minerals of industrial utility are available in quantities sufficient for the country's needs, while some are in exportable surpluses.

The experience of the last three years war effort in the production in India of a wide range of munitions, without any previous apprenticeship, is satisfactory proof of the country's adequacy in some respects, though still unequipped in a number of essentials, such as specialized steels, machine tools, manufacture of aircraft, high explosives, automobile engines, big ship construction, etc., on a scale commensurate with her internal requirements.

Social Obligations and Relations of Science in India

Last year, while dealing with the progress of the exact sciences in India during the last thirty years, I stated that the retrospect was satisfying and held out promise of further developments. The time, however, has come, and the events of the last few years forcibly remind us of the fact, that science, as pursued in the laboratory and the field, is becoming more and more a specialist's job and is becoming divorced from the life of the people. Science, as applied to the problem of daily living and the social needs of the common man, is the great necessity of the day. The advent of the motor-bus, the radio and railway engine in the villages of India is not the same thing as bringing science to the homes of our villagers. The impact of science on the Indian masses has come in the form of a rather rude intrusion of machines and mechanics into the essentially simple rural economy of the country, and it is not surprising that this meeting has not been a particularly happy one. It has disturbed the economic structure and created, if not some aversion, an indifference to the cult of science in the popular mind.

But we all know that science is not all mechanics, nor are its practical uses to man the greatest thing about science. The greatest thing about science is the scientific method—the most effective thing man has for discovering truth and the ways of Nature. It can bring solid benefits by releasing life from stagnation and the bonds of ignorance wherever these prevail, whether in cities or in the countryside, among the labouring masses or among the governing class. The awakening to the social obligations of science is of recent date, and even in Europe and America, this aspect of the cultivation of science was for long not realized and left to sporadic individual efforts. With this awakening, a two-fold problem faces science all over the world to-day—to press the newest discoveries and inventions of applied science into the service of agriculture, manufactures, hospitals, homes and schools, and with it so to control the impact of these on man's private life that his mechanized work-a-day life may not be totally divested of all higher spiritual values.

Our future national life and its material well-being largely depend on a wholesome balance being maintained between these two—the impulse to harness science to increase physical comforts of life and a restraining desire to preserve the old-world spiritual calm and simplicity of living. Happily for India, this balancing is somewhat of a natural hereditary trait and does not need much emphasis. While in the European countries the evolving of a true synthesis, a *via media*, demands much searching and learned arguing, our age-old traditions have made this work easier. India's late start in the application of science to industry also gives it an opportunity of planning along right lines. The significance of this problem has been realized both by our political leaders and by scientific men, and some progress is being made in this direction. I refer to the inauguration in 1939 of the National Planning Committee under the chairmanship of Pandit Jawaharlal Nehru, with the specific object of co-ordinating science with industry in all its phases, and to the establishment by the Indian Science Congress at its Lahore session in January 1939 of a Sub-committee on Science and Social Relations, mainly with the object of studying the influence of science on India and collecting data relating to the effects of science on society in India.

The National Planning Committee, through its twenty-nine sub-committees, has set out to formulate a programme covering many phases of the future life and activities of India, material, productive, educational, artistic. Their work, unfortunately, is in a great measure suspended to-day, though some of the sub-committees have furnished more or less complete, well-documented reports, while others have submitted interim fact-finding reports. Their conclusions, doubtless, will be subjected to thorough revision and deliberation by the main body, which comprises some two hundred of the leading industrialists, publicists and scientific men of the country, before they are offered to the public, but a great deal of spade work has been accomplished, a valuable mass of ascertained classified details collected and many blue-prints prepared. A planned reconstruction in a greater or less measure of India's commerce, industry, finance, land, labour, mining, transport, power-generation, technology alongside educational, cultural and social re-organization is expected to emerge from the labours of this body.

Proposed Academy of Social Science for India

The executive committee of the Indian Science Congress has before it a proposal for the institution of a National Academy of Social Sciences, drawn up by the Sub-committee on Science and Social Relations. It is interesting to trace the origin of this sub-committee, which goes back to the Blackpool meeting of the British Association for the Advancement of Science in 1936, where there was much discussion of the social relations of science. In the following year, a few leading science associations took cognizance of this subject. The International Council of Scientific Unions, with its headquarters at Delft, Holland, at its meeting held in April 1937 in London, established a committee on Science and Social Relations, with Prof. F. J. M. Stratton, of Cambridge, as president. This action of European men of science was followed by a resolution passed by the American Association for the Advancement of Science at its meeting in 1937 urging the various scientific organizations of the world to re-undertake examination of the profound changes brought about by science in human society, and thus be in a position to promote "peace among nations and intellectual freedom in order that science may continue to advance and spread more abundantly its benefits to all mankind". In 1938 the British Association at its meeting held at Cambridge brought into being a special Division for the Social and International Relations of Science, with Sir Richard Gregory as its chairman. This division organized a conference on "Science and the New World Order" in London during September 1941. In conjunction with these sister organizations of Europe and America, the Indian Science Congress instituted a Sub-committee on Science and Social Relations at its annual session held in Lahore in January 1939. This Sub-committee has been working for the last three years and its labours have fructified in the above proposal, which in due course will come before the Indian men of science.

The proposed Academy should be a body of high academic standing and professional knowledge, which can take up long-range problems of social well-being of the people of India with which the older societies and associations established along familiar but too general lines in some cases and rather over-specialized lines in others cannot deal without suspicion of religious or political bias. Socio-medical and political subjects, human relations, anthropology, political science, vital statistics, social biology, population problems, sociological research in particular bearing on various Indian communities, are the subjects on which such an Academy can work in collaboration with the Indian Science Congress and half a dozen other institutions already existing in India for some of the above-named specific objects. It can be a living organ in the body politic of India for voicing the collective opinion and focusing the specialized points of view of numerous isolated working bodies on the one problem—how to promote the well-being of the common man.

The Sub-committee has begun a survey of the status of sociological studies in all the Indian universities. Vice-chancellors of many Indian universities have endorsed the proposal about the Academy favourably, and the secretaries of those learned societies that have been approached have announced their readiness to co-operate. Dr. K. Motwani, secretary of the Sub-committee, placed the scheme before Pandit Nehru last July and, in accordance with Pandit Nehru's wishes, the executive committee proposes to appoint a committee of experts to suggest ways and means of bringing this Academy of Social Sciences into being. The matter rests here.

It is too early to outline the exact tasks to which the Academy will address itself. Its chief function will be to explore those avenues through which the contributions of science may be adapted to the life of the individual and the nation without allowing anti-social applications of science, such as have made a shambles of so many countries, ever raising their heads in our midst. Secondly, the Academy should emphasize an integrated, synthetic approach to every problem, pressing into service the contributions of various basic social sciences such as human geography, anthropology, psychology, economics, political science, philosophy and sociology. The bringing into being of a National Academy so constituted may well become a crowning achievement of the Indian Science Congress.

IMMUNITY TO VIRUSES

IN opening a discussion on immunity to viruses in the Section of Comparative Medicine of the Royal Society of Medicine on April 21, Sir John Ledingham said that notwithstanding the immense amount of attention paid in the last twenty years to immunization against virus diseases, Jenner's discovery still remains the touchstone by comparison with which all subsequent efforts in this field must be judged. All attempts at immunization against viruses present the same problem—the preservation in the vaccinating agent of the maximum antigenicity compatible with safety from both immediate and remote sequelæ. The solution of this problem has proved no easy matter and there is still a large field to explore in the exploitation of natural variants of pathogenic viruses of man and animals.

Three fairly general methods were available: (1) the use of the cognate living virus (as in cow pox); (2) the use of completely or partially inactivated living virus; (3) the exploitation of the 'interference phenomenon'. Unfortunately, each virus has to be investigated as a problem in itself, and success with one by a particular method is no guarantee of similar success with others. Cultivation in an unusual host (for example, cow pox in the chick embryo or in tissue culture, rabies in rabbits, yellow fever in tissue culture) may give good antigenic variants; but in the case of vaccinia, there is considerable evidence of loss of antigenicity after prolonged cultivation in eggs. Poliomyelitis virus transferred to the cotton rat, thence to the mouse, and so to the hamster, is so far modified that rhesus monkeys may survive infection with it; such survivors are immune to virulent monkey virus. The value of rabies vaccines is very difficult to assess owing to our ignorance of the probable mortality in untreated cases; according to Webster, the average mortality from rabies among persons bitten by proved rabid dogs, no matter with what vaccine they are treated, is about 0·2 per cent; in man, who is probably relatively insusceptible to rabies, all vaccines appear equally good or equally bad. Webster has therefore devised an improved method of testing rabies vaccines, and has elaborated what he considers an improved vaccine inactivated by ultra-violet light.

The success or failure of partially or completely inactivated viruses seems to depend on the amount of material injected representing a sufficient number of infecting doses of the original virus. Formalized virus vaccines have been found useful for protection against such infections as equine encephalomyelitis and canine distemper; in vaccinia they appear to be useless. In foot and mouth disease and influenza, immunization is complicated by the existence of numerous serological types; and so far in influenza no variant has been found with the necessary combination of negligible virulence and good immunizing power.

Very little use has so far been made of the 'interference phenomenon', wherein inoculation with two viruses is followed by the development of lesions due to one of them, but by the acquisition of immunity to both. A good example is the immunity produced in fowls against fowl pox by the simultaneous inoculation of large amounts of pigeon pox and traces of fowl pox virus. Peltier in Senegal has recently inoculated a large number of natives with a mixed 'vaccine' consisting of vaccine lymph and active neurotropic yellow fever virus. Only the lesions of vaccinia appeared, and the natives were apparently immune to both yellow fever and smallpox.

Even though some virus infections (for example, fowl pox, psittacosis) give rise to little antibody response in the host, it seems clear that a humoral mechanism is the main factor in immunity, for chorioallantoic grafts of skin from fowls immune to fowl pox are as susceptible to fowl pox as grafts from non-immune fowls. When regrafted on to immune fowls and thereby bathed in the fluids of the insusceptible host, they can no longer be infected with fowl pox virus. It is not yet certain whether a high titre of circulating antibody following vaccination betokens immunity to influenza virus.

The study of virus reservoirs might give many hints in the quest for effective immunizing agents. Healthy vampire bats can carry rabies virus, many species of birds carry psittacosis and psittacosis-like viruses, fowls, horses and other mammals can carry equine encephalomyelitis and St. Louis encephalitis, while the virus of lymphocytic choriomeningitis has been isolated from wild house-mice. Under normal conditions the virus remains latent; variations in the weather, the presence of biting insects and appropriate hosts might lead to conditions in which man becomes infected.

Very important advances have been and are being made in attempts to substitute inactivated for active virus; with further developments in recovering viruses from tissues and in methods of inactivation, we may hope to ensure the preservation of antigenicity necessary for effective immunization.

Mr. J. T. Edwards pointed out that measures for the control of rinderpest necessarily differ in different countries. In India, where the native cattle are relatively immune to the disease, greater risks can be taken than in England where all the cattle are susceptible. Four methods of conferring immunity are available: (1) Injection of hyper-immune or convalescent serum (cattle or buffalo). The immunity so produced is immediate, but lasts only nine days, and is liable to produce an unjustified feeling of security, as the infection will remain latent in the herd until the effect of the serum wears off, when infection will flare up again. (2) The serum and virus method gives lifelong immunity, but is expensive and risky; unless both serum and virus are effective, it is of little value. (3) Little progress was made with inactivated virus until it was discovered that most of the virus is in lymphocytes, and that vaccination with extracts of tonsils, lymph glands and lungs of infected animals, killed at the height of the fever and inactivated with 0·7–1 per cent of formalin, gives good immunity. The procedure is safe but expensive, and the duration of immunity very variable. Calves lose their immunity early, older animals may remain immune for two years. (4) Passage of rinderpest virus in goats reduces the virulence for cattle in about eighty passages, and vaccination with this modified virus gives excellent immunity, appearing 2–3 days after inoculation. The method is effective, safe and cheap.

Dealing with swine fever, Mr. T. M. Doyle said that in immunization against this disease, virus followed immediately by serum is effective but expensive, and great difficulty has been experienced in obtaining constant products. Crystal violet vaccine, though not so efficacious, is much more uniform and comparatively easily reproducible. Infective blood is incubated for 14 days at 37° C. with disodium phosphate and 1 : 1000 crystal violet; 1 : 2000 crystal violet, though it has the advantage of not producing any precipitate in the vaccine, is not sufficiently bacteriostatic. Under laboratory conditions immunity lasts for more than twelve months. In field trials excellent results have been obtained so long as pigs were vaccinated *after* weaning; pigs vaccinated before weaning developed only slight immunity.

Dr. C. H. Andrewes remarked that bacteriophages might show the 'interference phenomenon'; coliphages, for example, might inhibit one another, even though one is inactivated with ultra-violet light. Might not interference account for immunity in vaccination against small-pox and rabies? Dr. D. Maclean directed attention to the difficulty of producing immunity to vaccinia unless a vesicle develops —even though deep lesions and local adenitis occur. Dr. C. L. Oakley mentioned the corresponding observation in influenza; if mice are immunized with formolized virus intraperitoneally, they are immune only to the homologous strain, and possess significant antibody to that strain only. When, however, they have intranasal inoculation with living virus, they are immune to all strains if the immunizing dose has produced a lesion in the lung; their antibody is still only to the homologous strain. If the immunizing dose has not produced a lesion, the mice have neither immunity nor antibody.

OBITUARIES

Sir Edwin John Butler, C.M.G., C.I.E., F.R.S.

EDWIN JOHN BUTLER was born on August 13, 1874, in County Clare, Ireland, and was educated at Queen's College (now the University College), Cork. He was senior scholar in 1896. In 1898 he took the M.B. (Hons.) at the Royal University, Ireland, but never practised. During 1899 and 1900 he held a travelling scholarship and worked at Paris, Freiburg, Antibes, and Kew. In 1901 he arrived at Calcutta as the first cryptogamic botanist to the Government of India; in 1902 was transferred to Dehra Dun, and in 1905 as Imperial mycologist to Pusa, the site of the new Agricultural Research Institute. In 1919 he became the joint director, and in 1920 agricultura

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

UNIVERSITY OF EDINBURGH

ADMISSIONS—SESSION 1943-4

FACULTY OF MEDICINE.—Entrance to the Faculty will be limited and candidates for admission in October, who have not already applied, must submit an application to the Dean of the Faculty of Medicine—on a form to be obtained from him—not later than July 1, 1943.

FACULTIES OF ARTS (including COMMERCE AND SOCIAL STUDY) SCIENCE, LAW and MUSIC.

The number of admissions to Courses in these Faculties will probably be limited.

Application should be made by July 15 on a form to be obtained from the MATRICULATION OFFICE, Old College.

Information regarding the conditions of admission to these Faculties may also be obtained at the MATRICULATION OFFICE.

All admissions issued by the Ministry of Labour and National Service.

A stamped addressed envelope (1d.) should accompany postal requests for forms.

W. A. FLEMING,
Secretary to the University.

May, 1943.

CITY OF LIVERPOOL

APPOINTMENT OF CITY BACTERIOLOGIST

The City Council invite applications from registered medical practitioners who are not liable to military service for the post of City Bacteriologist. Applicants should have had extensive experience of Bacteriological methods and of the work of a large Bacteriological Laboratory.

The commencing salary for this appointment is £1,250 per annum, rising by annual increments of £50 to £1,500 per annum. It is a condition of the appointment that the holder of the office shall devote his whole time to the service of the Council and he will not be permitted to undertake further remunerative work without the consent of the Council.

Further particulars in regard to the duties and conditions of the appointment may be obtained from the undersigned, by whom applications will be received up to June 30, 1943.

Canvassing of members of the City Council, either directly or indirectly, will be regarded as a disqualification.

Municipal Buildings,
Dale Street,
Liverpool, 2.
May, 1943.

W. H. BAINES,
Town Clerk.

UNIVERSITY OF BRISTOL

Applications are invited for the CHAIR OF ELECTRICAL ENGINEERING.

Applications from persons engaged in work of National importance for the duration of the war will be considered.

Further particulars may be obtained from the undersigned to whom applications should be sent not later than June 1, 1943.

WINIFRED SHAPLAND,
Secretary and Registrar.

TRANSVAAL MUSEUM, PRETORIA
UNION OF SOUTH AFRICA

Applications are invited from suitably qualified candidates for appointment of Director to the above Institution.

Salary £850×£25 to £1,000 per annum.

Closing date for receiving applications, June 26, 1943.

Forms of application obtainable from Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2.

MINISTRY OF LABOUR AND NATIONAL SERVICE

AERONAUTICAL INSPECTION DIRECTORATE

Applications are invited from persons possessing a degree in physics or recognized equivalent for a senior post under the Aeronautical Inspection Directorate. Applicants should have an extensive knowledge of non-metallic materials, with a specialised knowledge of the production of one of the following:

Paints and Allied Products.
Rubbers, Natural and Synthetic.
Aircraft Dopes.
Plastics, Glues, Cements.
Aircraft Textiles.

The selected candidate will be responsible for the technical direction of inspection of all non-metallic materials. He will be stationed at Harefield, Middlesex, but will be involved in considerable travelling.

Preference will be shown to qualified candidates between the age of 40 and 50 years; salary according to age, qualifications and experience.

Written applications giving full particulars of age, qualifications and experience, including name of present employer and post held, should be sent to the Ministry of Labour and National Service (Ref. A.224), Alexandra House, Kingsway, London, W.C.2.

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

The Governing Body invites applications for the post of SENIOR LECTURER IN CIVIL ENGINEERING. Duties to commence on September 1, 1943. Candidates should hold a good honours degree in Civil Engineering and have practical experience in Structural Design and in teaching. Salary in accordance with the Burnham Technical Scale, with a special allowance of £48 per annum, and war bonus in accordance with the Soulbury award.

Further particulars and application form will be sent by the undersigned on receipt of a stamped addressed foolscap envelope. Last date for the receipt of applications May 22, 1943.

J. F. S. ROSS,
Principal and Clerk to the Governing Body.

May 4, 1943.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)

8 HUNTER STREET, BRUNSWICK SQUARE, W.C.1.

Applications are invited for the post of DEMONSTRATOR (man or woman) IN THE PHYSICS DEPARTMENT in London, from October 1, 1943, at an initial salary of £250 per annum, with superannuation benefits and war allowance. Further particulars may be obtained from the undersigned to whom applications should be sent by June 15, 1943.

Reed Hall,
Streatham Drive,
Exeter.

NANCIE MOLLER,
Warden & Secretary.

ST. MARY'S HOSPITAL MEDICAL SCHOOL, PADDINGTON, W.2

DEMONSTRATOR IN BIOLOGY

A Demonstrator is required in the Department of Biology, part-time duties, one and a half days per week. Candidates should be male, of British nationality, and exempt from service in the Armed Forces. Applications with copies of three recent testimonials should be sent as soon as possible to the Secretary of the Medical School.

A firm of Manufacturing Chemists in the Midlands requires the services of an assistant pharmacologist. Applicants should possess qualifications in physiology or biochemistry, with some research experience in pharmacology. Experience in the biological assay of drugs would be an advantage. Salary £450-£550 per annum, according to experience, plus war bonus, at present 12½ per cent. Superannuation scheme in operation.—Write Box 61, c/o Mather and Crowther, Ltd., Brettenham House, Lancaster Place, London, W.C.2.

Assistant Chemist (Female) with bio- chemical knowledge required for Food Research Laboratory, July-August.—Please reply to Box 659, Rays, Cecil Court, London, W.C.2.

Male or female abstractor of technical literature required for library of large industrial company. Knowledge of foreign languages essential, particularly French and German and some industrial knowledge or experience desirable. Applications should be addressed to Box 950, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Librarian, either sex, for research depart- ment of large old established Midland firm. Knowledge of French and German an advantage. Duties to include abstracting of technical and patent literature.—Application, with indication of salary to Box 951, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Organic Research Chemist permanently required by company for pure research work on Chemotherapeutic problems. (Essential Works Order.) Good salary and prospects of future advancement.—Apply with details of career and any published work to Box 953, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Editor or Editorial Consultant required. Whole or part-time. Ability to write interestingly and secure information on the development of the world's raw materials and the possibility of scientific exploitation of world resources.—Box 954, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Qualified X-ray crystallographer with research experience seeks work of national importance.—Box 956, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: pH meter, portable battery model, range 2-12 or over.—Offers to Box 952, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Gmelin's Handbuch: Volumes relating to Magnesium and Chlorine, Carbon, Manganese, Oxygen, Zirconium and Silicon. VIII (8th) Edition.—Box 955, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, second-hand, a large selec- tion of instruments in perfect condition; 3d. 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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adviser to the Government of India. The same year he returned to England as director of the Imperial Bureau of Mycology; and in 1921, his services to India were recognized with the C.I.E.

While still in Europe, Butler had commenced his study of the genus Pythium, and became an adept at isolating its species from the soil; his monograph on the genus was published in India in 1907, and is still in great demand. His special interest in the Phycomycetes, for example, Phytophthora, Sclerospora, and Rhizophagus remained to the end. At Calcutta he was introduced to the fungi of the agricultural crops; at Dehra Dun to the forest fungi, especially as they attack tree roots, and at Pusa finally became committed to crop fungi, which were then poorly known. A ubiquitous weed *Launœa asplenifolia* was a reputed alternate host for Indian brown rust of wheat; its rust, however, proved to be autœcious, and *Puccinia butleri* Sydow commemorates one of his first tasks. Monographs on sugar-cane diseases, wheat rusts (with Hayman), Fusarium wilts, Sclerospora disease, and rice diseases, including one caused by an eelworm, were among his special publications. Five papers on the micro-fungi of India, jointly with H. and P. Sydow, covered the Indian rusts, smuts, Phycomycetes, Ascomycetes, and Cœlomycetes, many new records being based upon his own collections. In 1918, with the publication of his "Fungi and Disease in Plants", he established an international reputation as a plant pathologist. To round off his work on Indian mycology, in 1932 he published, jointly with G. R. Bisby, "The Fungi of India", a compilation of the species recorded up to 1930, and of their literature.

The year 1921 was mainly spent in organizing the new Bureau; but during a two months visit to America, Butler established cordial relationships with numerous mycologists and plant pathologists, and secured their goodwill for his new venture. In January 1922, he brought out the first monthly part of the *Review of Applied Mycology*, and for many years, editing that journal had the first call upon his time. In 1923 he visited New Zealand on his way to attend the Pan-Pacific Science Congress in Australia, and again secured the goodwill of all he met; the recognition of *Phytophthora hibernalis* Carne as a distinct pathogen of citrus dates from that visit. In 1924 he successfully organized the first Imperial Mycological Conference. In 1926 he was elected F.R.S., and was chairman of the Mycological Section of the International Congress of Plant Sciences at Ithaca, U.S.A. In 1927 he was president of the British Mycological Society, and was invited to Nyasaland to inspect the tea plantations there; *Sclerospora butleri* Weston, the type of which he collected, felicitously commemorates this visit. In 1928–29 he was president of the Association of Economic Biologists, and in 1929, the year of the second Imperial Mycological Conference, was also vice-president of the Linnean Society of London. In 1930, he was recorder of the Section for Mycology and Plant Pathology at the International Botanical Conference at Cambridge. In 1931 he was invited to the Sudan, where 200,000 acres of cotton were threatened by black-arm; in 1932 he was awarded C.M.G.; in 1934 was elected to the Council of the Royal Society; and delivered the Lowell Lectures at Harvard University, the home of the famous Farlow Herbarium and Cryptogamic Laboratories.

During this period, Butler's published work was mainly for the occasion, and displayed his many interests. In 1926 at Ithaca, for example, his subject was the delimitation of fungus species; in 1927 the development of economic mycology in the Empire; in 1929 the morbid anatomy of plants; in 1932, to the British Association, tropical plant diseases with "every gradation of severity from the sorghum smut which levies a moderate toll of about ten per cent of the crop . . . to the Panama disease which completely exterminates the susceptible bananas and precludes replanting within any reasonable time". But through it all, his spontaneous interest in fungi as fungi, together with his genial hospitality, attracted to the Institute all sorts and conditions of mycologists. Thus in 1934 A. H. R. Buller dedicated the sixth volume of his "Researches on Fungi" to "E. J. Butler, the distinguished director of the Imperial Mycological Institute, in recognition of his contributions to our knowledge of fungi, and of his helpfulness to fellow workers".

His years of service were marked by his pre-eminent ability both to appreciate a situation and to state a case. Hence his advice was in constant demand in committee work both by such Government bodies as the Colonial Advisory Council of Agriculture, and such public ones as the Empire Cotton Growing Corporation. Finally, in 1935, he yielded to insistent pressure, and left the Imperial Mycological Institute, where he will long be remembered as a great chief, and became secretary to the Agricultural Research Council. In 1938 he was made LL.D. *honoris causa* of the University of Aberdeen. He was knighted in 1939 and retired for health reasons in 1941. Just before his death, he was back among the fungi again, exuberantly rewriting for a new book the first chapter of his "Fungi and Disease in Plants" in the light of the experience of another quarter of a century.

He died suddenly on April 4, following an attack of influenza: and is survived by Lady Butler, and by a son and two daughters. E. W. Mason.

Commander F. A. Worsley, D.S.O., O.B.E., R.N.R.

Commander Worsley was born at Akaroa, New Zealand, in 1872, and died at Claygate, Surrey, in February last. At fifteen years of age he was apprenticed in sailing ships of the New Zealand Shipping Company and made his first voyage in the square-rigged *Wairoa*. After his apprenticeship days, he became mate and later master of New Zealand Government schooners, among them the *Tutanaki* and the *Countess of Ranfurly*, working in the South Pacific. Afterwards he turned his attention to steam, joined the Royal Naval Reserve and had the usual training with the Grand Fleet. This was in 1908. In January 1909 he joined the Allan Line and made acquaintance during the succeeding five years with ice conditions on the Canadian route.

Worsley was appointed master of the *Endurance* in June 1914, and his abilities and untiring energy soon made themselves known. He was a splendid shipmaster and made an ideal combination with Shackleton. The *Endurance* was crushed in the ice after her adventurous voyage through the ice of the Weddell Sea and the crew then lived for six months on drifting pack-ice, until it broke up in the open sea east of Graham Land. Boats were launched and Worsley was in charge of the cutter *Dudley Docker* in the escape from the ice to Elephant Island. His outstanding feat was the navigation of the *James*

Caird on the historic journey from Elephant Island to South Georgia. It is no exaggeration to say that Worsley's study of the winds and currents of the South Atlantic and his knack of snapping the sun, no matter how adverse the conditions, ensured the success of the voyage and ultimately the rescue of the marooned party on Elephant Island. Worsley has himself written an account of this journey under the title of "Shackleton's Boat Journey", and other incidents of the expedition are to be found in his longer book "Endurance".

On his return to Great Britain, Worsley commanded P- and Q-ships and won the D.S.O. and bar for successful operations against U-boats during the War of 1914–18. He also served on the north Russian front, advising on arctic equipment and transport. On the conclusion of hostilities he again rallied to Shackleton and became sailing master and hydrographer of the *Quest* in 1921. From then onwards until 1939, Worsley sailed on occasional trading vessels. During the present War his activities were many and varied, such as Red Cross work in Norway, ferrying steamers, clearing wrecks, lecturing to troops, and ultimately as instructor in seamanship at Greenwich.

Two events stand out in the inter-war period. In 1925 he was joint leader of an arctic expedition in the auxiliary sailing ship *Island*, which penetrated to Franz Josef Land and of which a full account is given in his "Under Sail in the Frozen North". In 1935 his love of adventure took him to Cocos Island in search of hidden treasure.

Worsley was a man of action, always on the move and extremely alert, both mentally and physically. He retained this amazing vigour up to the very end and steadily refused to go into retirement. It was hard to believe that he had reached his three score years and ten. He was not a man of science in the strict sense of the word, but he was a born naturalist and observer, as the logs which he kept on his cruises bear out. Animal life appealed to him and he had a good working knowledge of sea birds, seals and whales. It was as a navigator, however, that he stood supreme, and there is nothing finer than his piloting of the *James Caird* to South Georgia, an island not much more than a speck on the wide South Atlantic Ocean.

R. S. CLARK.

NAZI air-raids and artillery bombardments of Leningrad, Moscow and other Russian cities are taking a heavy toll of the scientific workers who have remained at their posts. News has just reached Great Britain of the deaths in this way of the following entomologists: A. M. Iljinsky (specialist in insect toxicology); A. M. Gerasimov (lepidopterist); S. A. Predtechensky (specialist in Orthoptera and particularly in the locust problem); A. N. Reichardt (coleopterist, specialist in Histeridæ); V. E. Redikorzev (insect anatomist and histologist); A. A. Stackelberg (dipterist); S. P. Tarbinsky (orthopterist); "and many others" as is stated in the letter containing this sad list. All these entomologists were well-known specialists in their respective spheres, most of them in the prime of life, and these gaps in the ranks of leaders of Soviet entomology will not be easy to fill, particularly when even heavier losses can be expected among the younger entomologists serving in the Armed Forces.

NEWS and VIEWS

International Relations

IN the first Montague Burton Lecture on "International Relations" delivered at Leeds on October 9, 1942, which has now been published by the University, Mr. J. G. Winant, attempting first to answer the question, why should barbarism be so rife in our modern world, suggested that one of the reasons was that in the years following the War of 1914–18 we neither tried to build a kindly world nor apportioned a sufficient percentage of national income to be armed effectively against aggression. Further, we did not give sufficient attention to either national or international machinery to allow the people effectively to meet social and economic needs within their own countries, or to give effective expression to the vast majority of people who wanted peace. Our consciences had also been blunted in the face of challenges to the rules of civilized life, and this slow decay of conscience occurred in a world of declining economic stability.

Our first task, said Mr. Winant, is to rebuild the moral basis of our life, neglect of which invites a revolution against the very conception of moral law. A world revolt against civilization will begin again, even after the defeat of the Axis, unless we destroy the roots of cynicism by proving in conduct our belief in justice, freedom and Christian brotherhood. We do not need a new tradition or a revolution, but only to preserve and make real in a world of action the great traditions we have inherited and which should be realized in free government and the Christian faith. We do not need a new economic system, but to learn to use the system we already possess so as best to serve our purposes. The real question is whether they serve best the ends of our society, in promoting the justice and equality of opportunity and freedom which are its purpose. We need above all to subject the machinery of life to its purpose, in place of being slaves of that machinery. Under the pressure of the terrible events of to-day, we must be great of purpose or we cannot survive. The moral and high political aims of our society must be put first, and economy machinery made their servant. We are fighting for a second chance to make the greatest of traditions come true. There is nothing to substitute for it; we must go ahead perfecting the political and moral system we have inherited or we let the system perish and the world revert to barbarism. He believes that we could build beyond nationalism an orderly international world, but nothing less than to serve our great tradition greatly would serve us in the disasters of to-day.

World Waste and the Atlantic Charter

IN a lecture on "World Waste and the Atlantic Charter" at the Union Society's Hall, Oxford (Oxford: B. H. Blackwall, Ltd.; 1*s*. net), Sir James Marchant points out that the lessening rate of discovery and the intensive use of minerals have already, independently of the increased demands due to the War, led to shortages here and there which are not being compensated by discovery. Salvage and recovery are with us as permanent aspects of the conservation of resources, and not only as part of a war economy. Scrap recovery is of increasing importance and must figure with natural resources in any scheme affecting the control of raw materials. Referring to remarks made by Mr. Hutchings, principal director of salvage and recovery, Ministry of Supply, regarding economy in use and in manufacture, Sir James emphasizes that there must be substitution of one material for another so as to prevent a scarcity of one raw material holding up production. Salvage involves policy and planning to ensure that the materials required are in the right place at the right time and in the right amount, and the discovery of available materials, as well as their collection and disposal to the best advantage. In regard to metal scrap, an international convention for marking material made from the main types of alloys to help in their easy identification is required, as well as improved methods for sorting and cleaning old scrap and getting it into suitable form for re-melting. Losses by corrosion when scrap, often finely divided, is kept for long periods, must also be avoided by early removal of dumps. In the grand strategy of post-war reconstruction, the prevention of all waste throughout the world, Sir James urges, must occupy a dynamic position, and he includes in his survey not merely minerals, rubber, bones, oil, paper, kitchen waste, but also wastage of human material in industry or through defective education.

Engineers' Study Group on Economics

The tenth anniversary of the foundation of the Engineers' Study Group on Economics was marked on May 8 by a social gathering at the home of Lady Rhys Williams; among those present were Sir Richard Gregory, Prof. F. Soddy, Lord Marley and representatives of organizations interested in economic and social reform. Formed initially by a group of engineers through the efforts of the late Mr. John L. Hodgson, the Engineers' Study Group soon enlisted the support of other technical and scientific workers and, under the presidency of Sir Richard Gregory and later of Sir Richard Paget, set out to prove that the scientific method can be applied to social and economic problems. Among its earlier reports were an "Analysis of Twenty-four Social and Economic Systems" and "The Design of a Family Budget with Special Reference to Food" (see Nature, April 11, 1936, p. 627). Much of the work of the Group—which covers an unusually wide field, from statistical data on national production to psychological hints on how to deal with misguided enthusiasts—is issued in the form of duplicated reports which are circulated among members and associated organizations.

Perhaps a unique feature of the Engineers' Study Group on Economics is the way in which it sifts all types of suggestions and helps those who wish to build up groups and associations in the pursuit of desirable social ends. Lady Rhys Williams, who has prepared some carefully thought out proposals on the lines of the Beveridge Report (see Nature, December 12, 1942, p. 692), referred to her long association with the Group. Mr. Raymond Perry, chief executive officer of the Committee for the Scientific and Industrial Provision of Housing—whose report on pre-fabrication may well prove an important step in solving the post-war housing shortage—acknowledged his indebtedness to the E.S.G. and to the Research Co-ordination Committee, at the headquarters of which his own committee began its work. Prof. Jacques Metadier, wishing to start a journal to foster co-operation among scientific men of the United Nations, approached the E.S.G. and received help and advice which led to the publication of the "Solidarity" series. Mr. W. H. Edridge, of the Joint Council for Monetary and Economic Research—a body which has brought together many separate groups working towards monetary reform—likewise mentioned the collaboration of the E.S.G., which through its unobtrusive and disinterested help has won the confidence of many attempting to solve the problems of a rapidly changing world. Representatives of other organizations added their commendation of the work of the Engineers' Study Group, the address of which is now 20 Buckingham Street, London, W.C.2.

Crack Detection in Non-Ferrous Materials

At a demonstration given in London recently, the potentialities of the 'Hyglo' system of detecting flaws in non-ferrous metals and other materials were demonstrated. From its name it will be recognized as an application of the well-known phenomenon of fluorescence to the illumination of flaws, cracks, inclusions and porosity, which are thereby rendered quickly noticeable when examined under the ultra-violet lamp. This particular system is specially notable, from the point of view of the user or potential user, by reason of the simplicity, rapidity and certainty of its operation, and of the ease with which it can be introduced into a scheme of mass production. The articles to be examined are first dipped for about two minutes in a solution containing the fluorescent material and a substance which at its boiling point produces a vapour to quench fluorescence on the surface. By preparing a sufficient number of articles at the end of each day, the work of inspection can be started at once in the morning and can proceed without interruption. When the articles so treated are brought under an ultra-violet lamp, the fluorescent material which has penetrated the cracks, spongy places or other flaws glows strongly and defective articles can be recognized at once.

At the demonstration, various specimens could be examined, and these included aluminium castings, bronze rings and porcelain insulators. In most of these the defects might easily have been overlooked in visual examination even with the aid of a magnifying glass, but under the ultra-violet lamp they were unmistakable. It was evident that to some extent the seriousness of a particular flaw might be gauged by the greater intensity of the fluorescence due to the deeper penetration, but this should be regarded as of secondary importance, as the first consideration is that the flawless articles should be separated from those which have defects—the final decision on any defect is a matter which requires individual inspection. The suggestion that the system could be operated in conjunction with a conveyor belt is quite feasible, as two lamps can be used. After passing the first lamp each article is turned over by an automatic arm and so both sides come under examination. It will be noted that the 'Hyglo' system requires the two essential operations of dipping and exposure to ultra-violet light. The ancillary operations of washing and chalk dusting have been entirely eliminated and as a result the work can be carried out by unskilled personnel after perhaps half an hour's training in the routine. Further, as the liquid used is self-regenerating and waste is reduced to the absolute minimum, the cost of the process is moderate ; an example given was the case of a production run of 1,600 articles each having a superficial area of 2·1 sq. ft., in which the operating cost, including energy, drag-out losses and labour at standard rates, was 0·08*d*. per sq. ft. The makers of the plant are High Grade Metal Tests, Ltd., 24 Marshalsea Road, London, S.E.1.

Subnormal Factors in Human Personality

IN his presidential address before the Section of Psychology and Educational Science at the thirtieth Indian Science Congress at Calcutta in January 1943, Dr. B. L. Atreya spoke on the "Supernormal Factors in Human Personality". In a rapid review of his chosen field, Dr. Atreya sketched in broad outline the history of the subject as it was known in the West and pointed out the work that had been done since the early days of the Society for Psychical Research, when investigation was hindered by lack of means and by the slight development of those statistical methods whereby results might be quantitatively analysed.

Although Dr. Atreya appears not to have seen fit carefully to distinguish the wheat grains from the mountain of tares, his outline of the mass of material will perhaps fulfil the purpose of dissuading future students from tackling the subject unless they are prepared, not only to face some of the most formidable of psycho-philosophical questions, but also to make themselves acquainted with almost the whole range of studies dealing with the psychology of deception, testimony and so on. Competent investigators are rare and urgently wanted, and it is to be hoped that Dr. Atreya's address will stimulate Oriental students to apply Western methods to the abundant material available in their own lands.

Prawn Fisheries of India

DR. B. CHOPRA, in his presidential address to the thirtieth Indian Science Congress, Calcutta, 1943, has gathered together interesting information concerning the various Indian prawns of economic importance and their fisheries. There are many species of edible prawns in India, the most important and largest being the so-called sea-prawns or Penæids. These apparently breed in the sea, the young migrating to the lower salinities of backwaters, lagoons and estuaries to return again at maturity to the sea to hatch their eggs. Among the freshwater prawns the members of the Palæmonidæ occur in enormous numbers with extensive migrations from fresh to brackish waters, presumably for breeding. The tiny Sergestid Acetes, rarely more than an inch in length, makes up for its small size by its abundance and occurs in estuaries and backwaters, but rarely penetrates beyond tidal influence. Not a single complete life-history of any of these prawns is known, and there is here a great opportunity for research which should yield good results. Methods of fishing and curing are mostly very primitive although in certain parts, notably Madras, much progress has been made in improving methods, gear and boats. More research is necessary in every direction, and Dr. Chopra's address indicates the special needs of the industry.

Folk-Lore of Epilepsy

IN a recent paper on this subject (*Med. Press and Circ.*, 1, 154 ; 1943) Dr. J. D. Rolleston directs attention to the large number of synonyms for epilepsy, many of which are popular terms, alike in Ancient Rome, the Middle Ages, and Bavaria in recent times. The English term 'falling evil' or 'falling sickness', which corresponded to the Latin *morbus caducus*, was for a long time prevalent but has now become obsolete. The chief folk-lore cause for epilepsy, which is still held by primitive races, was demoniac possession. Many examples of this belief have been found not only in the ancient Babylonian and Assyrian texts and the literature of ancient Greece and Rome, the Bible and the Talmud, but also in the West Indies, West Africa, Patagonia, Siberia, India, Ceylon, China and elsewhere (Tylor and Frazer). Another factor in the folk-lore causation of epilepsy was an astrological origin and the moon in particular. Moreover, the state of the moon was responsible in popular estimation not only for the occurrence of epilepsy but also for the efficiency of treatment.

As regards prophylaxis of epilepsy, in accordance with the rule in medical folk-lore, preventive methods in epilepsy were much rarer than curative treatment, and can be classified into external and internal applications derived from animals or plants. Treatment consisted in remedies of human origin such as blood, umbilical cord or placenta by mouth. Animal remedies took the form of their flesh, blood, milk, rennet, bile, lung, urine, testes or dung and were administered most frequently by mouth, but were sometimes made up into a plaster, liniment or amulet ; plant remedies consisted of mistletoe, elder and roots and seeds of the pæony, and mineral cures were represented by precious stones, silver coins and lead. There are numerous examples on record of the supposed transfer of epilepsy to other persons, animals or plants. Other methods of treatment were charms, invocation of patron saints and miscellaneous cures, which included mock burial, castigation of the patient to drive out the supposed evil spirit, venesection and inhalation of tobacco smoke.

Simplified Subscribers' Telephone Sets

AN article by E. S. McLarn (*Elect. Comm.*, 21, No. 1 ; 1942) describes designs which represent the first successful attempt at evolving a type of subscriber telephone set in which the components are designed and co-ordinated logically with the view of achieving simplified installation, maximum reliability and economy in maintenance. The improvements resulted from lengthy and intensive study of subscriber set behaviour in the International Telephone and Telegraph Associate Telephone Companies, operating under the most diverse conditions. Maintenance cost could be lowered if repairs were reduced to a simplified error-proof mechanical operation, for less skilful help would be required and the training period curtailed. An analysis of telephone set troubles under all kinds of climatic conditions shows that the causes are due principally to (*a*), excess moisture, dirt, lint and insects, and (*b*), open- and high-resistance circuits brought about by deteriorated soldered joints, broken conductors and poor contact between conductors and screw-heads.

The improved features of the new telephone sets introduced as a result of the investigation may be summarized as follows : complete unit mounting of components; no loose wiring; screw connexions throughout and absence of soldering; gravity switch a single unit, and integral with the base assembly, being readily accessible for adjustment; dial mechanism and gravity switch springs protected from dust, lint, insects, etc.; all spring contacts double-connected in parallel; gravity switch springs operated by a bronze roller; simplified tamper-proof ringer; induction coil and condenser sealed in bakelite cases; cellulose acetate sheet and plastics used instead of paper, fibre and textile insulation; new tipless cord which is easier to connect, prevents error, is more durable, snarl-resistant, and cheaper to use; components of entire set replaceable with a screwdriver by unskilled repair men and impossible to assemble incorrectly; rust-resisting steel base plate of sufficient thickness to prevent thread stripping.

Electrical Installations in Hospitals

A PAPER on this subject read recently in London by F. Charles Raphael before the Institution of Electrical Engineers reviews the considerations which apply more particularly to hospitals than to other public buildings. For permanent work, paper-lead cable is recommended for the circuits to the fuse-boards and wiring in conduit for the sub-circuits. Under-floor ducts are not recommended for hospital wiring. Suggestions are made regarding the selection of accessories and fittings. For general ward lighting a comparatively low value of horizontal illumination is recommended, with local lighting at the beds. Capacitance dimming is described, the future use of fluorescent lamps is discussed, and the shadowless lamp for operating-table lighting is described. Precautions to be taken against explosions in operating theatres are referred to and the requirements for screening in connexion with high-frequency (diathermy) apparatus necessitated by war conditions are reviewed, the opinion being expressed that regulations for this will be continued after the War. The precautions necessary in the construction and use of apparatus for electric therapy are discussed, developments in X-ray apparatus are dealt with and questions of voltage-drop and shielding are briefly mentioned. On ultra-violet treatment, the opinion is expressed that the mercury lamp, possibly supplemented by ordinary tungsten filament lamps, should eventually entirely displace the more expensive arc-lamp treatment and that there is no need to aim at an artificial reproduction of sunlight. Other subjects which are dealt with briefly are infra-red rays, cardiograph wiring, heating, ventilation of operating theatres, water supply pumps, cooking, refrigeration, lifts and signalling circuits.

Tuberculosis in Peru

THE following results as to the incidence of tuberculosis in Peru were recently obtained by Dr. Ricardo Martinez of Lima (*J. Amer. Med. Assoc.*, Oct. 24). A positive index to tuberculin was found in 68·45 per cent of conscripts, 65 per cent in school children of the Callao province, 77·98 per cent among the applicants for entrance to the University of Lima, and 95 per cent in the various groups of teachers and unions of workers. The proportion of positive reactions to tuberculin in conscripts from coastal areas was 74·64 per cent, 58·43 in those from the mountains and 75 per cent in those from wooded regions. The positive results to tuberculin are higher in Peru than in the Argentine, Brazil, Paraguay and Uruguay, and less than in Cuba and Venezuela. X-ray examinations of school children show that active tuberculosis increased from 4·1 per cent in 1938 to 5·3 per cent in 1941.

Bibliography on Management and Labour

THE Sheffield City Libraries have issued as Research Bulletin No. 7 a select bibliography on management and labour. This covers approximately the period 1932–42, the periodical references being, however, limited mainly to periodicals which are available in the Commercial and Science and Technology Libraries at Sheffield. Books not easily consulted or obtained have also been excluded, but some older classic books have been included, such as F. W. Taylor's "The Principles of Scientific Management". These limitations somewhat diminish the value of an otherwise excellent compilation, for there are a number of excellent modern books such as T. N. Whitehead's "Leadership in a Free Society", C. I. Barnard's "The Functions of the Executive", F. J. Roethlisberger's "Management and Morale" which cannot be excluded on these grounds, and the omission of reference to any of the works describing the important investigations initiated by Elton Mayo at the Western Electric Co. is a serious defect. References to readily accessible pamphlet literature, especially that issued in Great Britain during the War, are also incomplete. Owing to the paper shortage, copies cannot be supplied to individual students, but are available to firms and research organizations on official application, with which 3*d*. should be enclosed to cover postage.

Announcements

PROF. A. C. CHIBNALL, professor of biochemistry in the Imperial College of Science and Technology, has been appointed Sir William Dunn professor of biochemistry in the University of Cambridge, in succession to Sir Frederick Gowland Hopkins (see NATURE, April 10, p. 415).

DR. E. D. HUGHES, lecturer in chemistry at University College, London, has been appointed professor of chemistry at the University College of North Wales, Bangor.

THE following appointments and promotions have recently been made in the Colonial Service: P. C. Owen, assistant conservator of forests, Sierra Leone; J. S. Webb, mineralogist, Nigeria; R. A. Hutchinson, veterinary officer, Gambia; N. V. Rounce, district agricultural officer, Tanganyika Territory, to be senior agricultural officer, Tanganyika Territory.

THE Academia Nacional de Medicina of Buenos Aires has recently established the Hirsch Medical Scholarship with a fund of 500,000 pesos (about £30,000) given by Mr. Alfredo Hirsch, of Buenos Aires. Selected students will follow medical studies in the United States or Great Britain for two years, beginning in the middle of 1943. For the first ten years the scholarships will be given for studies on cancer, leprosy and infantile paralysis.

ERRATUM. In the article in NATURE of May 1 on "Cultivation of the Douglas Fir in Great Britain", on p. 493, col. 1, line 17, the word "and" is superfluous; *Pseudotsuga Douglasii* and *Ps. taxifolia* are alternative names for the same tree.

LETTERS TO THE EDITORS

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

Anoxæmic Changes in the Liver, with regard to the 'High-Altitude Death' of Airmen

IN recent papers Büchner[1] and his disciples Pichotka[2], Müller and Rotter[3], as well as Hesse[4], have described peculiar histological findings in livers of airmen who died under the effect of atmospheric conditions at a high altitude. The pictures under consideration consist in the formation of big, round or polyhedric vacuoles in liver cells nearest the acinus centres; these vacuoles do not contain either fat or glycogen; they appear as optically empty spaces, including here and there a crescent-like hem of slightly acidophil, homogeneous material, probably serous liquid.

Corresponding changes could be produced in guinea pigs and rabbits under atmospheric conditions similar to those at high altitude by keeping the animals in low-pressure chambers under normal pressure but reduced oxygen content of the respiratory air.

Reviewing post-mortem material from recent years, Hesse has found identical liver alterations in cases where death had occurred in the course of an acute anoxæmic crisis, as for example, suffocation or drowning, etc.

These findings are important not only from the diagnostic point of view, where they may make possible the diagnosis of 'anoxæmia' by histological methods alone, but from the theoretical point of view as well, for, in combination with physiological methods, they may lead to a new understanding of the results on cell function of reduced or interrupted oxygen supply.

So far, no physiological studies on this special question seem to be available.

In the course of earlier systematic studies on the influence of phosphorus and chloroform poisoning on 54 guinea pigs, we have examined (together with Bueding[5]) the histological features as well as the formation of glucuronic acid of liver tissue, the latter by the method of surviving slices in the Barcroft-Warburg apparatus.

Among the poisoning experiments, generally performed by injection of the toxic compounds, there were but two, where the animals were held in deep, reflexless, chloroform inhalation narcosis for 3·5 hr., after which one of them agonized and was killed by a blow from behind; the second one was killed at the same time having shown no abnormal clinical behaviour.

Both the livers presented histologically exactly the picture as described above. Although at that time we had no knowledge about its possible significance, we noted the peculiarity of the alterations as something unusual, particularly as we have seen no similar features at any time before or after it. Only when reading the above-quoted papers, we became aware of the possible meaning of the changes concerned, particularly as a status of rather pronounced anoxæmia in the animals was safely to be assumed.

The physiological studies were based on the facts shown first by Bueding and Lipschitz[6] that surviving liver tissue possesses the conjugated faculty of forming glucuronic acid in the presence of incombustible alcohols like (0·1–0·25 per mille) borneol or (0·08–0·2 per mille) menthol in a saline phosphate medium; the same authors were able to show, too, that contrary to earlier assumptions, the glucuronic acids are the products of a biological synthesis of triose-alcohols where the synthesis of carbohydrates and that of glucuronic acids are concomitant reactions, the latter occurring, however, only when alcohols of the borneol type are present (which have to be detoxicated). The starting products for these syntheses being triose-alcohols of half-acetal character like lactic acid (or pyruvic acid), the formation of conjugated glucuronic acids is significantly increased by the addition to the saline medium of one of them (for example, 0·02 *M* sodium lactate), provided the liver tissue shows its normal physiological (and, therewith, catalytic) faculties.

In both our livers we have found under such conditions scarcely any changes, indeed, as compared with the behaviour of normal control livers.

We feel, therefore, justified in concluding that, under acute anoxæmic conditions in guinea pigs, at least one of the important functions of liver tissue, closely related to the carbohydrate metabolism, remains intact; further and more specially directed studies have to find out how other basic functions behave under similar conditions.

The accompanying table gives (*a*) the data of the experiments in question as compared with (*b*) results from 20 normal controls and (*c*) with those from 10 guinea pigs poisoned with phosphorus:

		Mgm. glucuronic acid produced by 1 gm. of dried liver	
		Saline containing 0·01 per cent borneol	Saline containing 0·01 per cent borneol and 0·02 *M.* lactate
(*a*) 2 guinea pigs 3·5 hours in chloroform narcosis ('anoxæmic livers')	Limits	3·8—3·9	5·0—7·5
	Average	3·85	6·55
	Average increase		+ 65%
(*b*) 20 normal controls	Limits	1·1—5·4	1·7—11·4
	Average	2·85	5·05
	Average increase		+ 77%
(*c*) 10 guinea pigs poisoned with phosphorus (0·75 mgm. yellow P per 100 gm. animal weight)	Limits	0·25—3·8	0·25—4·9
	Average	1·8	2·0
	Average increase		+ 11%

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[3] Müller, E., and Rotter, W., *Zieglers Beitr.*, **107**, 156 (1942).
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Nutritional Requirements of *C. diphtheriae* and *L. casei*

THE investigations of Lythgoe, Macrae, Todd and others[1] upon rat growth-factors present in liver extracts, and those of Evans, Handley and Happold[2] on the nutrition of *C. diphtheriæ* (types *intermediate* and *gravis*), established the identity of a common growth-factor in these extracts with pantothenic acid. The former investigators also established the presence of another rat growth-factor (factor β) in the amyl alcohol-insoluble fraction of acidified liver concentrates. Active preparations of this factor were found to promote the growth of certain intermediate types of *C. diphtheriæ*, and in 1940 Happold, Lythgoe and Todd commenced a joint investigation with the object of elucidating its nature. The factor could not be extracted by amyl alcohol from aqueous acid solution or by butanol from alkaline solution. At *p*H 1 it was not adsorbed on fullers earth but was readily adsorbed on charcoal (Norite), from which it could be eluted with acetone-ammonia-water. Treatment with 20 per cent hydrochloric or sulphuric acids at 100° for two hours caused little diminution in activity, but similar treatment at *p*H 11 (sodium hydroxide) caused almost complete inactivation. Complete loss of activity was also caused by acetylation, methylation or treatment in the cold with nitrous acid. The growth-factor was not precipitated by phosphotungstic acid, and attempts to purify further via the lead salt were inconclusive, much activity being lost in the process.

More recently, further progress has been made by Chattaway, Happold and Sandford using as test organisms strains of *C. diphtheriæ gravis* of a type at present prevalent in Dundee and obtained through the courtesy of Prof. W. J. Tulloch. The growth-factor for these strains has properties identical with those established for the intermediate type factor, but some additional facts can be given. It is readily adsorbed on Norite at *p*H 3 and 9 but seems less readily adsorbed at *p*H 6·5–7. It cannot be replaced by biotin nor is its activity reduced by avidin, and its properties appear to differentiate it from folic acid; it is insoluble in ethanol and in common organic solvents. The activity of concentrates is largely destroyed on boiling for fifteen minutes with ninhydrin in one third saturated potassium dihydrogen phosphate. It is not extracted by *p*-cresol from acid aqueous solution at *p*H 3; this differentiates it from a growth-factor for *Lactobacillus casei* ε the properties of which had, until this observation was made, appeared to identify it with the *C. diphtheriæ* factor. Another point of difference between the two has been found in the observation that the *L. casei* factor is precipitated as a silver salt at *p*H 7 while the *C. diphtheriæ* factor remains in solution.

It is our intention to publish elsewhere fuller details of the associated studies in our two laboratories, but in view of the general interest in this type of investigation we feel that the position of the work should be indicated at this time.

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Rumex Lunaria L., a Gynodiœcious Tetraploid Species

THE genus Rumex is divided by modern taxonomists[1] in three sub-genera: Lapathum, Acetosa and Acetosella. In the sub-genus Lapathum only hermaphroditic species occur, but in the other two sub-genera diœcious forms are met. According to studies on the mechanism of sex determination met in these two latter sub-genera, the sub-genus Acetosella belongs to the Melandrium type of localization of sex-determining genes, that is, the *Y* possesses strong male elements, which may dominate over all the female elements in the *X*'s and autosomes in the tetraploid, hexaploid and octoploid species of the subgenus[2,3]. The diœcious species of the sub-genus Acetosa, however, are found to belong to the Drosophila type of localization of sex-determining genes, that is, the *Y*'s are inert, and the sex is determined by a balance between the *X*'s and the autosome sets[4,5,6]. This latter mechanism prevents polyploidy, as shown by Bridges[7], Muller[8] and Ono[4]. The diœcious plants of the sub-genus Acetosa belong to the section Euacetosæ, but in the section Hastati polygamodiœcious and gynodiœcious species are met[3]. Hermaphroditic plants are met in other sections of the sub-genus, namely, Scutati and Vesicarii. Polyploidy has hitherto been known only within the British forms of the collective species *R. scutatus*[9].

According to an explanation given by Löve[3] on the evolution of the two different types of localization of sex-determining genes in the two sub-genera of Rumex, these are to be regarded as two fundamentally different lines of evolution. The type met in sub-genus Acetosella has evolved from hermaphroditic individuals by mutations in the *male* direction followed by chromosomal recombinations over the polygamodiœcious and *androdiœcious* state to the present diœcious state. The type of sub-genus Acetosa has evolved by mutations in the *female* direction from hermaphrodites over polygamodiœcious and *gynodiœcious* plants to the diœcious ones met in section Euacetosæ. According to this hypothesis, the polygamodiœcious and gynodiœcious species of section Hastati should be regarded as a younger state in the same evolution process as the diœcious forms of section Euacetosæ. When the process has evolved to the diœcious state, polyploidy will result in intersexual, sterile forms and in females, as found in the species *R. Acetosa* some few times[4,5,6], but if a polygamodiœcious or gynodiœcious species will become polyploid, no differences in its sex form will, theoretically, be observed. Its way to the diœcious state will, however, be practically blocked.

During the last four years, I have made a number of investigations on the cytogenetics of different species of the genus Rumex. One of the forms examined was the gynodiœcious *Rumex Lunaria* L., which is a Macaronesian species of section Hastati, often cultivated in botanical gardens. My material was obtained from the Botanical Gardens in Lisbon, Portugal, and it is of the same type as herbarium material from the Canaries found in the Botanical Museum at Lund, Sweden.

The only species of the section Hastati hitherto studied, *R. hastatus* D., showed the diploid chromosome number $2n = 18$ [10]. The chromosome number of the species *R. Lunaria* L. was, however, $2n = 36$, or the tetraploid one.

As expected from the above hypothesis, the hermaphrodites of *R. hastatus* and *R. Lunaria* represent the heterogametic sex, giving after selfing a number of hermaphrodites and some females. After a pollination of a female with pollen from a hermaphrodite plant about 50 per cent hermaphrodites and 50 per cent females are obtained.

The tetraploid plants show a very great power of vegetative propagation, which is not met in my material of other species of Rumex, as cuttings may be taken from different parts of the plant.

Although it is not very likely that this tetraploid form has arisen from a diœcious or almost diœcious form with the same type of sex determination as met in *R. Acetosa*, it is not a fully excluded possibility. All tetraploid intersexual types of *R. Acetosa* are, however, almost completely sterile, while the hermaphroditic plants of *R. Lunaria* show an almost complete fertility. If experimentally produced tetraploids of, for example, the diploid gynodiœcious species *R. hastatus* will be found to be gynodiœcious, it must be regarded as a good support to the suggestion that the tetraploid *R. Lunaria* originates from a gynodiœcious diploid, and it would also give strength to the above-mentioned hypothesis on the two different lines of evolution of sex mechanisms in the two groups of the genus Rumex.

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March 19.

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Polygenes in Development

In criticizing my conclusions[1] regarding the relations between polygenic buffering systems and oligogenic switching, or key, systems, and in considering the advisability of dispensing with the term polygene, Dr. Waddington[2] rests his case on three main points, namely :

(1) That switching systems may depend on the joint action of a number of genes each of relatively small effect and so cannot be considered to be distinct from other systems of genes each of small effect.

(2) That many genes are known to have large main effects combined with smaller secondary effects, so leading to the conclusion that a gene may simultaneously determine oligogenic and polygenic variation.

(3) That genes producing "very minor changes in a character must be acting as rather ineffectual buffering agents on the last phases of its development".

Let us consider these points further.

The first begins with a statement which is true—so far as it goes. But such jointly acting genes cannot constitute a switching system which is efficient, and hence able to survive the test of natural selection, unless they are completely linked and segregate as a unit. They will thus jointly act, and will appear in genetic analysis, as one gene of large effect, that is, as a major gene, not as polygenes. This is in fact one of the ways in which I envisaged the evolution of switching genes from polygenes in the discussion which is being criticized.

The second point is also true so far as it concerns the manifold action of some genes. But can the secondary effects of such genes be regarded as determining polygenic variation ? The polygene notion was developed (see ref. 3) in relation to the action of selection, both in experiment and in Nature. Natural selection must act on the total phenotypic effect of a gene, and hence genes of the kind Waddington considers will be selected almost entirely on their drastic main effects. Their secondary effects cannot thus give rise to polygenic variation of the kind which I have discussed. Nor can it be supposed that natural polygenic variation is of this secondary kind. It is rarely if ever associated with any detectable major effects, and such association would surely have been detected in a proportion of cases in intensively investigated organisms, like Drosophila, maize or man, were it a regular feature of the system.

Thirdly, we have the statement that genes causing "very minor changes" are "rather ineffectual buffering agents". This, however, misses the essential point that small gene changes can accumulate by selection without mechanical limit. Though the effect of one gene change may be minor, a number of them acting in aggregate can be far from ineffectual ; and, in accumulating, such changes will provide just that fine adjustment which is requisite in a buffering system, and which cannot be provided by the mutation and recombination of major genes.

In conclusion, I must mention Waddington's equation of polygenes to Nilsson-Ehle's polymeric genes. The latter are defined only by similarity of action to one another, whereas the former are defined also by the magnitude of their individual effects, which are small when compared with the total non-heritable fluctuation[1,3,4,5]. Nilsson-Ehle's original polymeric genes in wheat and oats had effects much larger than non-heritable fluctuation (or he could not have scored them individually by the Mendelian technique) and so cannot be regarded as polygenes. They were polymeric only by virtue of the allopolyploidy of these cereals, and it was this accidental circumstance which provided the basis for interpreting quantitative inheritance. It is indeed most important to recognize that major genes, as well as polygenes, can show polymeric action, and that in doing so they do not become polygenes.

Polygenes, as I have derived the notion from my experiments, are distinct from major genes and must play a different part in the selective adjustment of development.

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London, S.W.19.
April 8.

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A Light Effect in Chlorine under Electric Discharge: Influence of the Intensity and Frequency

FURTHER work on the diminution of the current which occurs on irradiation of chlorine[1,2] has shown that several factors, some mutually exclusive, determine the magnitude of the phenomenon, such as the various electrical quantities; the electrode spacing, area and 'ageing' under the discharge; the nature of the gas, its temperature and especially the pressure. The chief difficulty in ascertaining the optimum conditions for the effect was that more than a limited variation of one of these altered others so much as to reduce the comparability of results. Furthermore, there was a limit to the influence of any of them on the decrease of current; for example, within a restricted pressure range and at a given applied potential, it increases to a maximum with decrease of pressure; it is negligible when the pressure is small. A similar limiting effect obtains with increase of applied potential at constant pressure.

Detailed studies of the above factors showed that a large Siemens' ozonizer, irradiated transversely and filled with about 11 c.c. of chlorine, was a fairly representative condition within the limitations of the electrical supply and especially the sensitivity of the available, oxide-rectifier type A.C. indicator. With a 50-cycle frequency, $\nu = 9{,}000$ volts (r.m.s.); a deflexion of 54 served to indicate the current. On irradiation by the carbon arc, the current decreased by 20–21 or about 38 per cent (see table); the decrease in the green and red was too small to measure accurately.

DECREASE OF CURRENT ON IRRADIATION

Light source \ Wave-lengths	White (7800–3700 A.)	Violet (4750–4000 A.)	Green (5775–5070 A.)	Red (7070–6070 A.)
200-watt bulb ..	10	8	0·5	1
Mercury arc ..	18	16	1	
Copper arc ..	9	7	0·5	
Carbon arc* ..	20	21	1	1
Iron arc* ..	20	20	1	0·5

* Due to the unsteadiness of these arcs, the comparative intensity conditions were not constant.

The effective frequency of irradiation was varied by use of coloured glass strips, instead of the Wratten or similar filters, due to the size of the ozonizer. It was limited on the short wave-length side at about 3700 A. due to glass absorption. The intensity I was determined with a sensitive thermopile, a photo-electric cell and the corresponding spectrum. I_{green} in green was very low with all the sources used; this accounts for the corresponding decrease in current. With the bulb, the carbon and iron arcs, the decrease in the red is similar to that in the green. When, however, I_{red} was made comparable with I_{green}, the decrease in current due to the former was sensibly smaller and appeared attributable to the corresponding frequency difference. This factor also explains the comparatively large current decrease in the violet, although it is the narrowest of the bands employed; that this falls within the characteristic absorption of chlorine, namely, 2300–5000 A.[3,4] may well be an additional and important cause. It is interesting to note that the current decrease due to violet is comparable with that for the unfiltered, that is, white light, where the total intensity is much greater.

The absorption coefficient of chlorine increases rapidly with frequency and is 65·5 at the band head, namely, 3340 A. Its values at the short wave-length limits for the violet and the unfiltered white, namely, 4000 A. and 3700 A., are about 5 and 19 respectively[3,4]; the corresponding growth of current decrease with frequency, however, is not of the same order (see table). A like result suggestive of saturation or some limiting condition is revealed by observations, over a wide intensity range of the ratio, of current decrease in white to that in the violet. This diminished from about 2 to 1 as the intensity was increased 2,200 times.

The above work was intended to form part of a comprehensive report of work, in progress since 1939, on what would appear to be a new photo-voltaic phenomenon in chlorine and other gases[5,6]. Some typical results are indicated here, since it appears doubtful whether the work can be completed under present conditions.

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Feb. 19.

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The Hydrogen Bond and its Influence on Acid Strength

QUANTUM mechanical resonance is undoubtedly a determining factor in deciding acid strength in certain cases, and empirical relations sometimes exist between the number of possible resonance structures (taken as a measure of the resonance energy) and the logarithm of the dissociation constant[1].

The strengths of salicylic acid and 2 : 6 dihydroxybenzoic acid will be discussed here. There is first of all the difficulty of accounting for their strengths in terms of ions or dipoles, bond lengths, angles and simple electrical theory. An elementary analysis of the problem using the concept of electrostatic potential at the carboxyl ion, which is assumed to govern log K, indicates that both acids have abnormally high ionization constants compared with benzoic acid. Also inspection shows that the two acids have similar strengths to chloracetic and dichloracetic acids, the ionization constants of which have already been accounted for on the resonance hypothesis.

Now it has been recognized for some time that internal hydrogen bond formation takes place in these phenolic derivatives[2] which is stronger in the ion than in the undissociated molecule, appreciably diminishing the proton capacity. It was thus of interest to see whether any relation existed between the number of resonance structures (n) (taking into account the hydrogen bonding) which could reasonably be formulated for these acid ions and the free energy of ionization. The accompanying table contains the relevant data, K being the thermodynamic ionization constant. With $n = 1$, we are dealing with a non-resonating carboxylic group containing compound of very low acid strength.

Acid	K	$5+\log K$	n
Non-resonating carboxyl group	10^{-10}	0·00	1
Benzoic acid	$6{\cdot}27 \times 10^{-5}$	0·80	3
Salicylic acid	$1{\cdot}05 \times 10^{-3}$	2·02	6
2 : 6 acid	6×10^{-2}	3·8	12

A hypothetic salicylic acid, having $n = 3$ (neglecting the Kekulé resonance), would have an acid strength approximately equal to that of benzoic acid. The actual salicylic acid ion has $n = 6$ with three additional structures resulting from hydrogen bonding, and the di-ortho acid an additional six structures, making $n = 12$. An equation such as the following may be suggested:

$$5 + \log K = a(n - 1),$$

with $a = 0{\cdot}36$. So far as is known, no other attempt has been made to link up these acid strengths quantitatively. Others will, it is to be hoped, improve on it.

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[1] Jenkins, *J. Chem. Soc.*, 1447 (1940).

[2] Branch and Yabroff, *J. Amer. Chem. Soc.*, **56**, 2568 (1934); Baker, W., NATURE, **137**, 236 (1936).

X-ray Wave-lengths: Notation

It appears that future confusion could be avoided, and a considerable amount of space saved, if there were some short way of showing that a particular measurement was referred to the Siegbahn scale, and not intended to be absolute. Adoption of the suggestion of Lipson and Riley[1], that inaccurate measurements should be given in Ångstrøms and accurate ones in X-units, seems undesirable for two reasons. First, it might give the impression that the absolute accuracy of X-ray measurements is of the order of 0·1 per cent, not 0·001 per cent. Secondly, it is tacitly agreed among crystallographers that a unit about the size of the Ångstrøm is much handier than the X-unit. May I suggest that measurements based on the Siegbahn scale be denoted by 'kX.'? The symbol is short, and expresses fairly obviously that the measurement is in thousands of X-units. Thus the lattice parameter of iron (to use Lipson and Riley's example) would be expressed as 2·86 kX. or 2·8604 kX., the increase in accuracy not requiring a change in the unit.

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May 3.

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Control of Chemical and Mineral Products

As some aspects of the proposals made in my recent speech to the Parliamentary and Scientific Committee appear to have been misunderstood[1], may I clarify the matter in the following?

(1) It was envisaged that the rope of security would be many-stranded. We cannot rely on any one method as sufficient in itself.

(2) The only specific proposal I made was that the implications of technical disarmament should be studied in detail in advance.

(3) As an example I tried to establish a *prima facie* case for the inclusion of nitrogen products control by the United Nations among the topics to be studied.

(4) In the course of (3), I stated that, in my opinion, the arrangements would necessarily be such that *at no stage* would Europe, including Germany, be deprived of nitrogen products required for agriculture and peaceful industry.

In a subsequent memorandum to the Parliamentary and Scientific Committee, the whole emphasis was laid on the need for detailed investigation of the problem and I am quite satisfied with the outcome.

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[1] See NATURE, April 24, p. 455.

The Royal Aircraft Establishment, Farnborough

CRITICISM has been recently made of the work of the Royal Aircraft Establishment at Farnborough, Hants. This institution was known during the War of 1914–18 as the Royal Aircraft Factory and prior to that as the Balloon Factory where, in 1905, Mr. S. F. Cody began glider experiments on the adjacent common. Chemists in the Royal Aircraft Establishment still use the door on which can be traced the wording, Balloon School, and the laboratories were once used by women who pieced together gold-beater skins for making the linings of balloons and the early airships. These laboratories were used during 1914–19 by Lord Cherwell (then Dr. Lindemann) and by Dr. F. W. Aston.

In all fairness to the large scientific and technical staffs in the Establishment, much excellent work has been done, is being done, and we trust will continue to be done with ever-increasing scope. In the past there has been a steady stream of trained men, whether trade or engineering apprentices or staff, from the R.A.E. into important posts in the aircraft industry.

Looking back over twenty-five years of work in the Royal Aircraft Establishment, I do feel that my colleagues have contributed something substantial and important to aeronautical science and incidentally to pure science in the form of scientific papers on combustion, rheology, metallurgy and corrosion, etc. To attract and keep the best staff, it is obviously necessary, as indicated in the sixteenth report of the Select Committee on National Expenditure, that there be better remuneration and better prospects for the scientific and technical personnel. The chief designer, Royal Aircraft Establishment, is being established as an Assistant III (Carpenter Scale) and his salary is but a three figure one. A similar state of affairs applies to the chief metallurgist or head chemist, and this low remuneration and status exist towards the close of a long, useful career.

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RHEOLOGY OF RUBBER

RUBBER is one of the many materials of great industrial importance the physical properties of which have not yet been precisely formulated, with the result that, although the word 'elastic' has become in everyday usage almost synonymous with 'rubber', the standard text-books on elasticity, if they refer to rubber at all, leave the impression that it is little more than a scientific curiosity.

Evidence that this state of affairs is rapidly passing was forthcoming from the large gathering of scientific men and technologists at a joint conference of the local section of the Institution of the Rubber Industry and the British Rheologists' Club, held in Manchester on April 17, to discuss some of the rheological problems of the rubber industry. At the morning session, at which Mr. W. N. Lister (I.R.I. local secretary) presided, papers were given by Dr. L. R. G. Treloar (British Rubber Producers' Research Association), Messrs. J. M. Buist and R. C. Seymour (Rubber Service Laboratories of I.C.I. (Dyestuffs) Ltd.) and Dr. J. R. Scott (Research Association of British Rubber Manufacturers).

In the first paper of the morning, Dr. Treloar dealt with "The Behaviour of Rubber in Elongation, Compression and Shear". His object was to show how these three simple types of deformation can be produced, and to consider the corresponding stress-strain relations, both from the experimental side and from the point of view of the molecular theory. His treatment referred only to well-vulcanized rubber, which can be regarded, at least approximately, as ideally elastic.

Dr. Treloar said that the fundamental reason for the high degree of elasticity of rubbers is to be found in the thermal motion of the chain atoms composing the very long molecules of which they are composed. This 'kinetic' theory shows that an assembly of molecules will take up a certain normal distribution of lengths which can be calculated by statistical methods, in much the same way as the molecules of a gas acquire a definite distribution of velocities. Any deformation of rubber disturbs this normal distribution, and hence leads to a less probable state. By considering an idealized network of cross-linked molecules Wall (*J. Chem. Phys.*, **10**, 485; 1942) has recently shown how the molecular distributions corresponding to elongation, uni-directional compression or shear may be described, and has calculated the probability of the distribution corresponding to any given state of deformation. By thermodynamic reasoning the probability has been related to the entropy, and this in turn to the work of deformation. The stress-strain relations are derived from the expression for the work of deformation.

The conclusions to be drawn from the molecular network theory are that rubber should obey Hooke's law in shear, though not in elongation or compression. Wall showed also that the stress-strain relations for elongation and compression should form a single continuous curve. An interesting feature of Wall's formulæ is that the description of all three types of behaviour require the use of only one molecular constant, M, defined as the 'molecular weight' between junction points of the network. These conclusions are very illuminating, and must be regarded as of fundamental importance.

Dealing next with his experimental work, Dr. Treloar said that in comparing the experimental stress-strain relations with the theory it is desirable to use the same sample of rubber for the different types of deformation. He showed by practical demonstrations that a circular sheet of rubber clamped round its circumference can be inflated into a balloon, giving a 2-dimensional extension which is equivalent to a compression. A pure shear can be produced by applying a tension to a short wide strip of rubber gripped in wide clamps. The experimental stress-strain data for elongation and shear are found to be in agreement with Wall's formulæ when the deformations are not too large, but depart from them noticeably at higher deformations (for example, above 100 per cent elongation). For the compression the agreement is much closer. It is satisfactory to find that all three types of deformation lead to the same value of M.

Dr. Treloar believes that the experimental evidence shows that the basis of Wall's theory is substantially correct, but that modifications of it may be necessary to take account of certain properties of the molecules which the theoretical treatment does not at present include.

The second paper dealt with "The Position of the Rubber-like State on the Plastic-elastic scale". Mr. Seymour, who read the first part of this paper, began by referring to the classification of types of deformation put forward by the British Rheologists' Club (NATURE, **149**, 702; 1942) which represents a type of scale in which ideal elasticity occurs as one extreme and Newtonian viscosity as the other. Rubbers occupy an intermediate position, being either visco- or plasto-elastic. But rubbers are not adequately described simply as being intermediate between solids and liquids, for whereas Hookean solids and Newtonian fluids can be described by single physical constants, the characteristics of rubber-like materials depend upon strain and upon rate of strain. Thus, representation of the behaviour of rubbers requires more complex functions relating the three variables stress, strain and time.

The deformation of rubber in compression can be described by an equation of the Nutting – Scott Blair type, relating the shear σ with the shearing stress S and time t, namely:

$$\sigma = \frac{1}{\psi} S^{\beta} t^{k}.$$

For rubbers, β is approximately 1·0. There are thus two constants for a given material, ψ and k, which can be determined experimentally, and can be regarded as characteristic of a given rubber. A diagram can be drawn, in which k is plotted horizontally and ψ vertically, to represent the rheological properties of different rubbers.

For rubbers in extension an equation was proposed of the form

$$\psi' = S\dot{\sigma}^{-k'}\sigma^{k'-1},$$

which takes account of rate of strain ($\dot{\sigma}$).

The second part of the paper, read by Mr. Buist, included experimental data which show that the equations given above represent the behaviour of natural and synthetic rubbers. A study of a number of rubbers reveals that those having low values of k are relatively difficult to mill. Natural rubber is the most easily milled, and has the highest k value. Continued milling reduces ψ (that is, the rubber becomes more plastic), and the spread of k values for different rubbers is reduced, the lowering of k for natural rubber being attributed to oxygen vulcanization.

Vulcanization moves all rubbers towards the elastic end of the scale, giving lower values of k. An 'index of reinforcement' was defined as the ratio of k before and after compounding and vulcanization. For natural rubber this index is higher than for synthetics. This is reflected in the greater difficulty experienced in vulcanizing the synthetics. The movement toward the elastic end of the scale was demonstrated by analysis of the partial vulcanization (that is, 'scorching') of rubbers in terms of ψ and k values.

Values of ψ' and k' in the case of extension are characteristic for each rubber, but differ from ψ and k for the same materials.

The data of Hahn and Gazdik (*India Rubber World*, **51**, 103; 1941) on the slow creep of rubbers in shear give values of k and ψ which are in accord with the performance of the engine mounting compounds described by these authors. For a given value of ψ the smallest creep is obtained with the lowest value of k.

Dr. Scott's paper, entitled "Rheological Problems in the Rubber Industry", discussed a variety of problems in which the rheological properties of rubber are of great importance, and showed how the better understanding of these properties might assist in the control of technological processes.

Dr. Scott took a different line from the previous speakers, representing the properties by a plot of $d\sigma/dt$ (rate of shear) against S (shearing stress). One can recognize specific types of flow curve, such as viscous, pseudo-viscous, plastic, etc., which can be related to the suitability of the material in any given circumstances. In the plasticization of rubber, the incorporation of filling ingredients requires first, good wetting properties, which means high fluidity under the action of small forces, and secondly, the breaking down of aggregates of filler particles, which necessitates high shearing stresses, and therefore high viscosity. These apparently opposite requirements can be satisfied by a certain type of flow curve.

The moulding of unvulcanized rubber is related to other rheological properties. The moulded article must retain its shape. This requires (1) the absence of elastic recovery, and (2) the presence of a yield value, so that the article will not deform under its own weight. The latter property can be assessed from the flow curve. Other examples of rheological significance are the coating of fabrics with rubber, which requires ready penetration into the fabric, and the building up of tyres, etc., which requires good self-adhesion, and means the flowing of one rubber surface into the other. Vulcanization represents the suppression of flow, while reclaiming may be regarded as the recovery of the flow properties which have been suppressed by vulcanization. Methods of assessing degree of vulcanization, for example, by so-called 'permanent set' tests, and the study of reclaiming thus come within the scope of rheology.

Dealing with methods of measuring the flow characteristics of rubber, Dr. Scott discussed the Williams parallel plate plastometer, extrusion methods, and the Mooney (shearing disk) plastometer, and the sort of information which can be obtained from them. None of these methods provides a uniform rate of shear throughout the specimen, which he considers essential for the fundamental study of rheological properties. Finally, he suggested that the study of the rheological behaviour of rubbers in relation to technological processes on one hand, and to their molecular structure on the other, opens up the possibility of producing rubbers having the particular properties which the technologist may require for any given purpose.

A visit was made in the afternoon to the Rubber Service Laboratories of I.C.I. (Dyestuffs) Ltd., at Blackley, by permission of the delegate directors. Members of both societies were welcomed on arrival by Dr. W. J. S. Naunton. The principal aspects of the handling and testing of natural and synthetic rubbers were illustrated in the laboratories, by a number of demonstrations which emphasized the broad rheological field covered by rubber-like materials.

RECENT ADVANCES IN ORGANIC CHEMICAL METHODS

AT a meeting of the London and South Eastern Counties Section of the Institute of Chemistry on April 21, Dr. E. R. H. Jones, of the Imperial College of Science and Technology, gave a lecture on "Recent Advances in Organic Chemical Methods". He said that spectacular advances which have characterized contemporary organic chemistry are largely to be attributed to vast improvements in the technique of the isolation, purification, examination and synthesis of organic compounds, and both new and improved physical and chemical methods have been extensively utilized. It is ever the aim of the organic chemist to employ methods involving the mildest possible conditions and the minimum quantity of material, a trend determined principally by his growing preoccupation with labile compounds of biological importance.

Notable advances made in distillation technique are attributable to the influence of the ever-growing petroleum industry. Molecular distillation is becoming increasingly popular and has rendered possible the isolation of vitamin A in a crystalline form. Chromatographic analysis has enormously simplified the purification of both naturally occurring and synthetic organic compounds and has provided a valuable new criterion of purity. On the chemical side a number of new reagents have been developed for the separation of particular classes of organic compounds.

The contribution of microanalysis towards recent achievements cannot be easily over-emphasized, and has led inevitably to the universal introduction of micro-methods. Absorption spectroscopy has proved of great service in the isolation and determination of the structure of vitamins and hormones, and although our knowledge of the relationship between structure and light absorption is still largely empirical, a sufficient fund of information is available to give the method a high diagnostic value.

Greater selectivity can now be obtained following the discovery of hydrogenation catalysts of the Raney nickel type and more specific chemical methods of reduction, for example, sodium in liquid ammonia, and calcium-ammonia ($Ca(NH_3)_6$), are being continually developed. The Meewein-Ponndorf reaction is of unique value for the reduction of sensitive aldehydes and ketones, and Oppenauer's demonstration that this reaction can be reversed provides a useful means of oxidizing unsaturated secondary alcohols to ketones which renders unnecessary the protection of unsaturated linkages. Wide popularity has been accorded to such highly specific oxidizing agents as lead tetra-acetate, osmium tetroxide and selenium dioxide.

The high-temperature nitration of paraffins and substitution chlorination of olefines are recent technical developments of great significance. The α-methylenic halogenation reaction can now be conveniently effected in the laboratory under mild conditions by employing N-bromosuccinimide. The remarkable orientating effect of organic peroxides on the addition of hydrogen bromide to olefines has led to the discovery of other chain reactions, of considerable preparative value, initiated by these trigger catalysts.

THE GRID AND SECONDARY POWER STATIONS IN GREAT BRITAIN

IN a paper entitled "The Effect of the National Grid on the Operation and Maintenance of Secondary Power Stations" read before the Institution of Electrical Engineers in London on April 1, R. A. W. Connor discusses the status and function of these stations in relation to the Grid in Great Britain, together with some of the running and maintenance problems brought about by Grid operation, and some of the factors affecting cost of production. The paper directs attention to the important part played by the secondary power stations, the efficient and economic operation of which has undoubtedly contributed in no small measure to successful Grid operation, and to the benefit of the supply industry as a whole.

The following conclusions are reached as a result of the study. The general shape of the national load curve will remain for many years and will not necessitate radical changes in station design. The reclassification of every station through its normal working life must continue, and it would be uneconomic to lay down plant or stations specifically to deal with peak loads only. Future load curves may exhibit exceptionally high rates of change of loads during certain periods, but the capacity of secondary stations will increase and it is unlikely that any new plant will have to be relegated to secondary duties until some years of primary station duties have been completed.

Improvement in the average thermal efficiency of secondary stations will continue owing to the relegation to this class of more modern stations with higher steam pressures and temperatures. There is scope for further improvements in operation and maintenance, although running conditions and high banking losses impose a lower limit on station efficiency than is the case with base-load stations. Grid operation with its daily cycle of temperature changes has affected maintenance and repair work in secondary stations, but not seriously or to the detriment of plant.

Owing to the large variations in output encountered under two-shift, one-shift and peak-load operation, and also due to the high fixed-cost component, all station costs tend to vary in inverse proportion to the kilowatt-hour output, and comparisons need very careful interpretation to be of any value. A characteristic curve, hyperbolic in shape, correlating output and cost, can be built up for any station. Most secondary stations are called upon at varying intervals and seasons to work with very low outputs, in which region the characteristic shows a very sharp upward trend. Due to the predominating effect of running conditions on thermal efficiency and to the sharp upward trend of the unit cost at low outputs, many secondary stations have suffered reductions in thermal efficiency and increased costs as a result of Grid operation. This, however, has enabled the primary stations to operate under base-load conditions and the full financial advantages of Grid operation to be realized.

LOCATION OF INDUSTRY IN GREAT BRITAIN

THE paper on "Location of Industry" which Mr. R. G. Glenday, economic adviser to the Federation of British Industries, delivered before the Royal Society of Arts on February 10, roundly challenges current views on the location of industry, including some expressed in the Barlow Report, but his emphasis on the background of change against which the problem of industrial location should be viewed cannot fail to be stimulating, although apart from its provocativeness his paper offers little in the way of constructive suggestion. Fundamentally, Mr. Glenday reminds us, the problem of locating a country's industries and urban centres is part of the larger problem of adjusting a population to its environment, and it is the exceptional rate of growth of populations and industries during the last century and a half that has given rise to so many acute economic problems to-day. He regards the closing of the channels of international movement, following on the disappearance of the geographical frontiers of the civilized world by the first decade of this century, as the major event responsible for bringing to a close the era of democracy and free capitalism in many parts of Europe.

The problem of industrial location must be examined against this background, and Mr. Glenday argues next that the two main factors which determined the location of industry in Great Britain, particularly the move northwards in the nineteenth century, were, first, the development of the railway and steamship, coupled with the adoption of free trade, and, secondly, the development of road transport and electrical transmission in the twentieth century. With this, from 1931 onwards, was associated a re-direction of the 'growing-point' of Britain's industrial energies to home rather than to export activities. Most discussions on the location of industry tend to under-estimate the effect of such basic structural innovations, which affect the general lay-out as well as the skeleton of the economic system.

Mr. Glenday, like the Federation of British Industries, seems to be rather obsessed with difficulties, but more creative and adventurous minds may profit by his warnings without being deterred by them. He rightly directs attention to the importance—and the difficulty—of deciding which industries and occupations are essential parts of developing urban structures and which can be regarded as independent and mobile. He stresses also the vital importance of timing in industrial progress. The two main questions which require examination in regard to post-war location are first, the probable size and quality of the population involved, and secondly, the probable direction of the forces of economic evolution affecting the occupation of that population. In regard to the first, he observes that in the main the question will be the redistribution of a stationary or even a declining population ; and in regard to the second, he stresses the place of services rather than industry in providing the main channels of expanding employment.

Discounting somewhat the magnitude and significance of the drift to the south of England, though rather unconvincingly, Mr. Glenday attributes this migration to improved road transport, more flexible forms of power and the diversion of our industrial energies from foreign to home trade. The tendency of the newer occupations to be in service trades and luxury products requiring elaborate packing and careful handling as well as servicing after sale has made proximity to the main market a factor of growing importance. Moreover, the pre-war trends have been almost entirely reversed during the War. Stagnant industries have revived and expanded beyond belief and other industries have been scaled down and concentrated. These changes have been accompanied by a migration of population and industrial location in a direction entirely contrary to that of the past two decades.

The primary reconstruction problem, therefore, according to Mr. Glenday, will not be so much one of choosing the regions in which the new industries are to be established, as of selecting those in which over-expanded war industries are to be contracted. The days of expansion are ended, and in a period of increasing industrial efficiency we will have our stagnant population rapidly growing older. In the near future our main industrial pre-occupation is likely to be the development of alternatives and artificial substitutes for traditional raw materials, and replacement and concentration in existing industries and production centres. Mr. Glenday concludes by emphasizing the trend towards concentration of industry, in the sense of less labour and investment for more and more work, and that questions of industrial location and the redistribution of population will be increasingly settled in consultation with the State or with the authority responsible for dealing with the lay-out and planning of our towns and countryside.

There can be no doubt as to the importance of the new factors to which Mr. Glenday directs attention, and they will require close consideration in the planning of town and countryside which will be involved in post-war reconstruction. The picture he paints, however, is one-sided. He dismisses too cavalierly the problem which the depressed areas must again present when the war production programme terminates. He ignores the opportunities which dispersal of population, evacuation, and bombing have given us, and refuses to face the central fact that location of industry cannot be left unguided in the hands of private interests. No one could pretend that the location of industry is other than a difficult and complicated problem, any more than it can be seriously maintained that the growth of our larger towns or conurbations and the concentration of industry in London and the south-east of England has not distorted the national economic structure and imposed serious handicaps on the health and social welfare of the nation. Difficulties are no excuse for inaction, and however cautiously the problem is approached, the location of industry and the redistribution of the industrial population is an essential part of the larger problem of planning the resources of Britain to afford the maximum social and economic satisfaction to the population as a whole: and of providing such services as transport, amenities and recreation, health and occupation.

FORTHCOMING EVENTS

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

Saturday, May 15

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. O. Godart: "Belgian Scientists and the War".

Monday, May 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. H. V. A. Briscoe: "Some New Properties of Inorganic Dusts" (Cantor Lectures, I).

ROYAL GEOGRAPHICAL SOCIETY (Kensington Gore, London, S.W.7), at 5.0 p.m.—Major G. W. Morey: Kodachrome films of Algeria and Morocco.

Tuesday, May 18

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. E. T. Whittaker, F.R.S.: "Chance, Freewill and Necessity in the Scientific Conception of the Universe" (twenty-seventh Guthrie Lecture).

Wednesday, May 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—"Agriculture To-day and To-morrow", 10: Sir John Russell, F.R.S.: "Our Agriculture—its Relation to Ourselves and Others".

INSTITUTE OF CHEMISTRY (LONDON AND SOUTH EASTERN COUNTIES SECTION) (at the Institute of Chemistry, 30 Russell Square, London, W.C.1), at 6 p.m.—Dr. J. W. Cuthbertson "Recent Advances in Electro-Metallurgical Industry".

INSTITUTE OF METALS (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Prof. G. P. Thomson, F.R.S.: "Electron Diffraction" (thirty-third annual May Lecture).

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (JOINT MEETING WITH THE ARISTOTELIAN SOCIETY AND THE MIND ASSOCIATION) (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Conference on "The New Physics and Physical Materialism". Addresses by Prof. Susan Stebbing and Sir James Jeans, O.M., F.R.S.; discussion will be opened by Mr. R. B. Braithwaite and Prof. E. T. Whittaker, F.R.S.

Thursday, May 20

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 5.30 p.m.—Mr. O. W. Roskill: "Statistics in the Fuel and Power Industries".

Friday, May 21

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. E. H. Rayner: "Measurement of Small Quantities".

ROYAL INSTITUTION (21 Albemarle Street, London, W.1), at 5 p.m.—Dr. H. J. Plenderleith: "The Preservation of Museum Objects in War-time".

UNIVERSITY OF DURHAM PHILOSOPHICAL SOCIETY and KING'S COLLEGE PURE SCIENCE SOCIETY (at King's College, Newcastle-upon-Tyne), at 5.15 p.m.—Prof. Max Born, F.R.S.: "Experiment and Theory in Physics".*

Saturday, May 22

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on "Nutrition in Infancy" (Chairman: Prof. L. G. Parsons).

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. G. Coumoulos: "The Greek Scientists—Traditions and Ties".

APPOINTMENTS VACANT

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

SENIOR LECTURER IN CIVIL ENGINEERING—Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (May 22).

LECTURER IN MECHANICAL ENGINEERING for the Schools of Technology, Art and Commerce, Oxford—Chief Education Officer, City Education Office, 77 George Street, Oxford (May 22).

TURBINE SUPERINTENDENT AND MAINTENANCE ENGINEER at the Generating Station of the County Borough of Brighton Electricity Undertaking—The Engineer and Manager, Brighton Electricity Undertaking, Electric House, Castle Square, Brighton 1 (endorsed 'Turbine Superintendent') (May 29).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Town Hall, Leyton, London, E.10 (May 31).

TEACHER IN MATHEMATICS AND MECHANICS in the Technical School, Norwich City College and Art School—Director of Education, City Hall, Norwich (June 5).

CITY BACTERIOLOGIST—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (June 30).

TEACHER OF MECHANICAL ENGINEERING OR MATHEMATICS AND PHYSICS—The Principal, Stroud and District Technical College, Kendrick Hall, Stroud, Glos.

CHIEF ENGINEER, with experience of high-power high-speed petrol and Diesel machinery, in a shipbuilding and marine engineering firm—Ministry of Labour and National Service, Appointments Office, 16 Westwood Road, Southampton.

LECTURER IN BIOLOGY—The Principal, St. Katharine's College, (Liverpool), at the Queen's Hotel, Keswick.

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