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FUNCTION OF INFORMATION SERVICES IN GOVERNMENT

THE debate in the House of Lords on January 31, on Lord Elton's motion, regarding the setting up of an organization to assume after the War the responsibility for spreading knowledge of the British Empire, a duty which is at present undertaken by the Ministry of Information, touches one particular aspect of the wider problem discussed in the Political and Economic Planning broadsheet on "Government Information Services" issued a couple of days later. The debate, in which others besides Lord Elton paid tribute to the work of the Empire Information Service, amply demonstrated the need for such educational work, as well as the opportunities, and Lord Samuel and Lord Hailey lent powerful support to Lord Elton's plea that plans should be made for continuing the work of this unit if the general work of the Ministry of Information should be brought to an end. There was division of opinion as to how best this could be achieved. Lord Elton and Lord Hailey both suggested a form of Empire Publicity Board, with strong independent representation, in association with that of Government departments, and though Lord Cranborne in replying for the Government pointed out weaknesses in such a proposal, he indicated that the importance of the question is fully appreciated by the Government and that it has been for some time under the urgent consideration of the departments concerned.

The *Planning* broadsheet is concerned with the more general aspects of the question and is a sequence to an earlier broadsheet on "The Future of Foreign Publicity" which has already been discussed in these columns. It was assumed in the House of Lords debate and also in the broadsheet on information services that the Ministry of Information will be terminated at the end of the War ; and though this appears to be accepted as right and proper, there was strong support for the view that certain of its activities should be continued in some way under Government auspices. Powerful support is to be found for this point of view in two recent and important books. Sir Victor Wellesley, in "Diplomacy in Fetters", discusses the handicaps under which foreign policy is conducted by a democracy, and makes two points which are vital to the discussion of this subject. First, the danger which uninstructed public opinion represents in the conduct of foreign affairs ; and secondly, that if the maintenance of a lasting peace is the chief objective of our foreign policy, it is essential that domestic policy should conform to the exigencies of foreign policy, and vice versa. Sir Victor proceeds to outline some constructive proposals, based on his experience as Deputy Under-Secretary of State for Foreign Affairs, to provide a new technique by which policy could keep abreast of modern requirements. With its details we are not concerned here, more than to emphasize that it involves more accurate intelligence on foreign affairs—not merely fact-finding—as a basis

for the determination of policy, and also the education of public opinion.

Mr. McCallum's "Public Opinion and the Last Peace" contains no such constructive proposals, but his review of the changes in public opinion with regard to the problems arising out of the Treaty of Versailles and the way in which these contributed to the disaster of 1939, demonstrates once again the dangers of an uneducated public opinion and also of the absence of clear, straight thinking on the part of statesmen and party leaders. Once again it is apparent that courage and honesty are the foundations of effective policy, and there could scarcely be more emphatic evidence of the importance of some official effort to guide public opinion as to what is involved in public measures and policies than in these two books.

The *Planning* broadsheet drives home the same lesson, though from another point of view. The conception of government as a positive and not a merely negative function plays in this, as in other *Planning* broadsheets, an important part in leading up to the conclusions which are drawn: the Government cannot perform its larger functions in the social and economic life of the community unless it has the right and means to make its purposes and methods effectively known. That need cannot be wholly met by full reporting of Parliamentary debates, and it is high time, in consonance with democratic principle, that fuller and simpler explanations be given to the great majority of people, who have a right to know why and what their Government has done, is doing and wishes to do. Explanation cannot be left entirely to the initiative of newspapers and book publishers: the administration is entitled in the public interest to take its own view of what requires explanation and by what means the explanation can best be given. Equally it is important that Government should be kept continuously aware of the citizen's point of view.

The P E P Group which has produced "Government Information Services" has admirably fulfilled its set purpose of adding to public knowledge of this important aspect of government, evaluating criticism and drawing up recommendations for the future. The history of Government public relations departments is briefly reviewed, and the lucid analysis of current criticism and of future activities leads to proposals for their future scope and organization which are concisely summarized. While there is nothing very novel in these recommendations—the Group agrees on the whole with the view that the end of the War should see the end of the Ministry of Information—the need is emphasized for an early decision by the Government as to the way in which certain of the functions of the Ministry are to be perpetuated. Just how the centralized responsibility for public information should be discharged in peacetime may be a question to which the answer can best be found in practice. The broadsheet shows clearly that the function of Government information is not exhausted even in the adequate performance by administrative departments of their own functions.

The first P E P recommendation is that Government information services should continue after the War through departmental units. Their functions should include the provision of news and information about administrative activity and the background of policy; public instruction on appropriate themes; and advice to their Ministries on public attitudes and opinions. To avoid misunderstanding and to keep present to the minds of the officers themselves the essential nature and the proper limits of their task, the term 'public relations' should be dropped and 'information' substituted. To provide technical and creative services, P E P recommends that a central publicity unit should be set up, attached to the Treasury, the Lord President of the Council or the Cabinet Offices, and operating under the general direction of a standing committee of departmental directors of information services. The unit would take over the work of such divisions of the Ministry of Information as films, publications, photographs, exhibitions and campaigns, and be responsible for buying space, time and commodities for all Government advertising. In the production of publicity, departments should be free to deal direct with private agencies where these exist.

With regard to themes, it is suggested that, as before the War, information units should undertake publicity on such questions as health and road safety, and should also provide information about new post-war measures and policies. Fuller background information should be given on subjects of general interest such as foreign affairs and public finance. Food and works relations publicity should also continue, the latter under the joint sponsorship of Government, employers' organizations and the trade unions, with considerable devolution of control to the level of industries and factories. If the inherent dangers and difficulties can be overcome, information services in this field might do something materially to improve industrial relations and to promote the closer integration of industry with the community it serves. Furthermore, information services should cover the general nature and methods of the Civil Service and its work. A fuller and wider knowledge of the facts and reasons on the part of the public would both be a safeguard against bureaucracy and prejudiced criticism of the Civil Service and accelerate any necessary or desirable changes in the Service itself. The more light is thrown on the purposes and methods of Government departments, the less likely are obsolete techniques, sectional habits of thought and indifference to the service of the public to survive. Moreover, it cannot be doubted that if considerable changes in the machinery of government at any level prove necessary to serve our new needs, public understanding and consent will be indispensable before such changes can be implemented.

With regard to departmental arrangements, the broadsheet urges that the head of the departmental branch should have sufficient status to give him access to the Minister, and adequate authority in negotiation and conference; a rank of at least assistant secretary is proposed. While the size and

diversity of the staff must depend on the size and work of the Ministry, in general large technical staffs should be avoided; a small highly-qualified staff able to use outside services, with a chief of high Civil Service rank, is preferred. The director himself need not be a technician, but should be well qualified to buy and control the technical services involved. Initially, directors might be chosen from outside, sometimes on a temporary basis; but in due course these posts could be filled by Civil Servants with the right aptitudes and some experience in information branches.

The broadsheet also directs attention to the value of close links between information branches, departmental intelligence units and libraries. In the Ministry of Health, these have from their inception been organically related, but in other Ministries relations are casual, and there may be no functional or administrative relation between public relations and the library, the statistical branch and the intelligence branch or any of them. Indeed the broadsheet goes so far as to suggest that if Whitehall had before the War been staffed with public relations branches which knew their business, the neglect of statistics and research which marred the administrative work of some Departments of State might in part have been corrected. At this point some clear thinking will obviously be required if the proposals are not to conflict with those which have been advanced by the Council of the Royal Statistical Society in its memorandum on official statistics and which, as the Prime Minister has announced, are now to be discussed with representatives of the departments concerned at a special meeting.

Another subject which calls for further consideration is the provision of information about public opinion. The first and most important source of such information is Parliament, but the Parliamentary interpretation of public opinion needs to be supplemented, as it has been during the War, by scientific surveys of public opinion. This need may arise from administrative considerations — the Requisitioned Land and War Works Bill is a glaring instance of the consequences of administrative neglect in this respect —and while these needs may sometimes be served by limited *ad hoc* inquiries, there is little doubt that more elaborate and fundamental researches may sometimes be required.

The broadsheet is emphatic that the Government should not be deprived of the use of scientific research in this field, but is hesitant as to the method and safeguards. The results of such studies should be published, though delay might sometimes be desirable. Tentatively, it is suggested that the right answer might be to encourage the formation of a social research council or institute under the ægis of the Lord President, financed by the State, but with independent scientific status. Such a body might align itself with the work of the universities and private agencies in this field and could take charge of the official research unit. The broadsheet rightly points out that the public opinion survey represents a new and important method of investigation in the social sciences, of which the Government should not be wholly deprived; this should be sufficient answer to criticism about interference with civil liberties and spying into private affairs which have been made.

Local information services are important and should be remembered in connexion with the training of local staffs of central departments. The work of the Citizens' Advice Bureaux and the war-time local information centres should continue: the latter should cover the whole province of local government and should keep in touch with the local offices of the Government. Some regional co-ordination by the central Government of its own local information activities will probably be necessary, and the machinery for this could be attached to the central publicity unit.

Finally, reviewing the safeguards against the abuses to which Government information services might be subject, such as their use to press a Government case unduly against opposition, to give unfair advantage to a political party in power, to build up the personal reputations of Ministers, and to overweight the position of the executive *vis-à-vis* Parliament, the broadsheet points to the remedies in due publicity for the nature and operations of the information services themselves; the maintenance of proper codes and standards of conduct among the information staffs; responsible use of them by Ministers; and continuous vigilance by Parliament and the Press.

The careful examination of these dangers and safeguards in the broadsheets does not warrant pessimism as to their adequacy. Vigilance undoubtedly will be required, but an independent central publicity unit as suggested may be free from some of the dangers of departmentalism and be competent to make its contribution in that important field of policy-making which increasingly calls for the work of committees of Ministers dealing with wide general spheres. This is the reason for the suggestion that the standing committee of public relations or information officers should meet under the auspices of the Cabinet Office with a secretary provided by that Office, and that the central publicity unit should be similarly affiliated. Whether or not such developments in the direction of a Civil general staff come soon or late—for there is little doubt they will come—there can be no question that Government information services rightly organized and wisely handled have an important if not an indispensable part to play in the establishment of right relations between knowledge and power, the application of scientific and technical knowledge to public policy, the elimination of prejudice and passion and the harmonization of executive action and public opinion. Scientific workers who study this lucid broadsheet, with Lord Woolton's observations at the recent British Association Conference in mind, can scarcely miss the implications it holds for one of the central problems of to-day, namely, the question as to how best the results of scientific inquiry can be translated into public policy for the general welfare of the community.

INDIVIDUALITY IN HIGHER ORGANISMS

The Biological Basis of Individuality

By Prof. Leo Loeb. Pp. xiii+711. (Springfield, Ill., and Baltimore, Md. : Charles C. Thomas ; London : Baillière, Tindall and Cox, 1945.) 10.50 dollars.

THE origin and scope of this book are perhaps best indicated by the following paragraphs from the preface : "The starting point of this analysis was a series of investigations on the transplantation of normal and tumour tissues which the author and his collaborators have carried out in the course of about forty-eight years, some of which, especially those dealing with inbred strains of mice, have not yet been published. To make possible a unified account and interpretation of the various aspects of individuality, it was necessary for one person to undertake this work, rather than to edit a collective book written by specialists in the different sciences which contribute the data needed for this purpose. The method thus chosen suffers from the difficulty that a single author may not be able to treat with equal competence the problems involved ; but it is believed that the unified presentation of these fields may, to a certain extent, compensate for such a deficiency.

"In the following chapters these types of individuality are analysed as to their evolution and their biological and physical manifestations.

"It is hoped that this presentation may be of interest to the biologist and to the general pathologist and that certain parts of it may be helpful even to the surgeon in the practice of tissue grafting, to the geneticist, to the student of cancer and to the immunologist ; perhaps also to the psychologist and to some philosophers."

There is, however, much more in the book than might be gathered from these introductory remarks as it is, in fact, a serious and lengthy treatise on the whole subject, including its history and later developments. These are gone into in very considerable detail and a valuable bibliography, brought up to 1943, of some eleven hundred and fifty books and papers is appended.

Within the limits of a short review it is obviously not possible to give more than a general idea of a work of this size, but some points may be noticed.

In the first place, as the term 'individuality differential' and other 'differentials' are constantly used throughout the book and, as the sense in which they are used by the author may not be immediately apparent to the reader of this review, a few words on their meaning may not be out of place. It is now known that there is inherent in every higher individual organism something differentiating it from every other individual, which can be discovered by observing the reactions of certain cells and tissues belonging to one individual towards the tissues and cells of another individual of the same species. This particular characteristic the author names the 'individuality differential' ; which is common to all (or almost all) the various tissues and organs of the individual. In the same way there are species-, genus-, order-, class-differentials which, together with the individuality differentials, he designates as 'organismal differentials', among which the individuality differential is the highest and finest one.

There are two principal methods by which the organismal differentials in general can be analysed : (1) by various types of transplantation, and (2) by serological methods. The author and his collaborators have concerned themselves principally with the former method, which he regards as best suited for the investigation of the individuality differential. A very large number of transplantations of various tissues into different animals are described and discussed in detail. The subjects dealt with in this way include autogenous and homoiogenous transplantations in various species, the individuality differentials of closely inbred animals, the problems and criteria of success or failure in transplantation of tissues and organs, transplantation of tissues into the allantois of chick embryos, into the brain or into the anterior chamber of the eye. The local and general reactions of the host to the transplanted tissues have also been investigated and critically discussed.

Interesting chapters deal with the phylogenetic and ontogenetic development of individuality, and with transplantation and individuality in certain invertebrates and lower vertebrates.

Another section of the book is concerned with the nature of tumours, with a comparison between the results of the transplantation of tumours and of normal tissues. The influence of heredity and of immunity on the results of such transplantations are also discussed.

In evaluating the results of transplantation experiments for the analysis of the individuality differential, the author classified these into six grades according to the degree of reaction provoked in the host by the graft and, while admitting that the method can claim only approximate exactitude, he regards it as still very helpful in comparing the results obtained if different types of individuality differentials are made to interact.

As regards serological methods, although these have not engaged the practical attention of the author to the same extent as transplantation, they are very fully dealt with in chapters on the blood groups and heterogenetic antigens, the differentiation of individuality differentials by serological methods, idiosyncrasy and anaphylaxis, and the chemical nature of organismal differentials, etc.

There is one point on which the reviewer cannot see eye to eye with the author. He says that, "While the serological tests are especially useful in the analysis of the differentials of groups of animals, such as species, genera, orders, and classes, transplantation experiments are best suited for the analysis of the differences between individuals as expressed in their individuality differentials" (p. 6), and that "serological tests are only under very restricted conditions serviceable in the detection of finer differences" (p. 8). Up to the end of last century this may have been the case, but the discovery of the isolysins by Ehrlich and Morgenroth in 1900, by eliminating species and similar complicating factors, enabled attention to be concentrated on the finer differences, and later work showed that, at any rate in certain species (for example, cattle and fowls), it is possible by means of comparatively simple serological reactions to identify with ease and certainty any one individual out of a large group of individuals of the same species, provided that none of these is closely related, thus demonstrating the extraordinarily delicate nature of these reactions. The objection, that only one kind of cell (the red blood corpuscle) is used, is met by the definition of the individuality differential which postulates the presence of this differential in all, or almost all, the cells and tissues of the individual.

A perusal of the very full and interesting chapter on the chemical nature of organismal differentials will probably convince most readers that future advances in the subject are to be looked for as the result of the efforts of serologists and chemists working in collaboration.

The author concludes with several chapters on more general aspects of the subject, dealing with psychical-social individuality, individuality and the world, and the evolution of individuality. These, however, come more within the sphere of philosophy and are outside the competency of the reviewer.

This book, which embodies the life-work and thought of its author, and includes a critical and almost encyclopædic account of the work of others, will be invaluable to all workers on the subject of individuality and, in view of the wide field covered, will greatly interest many of those working on allied subjects, as suggested in the preface.

C. TODD.

STIMULATING INDUSTRIAL ENTERPRISE

Refrigeration in the Engineering Industry

Pp. xii+69 (typescript). (London: O. W. Roskill and Co. (Reports), Ltd., 1945.) 42*s*.

IT is generally agreed that in the industrial organization which will follow the War it will be necessary for each manufacturer to take full advantage of any technological advances which may be applicable to his particular work. The object of the present report is to help manufacturers of refrigerating plant by pointing out to them some of the fields in which refrigeration can be applied, and conversely to help those engaged in industrial processes where refrigeration would be helpful.

The first suggestion which is offered relates to the maintenance of upper-air conditions in rooms where tests or development of aeronautical instruments, engines or components may be carried out. Here, it is evident that no one wishing to test such appliances under conditions approximating to those which they will meet in service would overlook the need for refrigeration, though it is possible that refrigerating engineers might overlook the special needs, and the potential market, of this application. What the report does is to describe, in not very great detail, the installations which have already been set up for this purpose.

Another application is to the age-hardening alloys. As is well known, after heat treatment, these alloys alter in constitution at temperatures so low as ordinary room-temperature; in many cases it is essential to use them before the age-hardening has taken place, which often means, within two hours of the heat-treatment. Now, by storing them at really low temperature, the age-hardening can be delayed, so that it becomes possible to store the articles for periods of the order of a week. The obvious gain to a manufacturer, who needs, say, a stock of rivets, is immense, if he is relieved of the necessity of matching the supply always to the demand.

There is another metallurgical field in which refrigeration may be of use, namely, in the ageing of iron and steel castings, either by removal of mechanical stresses or by accelerating the changes in constitution which occur when the metal is cooled. There is some divergence of practice in this subject, and the conclusions reached by several workers are outlined in the report. It is noticeable that all the descriptions and references are taken from the work of practical engineers, that of physicists and the more academic metallurgists being ignored. It is probable that more careful consideration of their results and conclusions would either reconcile or explain the divergences of practice mentioned.

The older method of making a shrink fit is to heat the member which is too small until it just fits the other; obviously, where the one that is too large is more easily manipulated, refrigeration can help by providing means of cooling this member until it fits the smaller. Examples of this method are given, and will no doubt suggest other cases to enterprising readers.

This part of the report closes with an account of the attempts which have been made to apply local cooling to welding-electrodes, and of other miscellaneous applications, one of which (the desiccation of air supplied to furnaces) is simply a special application of the problem of air-conditioning, an art which refrigeration engineers have certainly not neglected in the past few years.

The second part of the report reviews refrigeration plants themselves, mentioning what has been done to produce multi-stage machines and to make absorption and cold-air machines practicable. Its value will therefore be mainly to the manufacturer, and less to the purchaser or prospective purchaser of a plant, though the latter may benefit by having this conspectus of types available, and may be enabled to put his inquiries direct to a firm specializing in the kind of machine best suited to his problems.

From this account, it will be seen that the report, while offering suggestions for new work or methods of working, to manufacturers and others, does not make new, original suggestions, but simply displays for consideration the more novel processes or devices already used and described. Clearly this is a legitimate activity for business consultants to engage in, and it is apparently found to be useful, for this is at least the fourth report published by the same firm. At the same time, if these reports are useful, the question presents itself whether a much larger series, covering indeed all the main branches of technology, may be needed, and whether it would be better undertaken as a definite series under the guidance of some such body as one of the engineering institutions.

Chemists already have reviews of this sort, one for pure chemistry and one for applied, while physicists have the "Progress Reports" and the (American) *Physical Reviews*. All these publications find a ready sale, and it is at least possible that similar reviews, in which an engineer engaged in one part of the industry might rapidly survey the advances in other parts, would be equally valuable. Another means by which engineers could be kept in touch with advances in regions other than their own would be an abstract journal, but experience seems to show that engineers are not attracted by these.

If either a journal of reviews or one of abstracts is desirable, it is clearly for engineers to say which they want, how detailed the reviews should be, and how the journal should be directed. It is to be hoped that some responsible body will take up this inquiry. Meanwhile, reports such as the one under review will help to show what could be done.

J. H. AWBERY.

NAMING OF THE REDWOODS

By PROF. J. DOYLE
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A GENERIC segregation of the two redwoods has recently been proposed by Buchholz[1] on grounds to be referred to later. The coast redwood, with obvious priority claim to the name *Sequoia*, remains *Sequoia sempervirens*. A new generic name *Sequoiadendron* has been proposed for the Sierra redwood, long known as *Sequoia gigantea*. Buchholz[1] rejects the possible use of *Wellingtonia* as it was earlier used, though afterwards discarded, for one of the Sabiaceæ and is thus a later homonym. In a later paper Looby and Doyle[2] expressed a general agreement with the advisability of a segregation, though they were not attracted by the choice of the new generic title. Now in many quarters, especially in California, a body of opinion objects to any change in the name of the Sierra redwood, desiring the retention of *Sequoia gigantea*. In a discussion of this subject in *Science*, Jones[3] quotes extensively from this paper by Looby and Doyle as scientific support for the necessity of a segregation and refers to the authors as botanists "who, presumably, may be safely considered free from any motives ulterior to the spirit of scientific enquiry". Having been thus dragged, as it were, on the arbitration board dealing with this vexed question, a further personal statement may be permitted.

This question of the generic segregation of the Sequoias has been in mind for a long time. It was discussed, for example, with Dr. Florin of Stockholm when he visited Ireland in 1938, but at that time the evidence did not seem convincing. It is now definitely and strongly felt that this earlier conservative view was the sounder, that the later agreement with the idea of segregation was a hasty judgment and that the Sierra redwood should retain the name *Sequoia gigantea*.

Dayton[4] has reported the results of a questionnaire sent to a number of Californian botanists and foresters asking for their views on this matter. It is clear that a large majority wish to retain the old name. The objections raised, in most cases, have not, apparently, a strictly scientific basis. They amount rather to the raising of a slogan "Hands off the Redwoods", or an appeal to the Save the Redwoods League. Is the Sequoia National Park to change its name? If there are in future to be no Sequoias in that happy Eden, must it now be called the Sequoiadendron National Park? Such an approach to this question may appear unscientific; nevertheless such objections have a force and a vivid claim to sympathetic consideration from all to whom a tree, and especially a redwood, is something more than a mere name in a catalogue. For these redwoods are not ordinary trees. They are among the world's wonders. They are the possession, not only of professional botanists, but of also every forester and of every tree-lover. It is easy to appreciate the feelings of so many, who, regarding them with reverence and awe, shrink from subjecting them to the cold pedantic analysis of scientific botanists. The point is that, from the replies to Dayton's questionnaire, there is shown to exist a strong human emotional background against which the naming of these trees *must* be viewed. The evidence forcing a change of name must, therefore, be very cogent, and it is the purpose of this short article to submit that there is no such cogency. On the contrary, even apart from this background, even if the Sequoias were little-known plants, familiar to only a few specialists, it is hoped to show that generic segregation, on the basis of the evidence advanced, would be, at least among the conifers, a case of unnecessary splitting.

It may be recalled that Looby and Doyle[5], having emended Lawson's[6] early account of development in *Sequoia sempervirens*, first showed that the proembryo in *Sequoia gigantea* differed from that in the coast redwood. Buchholz[7] afterwards described differences between them in the early embryogeny and followed this shortly by his formal proposal[1] for a generic segregation. In a later paper Looby and Doyle[2] further described many differences in the earlier stages from gynospore to fertilization. This is the paper from which Jones[3] has quoted, and in which a general agreement, now withdrawn, was expressed with the idea of segregation. It is at any rate clear, without delaying on specific illustrations, that, from gynospore to early embryo, there are many differences in development in the two species.

Now the segregation as proposed by Buchholz[1] is, in fact, formally based on certain external features, on six of which special emphasis is laid. But in this paper Buchholz lists also a series of differences between the two under thirty-three headings. Sixteen of these are gametophytic or embryological. Further, certain of the headings are emphasized in italics and *each* of these is claimed to be of *generic* significance. Of such items only six are external features, but ten are features of development. Clearly, although not included in the formal diagnoses, these developmental differences must have considerably influenced Buchholz in proposing the segregation. "These weigh heavily," he says, "in confirming the conclusion that we are concerned here with two distinct genera." I was certainly influenced at the time by these developmental differences, and by these alone.

A little further consideration, however, shows that the use of gametophytic and embryological features as points of generic significance cannot be readily accepted. Obviously such features can seldom, if ever, be employed in the discrimination of fossil genera and, to be of value among living forms, their application to the conifers as a whole must be considered—their significance cannot be limited to the Sequoias alone. If so applied, and if *differences* are significant, are *similarities* to be significant or are such features to be used or ignored at will? Thus, almost all the stages in development, from gynospore to early embryogeny, are similar in *Saxegothæa* and *Podocarpus andinus*, some being all but indistinguishable even in detail. On the other hand, most stages in *Podocarpus andinus* differ from those in *Podocarpus nivalis*. Developmental phases in species of *Phyllocladus* and *Dacrydium* also resemble those in *Saxegothæa* and all, at least up to the early post-fertilization stage, show some remarkable similarities with *Pinus* and *Araucaria* (cf. Looby and Doyle[8]). What is the *generic* significance of such facts as these? There are intergrades in living *Podocarpus* species, between the developmental type of *Podocarpus andinus* and that of *P. nivalis*; but, if *Podocarpus* to-day were only represented by two extreme types, what would the position be? It surely is that gametophytic and embryological features may be of great value in assessing broad relationships and developmental lines within groups, large or small, but their *generic* significance is doubtful and indefinite.

The differences in development which, in fact, exist between the two redwoods may be related to another feature listed but not emphasized by Buch-

holz[1]. Although the chromosome numbers have not yet been exactly counted, it is clear enough that *Sequoia gigantea* is a normal diploid conifer type with $n = 11$ or 12, while *Sequoia sempervirens* is a tetraploid with $n = 22$ or 24. Tetraploidy is rare in the conifers, being only known to occur elsewhere, according to Sax and Sax[9], in one rather rare garden variety—var. *Pfitzeriana*—of *Juniperus chinensis* and probably also in *Pseudolarix*. There may be features in the genic and chromosomic balance of the order unfavourable to tetraploidy. Certainly the constitution of *S. sempervirens* itself seems to be somewhat unstable, as shown, for example, by the great vegetative variability and by the extreme condition of seed abortion which occurs. Commercial samples, collected from natural habitats, may show only 3 per cent of good seed. A strong tendency to sterility appears also at all stages of gametophytic and embryological development, at least under Irish conditions, and considerable variations, amounting to abnormalities, occur frequently at certain phases. It is suggested, therefore, that the gametophytic and embryological features shown by the coast redwood are developments induced by the tetraploid condition and that the species is best considered as a somewhat sterile, unstable and slightly aberrant derivative from a basal diploid *Sequoia* type now represented by *S. gigantea*. It is unlikely in an angiospermic genus that a generic segregation would be proposed if a tetraploid species showed some peculiarities in development.

Since developmental features seem little suited for use as *generic* characters, segregation must be based on external features and, in fact, it is on such features that Buchholz[1] has been forced to make his formal distinction. There is, however, nothing new in the list of external differences drawn up by him. The features cited have long been familiar to systematists such as Torrey, Masters, and Pilger, and differences that failed to impress them cannot be blatantly cogent. Many of these differences are obviously of minor importance. A long list of such could be drawn up between any two species, the length of the list depending merely on the patience of the observer. Points such as variations in wood density, in habit, or in bark appearance can be readily paralleled in any large genus such as *Pinus*. It is not proposed to go over, *seriatim*, all the minor points listed by Buchholz. Reference here can be limited, and then as briefly as possible, to some of the features which he lists as of greatest generic significance and on which his distinction is essentially based.

(1) Buchholz emphasizes that the Sierra redwood requires two seasons to ripen the embryo and seed while the coast redwood requires only one. This, however, is merely another example of a widespread phenomenon in conifers. Forms closer to the basal type show frequently a longer cycle, derivatives and more advanced forms a shorter cycle; and this may be shown within the *family* or within the *genus*. Thus within the *family* Pinaceæ *Pinus* retains a longer, while *Pseudotsuga* shows the shorter cycle; but within each of the *genera*, *Podocarpus*, *Dacrydium* and *Araucaria*, as examples, the same phenomenon occurs.

(2) Difference in form of the cone scales in the two species is emphasized. But the difference is, in fact, slight. It is much less than exists between many species of *Pinus*. It is a great deal less than exists between, say, *Athrotaxis selaginoides* and *A. cupressoides*. These, however, are linked by *A. laxifolia*, the scales of which are nicely intermediate between the other two. If this species did not exist, a stronger claim could be made for the generic segregation of the first two on the basis of cone scale difference than can be made for the two Sequoias. It is of particular interest in this connexion to recall that Chandler[10], in a revision of *Sequoiites Couttsiæ*, describes considerable variation in cone scale form. The same specimen may show thin imbricate scales, strongly peltate scales and many intergrades. Thus this well-known fossil type may show, in *one* specimen, greater differences in scale form than those which are claimed to be of *generic* importance in the living types. Further, even a small collection shows some variation in cone scale form in both the living redwoods. It is therefore worth while noting, in view of the great variability shown by *S. sempervirens* in its foliage, that it is not clear whether the slight difference in cone scale form is in fact constant over a wide range of types and habitat.

(3) The ovules and, later, the seeds are stated to be more numerous and in a double row in *S. gigantea*, but fewer and in a single row in *S. sempervirens*. But even Buchholz[1] himself states that this is not constant. He gives 3–7 as the ovule number in the latter species and 3–12 in the former. What then of forms with 5 or 6? A few minutes' dissection of young cones shows, in any event, that scales of *S. gigantea* with 5 or 6 ovules may show no doubling, while in scales of *S. sempervirens* with 6 or 7, some of the ovules are commonly out of place, forming an incomplete second row. Buchholz further gives the seed number as 2–5 in a single row for *S. sempervirens* and 3–9 in a double *or single* row for *S. gigantea*. It is difficult to see how a character which may show such wide variation and such a degree of overlapping can be used as a generic character.

(4) The foliage differences, including the leaf dimorphism of *S. sempervirens*, are emphasized. But it is surely common knowledge that much wider foliage differences are tolerated in other genera, *Podocarpus*, for example. If it be objected that the present *Podocarpus* should be split into a number of separate genera, must we then generically segregate *Araucaria Bidwillii* and *A. balansæ*? The foliage difference between these is wider than that between the Sequoias. And what of the junipers? Buchholz refers to the foliage of *S. gigantea* as "juniperoid". It is not clear, however, what is meant by that term as there are to be seen, in *Juniperus*, flat linear leaves with an abrupt peg-like base recalling the spruces, similar leaves with a green decurrent base, smaller acicular leaves close to the stem, closely adpressed cupressoid leaves and a whole series of intermediate types—the extremes much wider apart than in the Sequoias.

In regard to leaf dimorphism, it is again common knowledge that many conifer genera include species with only one leaf form and species showing leaf dimorphism of various types. This is well shown by the podocarps and araucarians. Thus *Araucaria Bidwillii* shows dimorphism, but the foliage of *A. araucana* is practically uniform. *Podocarpus* and *Dacrydium* both include species with only taxoid or only cupressoid foliage and species showing varying degrees of dimorphism. Thus *Dacrydium Kirkii* may carry, on the same branch, flat taxoid leaves up to 1½ in. long and densely imbricate cupressoid leaves averaging only 1/10 in., and the transition is abrupt. Other species of *Dacrydium* are less spectacular, but these dimorphic types are not generically segregated *on that basis*; rather they help to link up the purely cupressoid and purely taxoid types. *Podocarpus dacrydioides* also bears cupressoid and taxoid foliage,

the two types grading somewhat. The taxoid type is essentially juvenile, but considerable foliage mixture occurs on older branches. Specimens may, however, retain completely the taxoid foliage for periods up to a hundred years, dependent on habitat and environment, so that full-grown coning examples of the same species in the same locality may appear very different and at least as distinct as the two Sequoias.

The occurrence, in *S. sempervirens*, of branchlets of a giganteoid type and the fact that some specimens, especially on freely coning branches, may carry almost as much giganteoid as taxoid foliage suggest, then, that the leaf dimorphism can be considered a linking rather than a separating character. This is not the place to survey fully the vegetative features of the coast redwood, but one further comment may be made. Possibly in relation to a polyploid instability it is one of the most variable of conifers. No *one* specimen can possibly be selected as the *type*. It would need many herbarium sheets to illustrate the manifold variations which may quite commonly occur. It is then remarkable that Buchholz[1] lists as *typical characters of generic importance* features of the taxoid leaves which are *not* to be found in *any living* material here available and which are not recorded in any of the better-known descriptions and drawings. The leaves are said to be scythe-shaped and petioled with prominent midrib and revolute margins. If these features do occur on fresh material and were not described from dried specimens only, they cannot be characters of the type, but serve merely to extend the range of variability within the species.

(5) The buds of *S. sempervirens* are said to be scaly and those of *S. gigantea* naked. The meaning of the term 'scaly' is not quite clear, as it is obvious in winter that the dormant terminal apices of *S. sempervirens* are not covered with highly specialized bud-scales like a spruce or a fir. Anyone not familiar with the redwoods, however, could easily get the impression from this statement by Buchholz[1], and from others in the literature, that the 'buds' of *S. sempervirens* are rather specialized structures and quite different from those of *S. gigantea*, whereas, in fact, the basal structure of the apices of branchlets and twigs is essentially the same in both. As the commonly available accounts are rather inadequate, this point needs, unfortunately, more lengthy comment than the others.

A certain common plan of construction can be seen in many conifers—*Cryptomeria*, *Cunninghamia*, species of *Araucaria* and many others. Irrespective of the type of foliage, a number of the leaves at the end of a current twig in winter can be seen to be smaller, closely imbricate, and commonly of a modified and reduced form. The most terminal, which may be slightly more modified though grading into those behind, cluster closely round and protect the dormant apical meristem and the young leaves of the next season already organized by it. These outer protecting leaves themselves grade into the inner protected ones; the whole is thus a simple bud. We have here just a cessation of growth with protection given by the last-formed modified leaves of the previous year. On resumption of extension growth in spring the group of small terminal leaves is left behind as a special zone at the base of the elongating twig, and these zones, scattered along the branches, indicate the sites of the winter rest. Their distinctness depends on the relative size of the adult leaves. In *Araucaria Bidwillii* longer zones of linear pectinate leaves alternate with the shorter clustered zones, while in *Cryptomeria* and many of the small-leaved species of *Araucaria*, in view of the more compact foliage, the sites of the winter rest are less obvious or even only to be found by close scrutiny. In cupressoid forms the distinction scarcely exists.

The Sequoias show a similar plan and similar differences. The contrast between the zones of linear pectinate leaves and short imbricated ones is commonly very obvious in *S. sempervirens*, whereas close scrutiny is needed to locate the sites of winter rest in *S. gigantea*. Incidentally, since the coast redwood shows such great vegetative variability there occur also, as might be expected, variations in bud organization. It would take a long descriptive account to explain adequately the nature of these and this is not the place to deal with them. Suffice it to say that such variations are slight or rare or mainly affect bud location. *Typically*, however, the structure of the terminal apices is essentially similar in both Sequoias and quite in accordance with the plan outlined above, so that it cannot be said that one shows scaly buds, *in winter in the open*, and that the other does not. Of course, there may be differences, often marked differences (in detail ; identity can scarcely be expected in two very distinct species. But often, as in the frequent case in *S. sempervirens* of short lateral branchlets closely covered with densely imbricate reduced leaves, the structure of the apex, as well as the appearance of the whole branchlet, may be so strikingly similar to corresponding branchlets of *S. gigantea* that careless scrutiny could confuse small detached specimens.

The coast redwood, however, shows the peculiarity which has probably earned for it the reputation of having 'scaly' buds. The terminal group of small modified leaves, left behind on the resumption of extension growth in spring, may gradually wither and become brown so that the base of each branch may be encircled with a cluster of thick brown leathery scales. A few points in connexion with this are of interest. The withering and browning, in the first place, are gradual—a matter of weeks or months. In the second place, though common, they are not necessary or constant. Examination of almost any specimen will show cases, often quite frequently, in which some or all of these modified terminal leaves remain permanently green. Further, the browning is not limited to the most terminal of these leaves, to those that cluster immediately round the resting meristem and which might be considered bud scales proper. Those back along the stem, for a distance which is usually short, but which may extend to as much as an inch, turn brown also. It would appear that a certain number of the last-formed modified leaves of the previous growth, those fairly mature, exposed, and attached to a stem zone which will not elongate in spring, may turn brown. Those not matured in the previous growth, protected by the outer older ones, and attached to a stem zone which will show extension, expand as foliage leaves. Needless to say, the delimitation is not absolutely sharp, and many intermediate stages may be seen in spring.

Thus it is not a question of one type having 'scaly' buds and the other 'naked' buds. In both we are dealing with similar buds of a simple construction and of a relatively common type. The point is merely that in *S. sempervirens* a number of the terminal modified leaves of the previous growth may or may not turn brown in the course of the succeeding season. This unstable feature scarcely seems sufficiently weighty to necessitate a generic segregation, especially

as within *Juniperus*, *Podocarpus* and *Dacrydium*, in relation to their wide variation in foliage type, a much wider range of differences can be met with in the structure and behaviour of branch apices. Anyone with access to a collection of junipers, to take one case, will find species with well-organized buds protected by definite and distinct bud-scales which may be deciduous; species with a later browning, like that of *S. sempervirens*; species that behave like *Crytomeria* or *Araucaria Bidwillii*; species with only a slight difference in foliage around the sites of dormancy; species showing a cupressoid habit with no distinct break between successive years' growth; and many intergrades. If the intergrading species disappeared and if *Juniperus* was now represented only by *J. oxycedrus* and *J. virginiana*, these, on the basis of leaf habit and bud type, would have a greater claim to generic segregation than the two Sequoias. Fortunately, however, the intergrades do exist.

Clearly, one of the many phases of vegetative development shown in *Juniperus* is the organization of fairly specialized buds. To anticipate comment it may be mentioned that some of the *S. sempervirens* variation types show a tendency in this direction, though this appears to be rare. Young shoots however, arising after felling, show the simpler type of bud.

(6) Buchholz[1] also states, and considers it important, that in the coast redwood the cone matures, browns and sheds seed within the year, while, in the Sierra redwood, the cone remains, for a number of years, green, attached to the tree and retaining its seeds. Actually the difference between them is less than would appear from this statement; there is a difference of degree only and not of kind. In *S. sempervirens*, at least under Irish conditions, the cones begin obvious growth from the bud in November, the matured cones shedding their seed late in December of the following year or even not until January of the next year still. Thus from onset of growth to shedding of seed may take up to fifteen months, after which the cones remain attached to the tree for a further couple of years. In *S. gigantea* visible growth from the bud begins in March, and the cones open to shed the seed any time after the third succeeding December, full maturing being thus spread over from $2\frac{3}{4}$ to about 4 years. During this period they gradually darken and harden. But at any time after the maturing of the seed, late in the second autumn of growth for example, cones, brought indoors and kept dry and warm (60° F. or less), will open the scales and become brown within about ten days. Maturing cones of *S. sempervirens*, brought indoors about the same time while still dark green and closed, take, surprisingly, nearly as long to brown and open. The physiological difference between the two does not seem considerable. It would be of interest to relate the behaviour of the two redwoods to their very different ecological habitats and to determine, under natural conditions, the actual factors controlling the shedding of seed in relation to the age of the cone and the like. It is suggested, however, that the important point in the cone behaviour of the two species is probably the ecological one of the longer seed retention by *S. gigantea* and that the slowness of the changes in its cone advancing to maturity, changes which can be so hastened by drying, are physiologically related to this. Whatever its biological interest, however, the behaviour difference seems generically a minor point, comparable to the fact that, in many of the larger genera, the leaves may persist on the stem for greatly varying periods. But, even if the difference were more fundamental than it appears to be, the relatively longer retention of seed by *S. gigantea* is, in any case, paralleled elsewhere in the conifers and the point *not* given generic significance. Such a retention is well known to be characteristic of many species of *Pinus* and is also seen in species of *Cupressus*, *C. torulosa* shedding both seeds and cones at seed maturity while *C. macrocarpa* may retain the seed for years, its cones gradually darkening and hardening.

In addition to these comments on six of the features most heavily emphasized by Buchholz[1], a few words are necessary on a very important consideration not referred to by him. If this generic segregation be made between the two living types, what then is to be done with the fossil nomenclature? What meaning in future must be given to *Sequoiites*? Or must there be two fossil genera *Sequoiites* and *Sequoiadendronites*? And how are the known fossils to be sorted between the two? Take, for example, the well-known *Sequoiites Couttsiæ*. Its foliage, using the criteria of Buchholz, would bar it from *Sequoiites*, and its cone, apparently, would bar it from *Sequoiadendronites*. Must we straight away found a new fossil genus for it? That way lies chaos. This again is scarcely the place for a survey of the relations between living and fossil Sequoias; but looking, without any special bias, at the fossil record as a whole, surely it is simplest, with our present knowledge, to take it as it appears to be, namely, the record of a widespread genus with a good range of form in foliage and cone; and it is surely simplest, for the present, to consider the two living redwoods as two surviving species, showing naturally certain marked differences, but differences within the gamut of the fossil range.

It is claimed, therefore, from this cursory survey, that against the background of intense human interest associated with the redwoods, there is no real evidence for a generic segregation. Ignoring the fossil record, as it does, the proposal appears based on the overemphasis of points, long known to systematists and not of fundamental significance. The points of difference brought forward are either variable and intergrading or points which are definitely *not* given generic significance elsewhere in the conifers, even though shown in a more extreme condition. If the segregation of the two Sequoias is admitted on this evidence, such criteria must be applied to the conifers in general, and then a wholesale splitting of other genera must straightaway be made. Such splitting would affect, for a beginning at least, *Araucaria*, *Dacrydium*, *Juniperus*, *Podocarpus*, *Pinus* and possibly *Abies*. The logical issue might be, at the last, the institution of a separate genus for each species even reasonably distinct from its fellows.

Let us, then, leave those sentinels of the Sierras, the General Grant, the General Sherman, the Four Guardsmen, and the others, to stand watch in the centuries to come under a banner with the old familiar inscription—*Sequoia gigantea*.

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GEOLOGY OF THE PUNJAB SALT RANGE

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MY first contribution to the discussions on the age of the Saline series or Salt marls in the Salt Range, both in the Punjab and in the trans-Indus area in Kohat, was published in 1928[1]. Since then, several important papers on the subject have been published, by Messrs. D. N. Wadia, L. M. Davies, G. de P. Cotter, E. R. Gee, and others. These have been very ably summarized by Dr. W. D. West in a paper entitled "Some Recent Advances in Indian Geology: The Geology of Salt Range"[2]. In the meanwhile, Mr. E. R. Gee has completed his seven years careful and systematic mapping of the Punjab Salt Range and its continuation across the Indus into the North-West Frontier Province. He, in 1939, finally arrived at the conclusion that the Saline series or Salt marls occupy a stratigraphical position below the marine Lower Palæozoic strata and should be regarded as pre-Cambrian in age. Now quite recently Prof. Birbal Sahni and his co-workers in palæobotany at Lucknow have announced the discovery of abundant microfossils in the Salt marls[3].

In the above-mentioned contribution Prof. Sahni writes: "Fossils found in the Saline Series in recent years have repeatedly suggested that the beds are early Tertiary or even younger. But the value of the evidence has been questioned. . . . In view of these objections, I collected . . . some lumps of rock-salt with intercalated thin laminæ of saline earth or 'kallar' from positions deep within the salt mines, with the view of examining the kallar for possible microfossils. . . . The investigation of this material has given results beyond all expectation: the bands of kallar must be teeming with signs of life; for every single piece has yielded microfossils. . . . The great majority are undeterminable as to genus and species, being mainly shreds of angiosperm wood, but there are also gymnosperm tracheids with large round bordered pits, and at least one good, winged, six-legged insect with compound eyes. These facts suffice to prove that the Salt Marl of the Punjab cannot possibly be Cambrian or pre-Cambrian as suggested among others by Dr. Murray Stuart, Sir Cyril Fox, and now also by Mr. E. R. Gee, until recently a strong advocate for the Eocene view. . . ."

No one has, nor will, question the importance of these discoveries now recorded by Prof. Sahni—the presence of abundant microfossils in the kallar or red saline clay, which is found associated with the rock salt in the cis-Indus mines, but appears to be absent or rare in the trans-Indus exposures. It is quite another matter where the interpretation of these facts is concerned, because the meaning of the term *in situ* needs explanation in relation to original sedimentary deposition, as will be discussed later. Dr. Sahni's communication conveys the impression that the microfossil assemblage is younger than Lower Tertiary (Eocene), the age which is usually ascribed to the Salt marl by those who have supported the idea that the Saline series is of Tertiary age. In view of Mr. Gee's mapping and the Lower Palæozoic to pre-Cambrian age which he has been obliged to admit, the question for the present must be how these Tertiary microfossils have found their way into beds which lie below those with a marine Cambrian fauna and are considered pre-Cambrian in age. It is to be remembered also that Mr. Middlemiss was so struck with the unaltered condition, both dynamically and chemically, of these Lower Palæozoic formations in the Punjab Salt Range that he compared them with the pages of a volume fresh from the binders' hands.

Mr. Middlemiss' original remarks are well worth reading[4]. Although so old, the original sandstones, shales and limestones remain as such and have not been converted into quartzites, slates or marble as is the case with equivalent strata in the Himalayas. Nor are these beds in the Punjab Salt Range found folded or even severely buckled in any widespread kind of way such as is common in regions of orographic mountains, as those in the trans-Indus area of the North-West Frontier. Beneath these unaltered Palæozoic strata lie the plastic and soluble deposits of rock-salt and saline marl (kallar) of the Saline series, and above the Palæozoic strata there are younger formations successively upwards to Lower and Middle and Upper Tertiary (see section given in Dr. W. D. West's summary[2]). In the exposures seen along the scarp of the Punjab Salt Range the salt marl are the most disturbed where, as might be expected, such plastic material is able to escape outwards from under the weight of overlying strata; and the overlying formations are seen to be tilted as though by block-faulting and, in places, have sunk into the marls (see ref. 1, plate 9). In other places there are evidences of subsidence by the actual solution of the salt, as occurred in Khewra village in 1925, when it was found that a spring of water was removing salt in solution at the same rate as organized mining was producing salt for the Government of India.

At Pidh, on the Dandot plateau of Nummulitic limestones, the drainage is enclosed and sinks underground; and the water presumably carries some silt and such material in suspension with it. No details of the movements of such waters, or of the material they carry, have been made known; but there is very little doubt that such an investigation will yield interesting and perhaps surprising results, both as regards the salinity of the water and the material carried in suspension at different stages of its journey. Indeed, it is quite well known that pieces of wood and even the trunk of a tree (of a type now found growing on the hill slopes) have sunk down so-called 'swallow-holes', and are met with embedded in the solid rock-salt as though by movements akin to regelation. The kallar itself was thought, by Dr. W. A. K. Christie, Dr. Murray Stuart and myself, to represent the insoluble residue which is left when rock-salt has been dissolved and removed in solution[5]. Indeed, it is not uncommon to see 'pipes', which are filled-up sink-hole channels, down which water came but which were later choked up with transported solid residue or saline red clay very similar to kallar.

So long ago as 1878, when writing the official opinion of the geology of the Saline series, which were then regarded as probably Infra-Silurian (in the Murchisonian sense that the Silurian included the Cambrian), Dr. W. T. Blanford wrote as follows[6]:

"Owing to the softness of the marl, and to the tendency of harder rocks to slip upon it whenever it is sufficiently saturated with water, to destroy its coherence, and also to the salt beds being dissolved by water, the rocks of the Salt Range are broken and mixed up in a most complicated manner, masses of the marl having been squeezed by pressure in places into a position in which they appear to overlie more recent rocks, while all the newer formations are

cracked and faulted. The detailed geology of the range is consequently very intricate, and it is not always easy to tell whether dislocations of the strata are due to true faults traversing all the beds, inclusive of the salt marl, or whether the displacement is merely due to complicated landslips".

Dr. Blanford did not comment on the exceeding solubility of rock-salt (20,000 times that of limestone) or on the extreme plasticity of the saline marl, but these factors are thoroughly well known to-day; and will be appreciated by those who know the solvent effects of water on limestone—the various grottoes and caves, the removal of a bed of limestone beneath coal-bearing strata at Cherrapunji (Assam), the formation of bauxite (*terra rossa*) in the *dolinas* of Istria, etc.

Those who have a good knowledge of the probable depositional conditions—climates and land distribution—in the various geological epochs since Lower Palæozoic era in the Indian region are well aware that an arid period almost certainly prevailed when the Upper Vindhyans and their equivalents in the Salt Range—the Purple Sandstone—were laid down in early Cambrian or pre-Cambrian times, which, according to Mr. Gee, and those of us who have held the same opinion previously, was soon after the rock-salt deposits had formed in the Punjab area. These desert conditions and marine associations were widespread at that early epoch of the historical geology of India and adjoining countries to the west, so that there is nothing improbable about the geographical aspects of a pre-Cambrian to Cambrian age for the Punjab rock-salt occurrences. On the other hand, there is little such evidence in support of an Eocene age for these deposits, and my own special studies of the coalfields of Baluchistan, the North-West Frontier Province, Kashmir, the Punjab and Rajputana can find no epoch when marine and climatic conditions could favour the deposition of salt on a considerable and widespread scale. Better possibilities may have existed in middle and upper Tertiary times, but so far as I know there has been no one who has claimed a younger age than Eocene for the rock-salt deposits of the Punjab or of the trans-Indus area. It is difficult to conceive of such conditions over the Salt Range area of the Punjab in middle Tertiary times and more so for such an upper Tertiary epoch, geographically at least.

The problem, therefore, seems to be to discover how the microfossils, found by Dr. Sahni and his co-workers in the Punjab Salt Range, have been carried into the Salt Marl or Saline series which are regarded as Cambrian to pre-Cambrian in age. Also, and this is a similar problem, how it is that Messrs. P. Evans and M. A. Majeed were able to show that the heavy mineral residues, from samples of the Salt Marl, agreed most with the results obtained from Tertiary strata. I have not seen these results and do not know with what Tertiary strata the Saline series would be correlated on this kind of evidence. I have had the reliability of the heavy mineral assemblages tested by obtaining samples of sand from the Damodar—in its upper waters, at several places on its course through the coalfields and finally where it enters the Burdwan alluvial plains—and found that the proportions of certain heavy minerals were remarkably persistent. This may thus suggest the idea that the streams flowing underground to the Salt marl may have carried heavy minerals down with them with the same persistency of proportions prevailing as those in the rocks from which the water derived its heavy minerals. There may thus be no evidence to prove that the Saline series are of the same age as the residues, from residues found in the rock-salt deposits. I suggest that the same argument applies to the microfossils. Incidentally, full details are not yet available of these microfossils, and a great deal more has to be done, such as a search for similar remains in the Tertiary strata of the Salt Range.

A small field committee consisting of Dr. H. Crookshank and Mr. E. R. Gee of the Geological Survey of India, with Dr. E. Lehner and also Messrs. E. S. Pinfold and J. Coates, geologists of the chief oil companies in India, are, at the time of writing (November 7, 1944), in the Salt Range to re-examine all the critical geological sections. They will no doubt give the subject of Dr. Sahni's microfossils and Mr. Evans's heavy mineral assemblages the most careful consideration [see p. 266 of this issue of *Nature*. Eds.]. They are also unlikely to leave the question of the gypsum unattended to; but in this connexion I would say that the conversion of limestone into gypsum is not a remarkable phenomenon if the necessary conditions are favourable and a decomposable sulphide, such as pyrite, is available. The gypsum is, of course, a secondary product whatever might have been the age of the original materials involved—limestone and pyritiferous coal as an example. It is very likely, indeed to be expected, that a careful examination of the gypsum for microfossils and heavy minerals would provide evidence as to the age of the original substance, for example, limestone. It does not follow that this method of determination will fix the age of the strata in which the gypsum occurs, because the limestone (if so proved) might have been xenolithic. For example, it may be in other strata than those belonging to the beds in which the limestone was deposited and in which it was originally truly *in situ*.

In contrast with the absence of tectonic folding in the strata above the Salt marl in the Punjab Salt Range, as around Khewra and Dandot, the beds associated with the rock-salt in the trans-Indus areas are characterized by folding. Highly inclined beds with evidences of synclinal and anticlinal structures are common. Indeed the rock-salt occurrences appear to be normally found in faulted anticlinals in this Kohat region. It is just the position in which a plastic substance might be expected if it had been squeezed up from below by the dynamic forces of folding. The salt certainly appears to have been extruded upwards by great tectonic pressure, and shows evidence of this in its own texture. From a distance of only a few yards the rock-salt can often be mistaken for gneiss, as it possesses a gneissose structure; it is thus entirely different from the rock-salt in the Punjab, which appears to have escaped this degree of dynamic force. This is in general agreement with other observations. The trans-Indus region is closely involved in the orographic mountain ranges of the Indian borderland, while the Punjab Salt Range can scarcely be claimed to possess any orographic axis and is largely the southern scarp of a plateau region. It is for this reason that the supporters of a Tertiary age for the Salt marls have usually invoked an almost flat plane of sliding for the superincumbent strata. It is needless to say that over-thrusting for twenty miles or so in a region evidently devoid of serious folding has always been a mechanical defect in such explanations.

It must therefore be recognized that the two regions—the *cis-* and the *trans-*Indus—are orographically different, although one passes almost insensibly into the other. For this reason the rock-salt

has behaved differently under tectonic squeeze—which was very severe in the trans-Indus area and almost absent in the Punjab area. The salt deposits are probably of the same age—laid down in Cambrian and pre-Cambrian times. They were protected by overlying strata until comparatively recent times, when erosion in the Punjab area and dynamic folding in the Kohat region have disclosed these valuable deposits, which have been preserved for us since the Lower Palæozoic age. The treatment of the plastic salt in the folded strata will fully explain how it escaped upwards along a fault into an anticlinal; also how it was carried upwards or became entangled with newer strata—nummulitic limestone, oil shale or pyritiferous coal; and further, how when conditions and material were favourably disposed, gypsum has formed—from the included or xenolithic fragments in the rock-salt or adjacent to it in the strata from which the xenoliths were derived. The *modus operandi* in the Punjab area was somewhat different; it consisted of subsidence by solution and transport by underground water, whereby blocks of stone, tree stems and other derived material (such as microfossils and heavy minerals) have become embedded in the salt and in its insoluble residue (the kallar) in the Saline series of the Punjab areas. In neither case, however, *cis-* or *trans-*Indus, are these incorporated materials strictly *in situ*, and thus any gypsum formed from such derived material is, so to speak, truly *tertiary*, but in a *primary* setting.

In conclusion, I would like to quote a few lines from the last report submitted to the Government of India by Mr. H. B. Medlicott, director of the Geological Survey of India, before he retired in 1886[7]. He wrote:

". . . The geologist's work is therefore sound and useful or false and misleading in proportion to his real acquaintance with the actuals and the principles of the exact sciences, and unless he reaches a certain standard of excellence his work is absolutely useless, or worse. In this respect the geologist is unique. A doctor may acquire a useful skill in the practice of medicine without being anything of a biologist: an engineer may do fair work with little or no knowledge of mechanics; a man may be a surveyor . . . without any proper knowledge of geodesy or astronomy: because in all these businesses there are practical rules by which ordinary work can be safely executed. . . . Geology is the opposite of all this: there is no operation called for: every act in its service is an independent judgment upon very complex inductive facts through an accurate knowledge of physical phenomena and their laws; if not scientific it is nonsense. Further it is to be noted that the data upon which the geologist has to frame his judgments are for the most part very scanty: from occasional scattered sections or single outcrops he has to attempt the representation of the rocks as they lie underground and their remote history. Thus, though based on the exact, it is itself the most inexact of sciences, and eminently demands conscientious and sober judgment. There is no science with which it is so easy to acquire a superficial acquaintance and to play the impostor. . . ."

[1] See *Rec. Geol. Surv. India*, **61**, Pt. 2 (1928), pp. 147–179, with plates 2–17 showing various views of plastic marls, tilted strata and subsidences.
[2] *Current Sci.*, **3**, No. 9 (March 1935).
[3] *Nature*, **153**, 462 (1944).
[4] *Rec. Geol. Surv. India*, **24**, 19 (1891).
[5] *Rec. Geol. Surv. India*, **44** (1914); **50** (1919).
[6] "Manual of the Geology of India", Pt. 2, Extra-Peninsular Area, p. 487 (1878).
[7] *Rec. Geol. Surv. India*, **20** (1887), Annual Report for 1886, p. II.

SCIENCE IN PEACE

THE most striking characteristic of the open conference on "Science in Peace", organized by the Association of Scientific Workers at Caxton Hall, Westminster, on February 17 and 18, was neatly expressed by Prof. J. D. Bernal in his final summing-up of the Conference. The content of the fifteen papers submitted in three sessions devoted respectively to "Science and Production" (chairman, Prof. P. M. S. Blackett), "The Future Development of Science" (chairman, Sir Robert Watson-Watt) and "Science in Everyday Life" (chairman, Prof. H. Levy) had, he said, had the quite remarkable quality of having been 'orchestrated'. An account of the whole opus will accordingly be attempted here, not by separate discussion of the component movements, but by tracing the *leit-motiv* which recurred so clearly, inevitably and appropriately through all. They are all familiar themes enough; but their interrelations took new emphasis, and their combined intellectual and emotional appeal was profound. They were expansion, investigation, documentation, publication (the key theme in some expected and some less expected contexts), organization, integration, mechanization, standardization, nationalization.

The Conference opened appropriately with a paper on "The Future of British Economy", by G. D. N. Worswick, and closed equally appropriately with one on "The Place of Science in Culture", by Prof. B. Farrington. The whole argument of the Conference was necessarily based on an expansionist economy providing full employment; the practicability of continuous full employment is in large measure governed by the full utilization of science, including the scientific control of processes; on the other hand, potentially revolutionary applications of science in industry are only acceptable to the workers if their justifiable fears about continuity of employment are categorically answered by a declared Government policy for assured and continuous full employment. The honouring of such an assurance depends on giving to the public interest its rightful place relative to private interest, and this in turn can only be assured by a substantial measure of Government control. No point made was more heartily applauded than the statement that bureaucracy is far more prominent and harmful in the larger aggregations of 'private' enterprise than in Government departments. Government control, varied and adapted to the needs of public interest in application to each main industry, must be control by the people acting through a democratic government in the interests of the people. The overall success of government control in the greatly expanded industry of the war effort was cited as an augury for the future.

The paper by Mr. Joe Scott, member of the Executive Committee of the Amalgamated Engineering Union, on "Science and the Productivity of Labour", emphasized the role of science in improving the conditions of life of the worker while at work and at leisure, in lightening labour and improving the use of leisure, in avoidance of injury and improvement of health. He stressed the inseparability of science from production; it was another of the recurrent themes of the Conference that we are no longer dealing with separable applications of science to industry; that we are now at a stage where scientific method should be inherent in every step of the industrial process, where the permeation of science through the whole of industry is a happily

irreversible process preventing the picking out of samples to be exhibited as 'science in industry'. This permeation of process demands a corresponding permeation of organization, in which the place of scientific work in the national economy is recognized and ensured by detailed interlacing in an industrial democracy, at all levels and in all significant groupings. An important element in this permeation is a much closer co-working with the trade unions, individually and collectively.

Mr. Scott introduced the two themes of investigation and documentation, with examples of welfare and health investigations, which could not have been carried through save by the machinery of the trade unions and shop stewards; and, from another angle, with a plea for direct availability to trade union negotiators of the scientific and technical facts which they require to support and answer statements made in negotiation.

This was one aspect of a universal demand for public availability of the facts—many already known privately, many not yet known even to managements in private enterprise—by which the efficiency and potential of any stage in the industrial process can be measured. The filling of the gaps in private and public information is essential to progress, and involves the large application of the methods of operational research within industries. There is need, indeed, not merely for organized research but also for research on organization; the appropriate structures for scientifically operated and publicly controlled industry are still in large measure unknown or ill-understood.

The demand for publication as a safeguard of the public interest was pressed at every session and thus in many different connexions. If it were necessary or desirable to condense in four words the essence of the discussion on "Science in Everyday Life", the words might well be "Publish and be Blessed". Full and free interchange of knowledge not only from scientific research, but also from studies on organization, not only on engineering efficiencies but also on economic efficiencies, 'all facts on the table' was regarded as essential to increased productivity, to improved conditions of life, and to the avoidance of diversions in favour of private interests.

"The Organisation and Finance of Science" were discussed by Dr. S. Lilley, who argued the case for the Association of Scientific Workers policy in favour of a national research and development council, responsible to the Lord President of the Council, for surveying national needs and resources and planning the broad lines of scientific work to meet the needs and develop the resources. The Council would plan the strategy of attack on these problems; it would neither execute the work in laboratories of its own nor interfere in the tactics of work in the laboratories, of existing types, to which it would allocate broad responsibilities and adequate finance. Expenditure at the rate of some twenty-four million pounds per annum, as compared with our pre-war seven million pounds per annum, it was stated, is required; a great expansion of laboratories would be needed; the research associations would be key factors in the plan, and no industry would be allowed to stifle co-operation by the withholding of financial contributions; the naïve form of subsidy-without-supervision represented by tax remission on alleged research should not be permitted; publication of results would be insisted on. The new organization would require the participation of the representatives of the people in general, and of the scientific worker in particular, at all levels in the formation and execution of policy.

An important part of the problem of the deployment of our scientific forces is the striking of a balance between long-term fundamental work and short-term work of direct and immediate application. The chairman of the session on "The Future Development of Science" described the problem as one in the "intellectual economics of the social conscience"; Prof. Blackett emphasized the high long-term productivity of fundamental science, which must pass from its old state of self-determination towards an imposed orientation arising from increased direct support from public funds. This fundamental science must be guided by men of science, acting under broad directives on social objectives coming not from a bureaucratic Civil Service but from public opinion through Parliament and the Government answering to Parliament. An important part of this direction must rest on the economic policy adopted by the nation; there is virtually no limit to what science can do; there are limits set by economics on what it is worth doing, for example, in developing synthetics and substitutes as an alternative to importing. A short-term crisis, such as the present War, is the only exception to the law which forbids the sacrifice of the big future dividends offered by fundamental research to the smaller quick returns of too closely applied development.

Both Sir Robert Watson-Watt and Prof. Blackett directed attention to the need for a federation which could speak with the voice of the scientific practitioner at large; on a wider basis than the highly selective Royal Society and the highly specialized professional institutions; including the Association of Scientific Workers, with its vitally important trade union affiliation, but not excluding those who do not recognize that affiliation as necessary or desirable.

Prof. Bernal, in his contribution on the future development of "Applied Science and Technology", carried the development of the theme of 'organization' into the enunciation of the theme of 'integration'. The application of science is the practical side of the war against poverty and calls for the same spirit and intensity of organization as the current War. The revolution in the relations of science to industry is now far advanced; the essential now is the complete integration of science with industry; the dual problem is to make industry scientific through and through, and to make this possible by demonstrating to the public the need for this permea tion and integration. The public has still far to go in appreciation of the need: it is still merely 'gadget-minded'.

This integration demands the full democratization of science in industry; democratization is far less advanced in industry than in politics. One necessary element, that of public criticism, is provided in the political sphere by Parliament; it could be provided in the sphere of industrial science by trade union organization. Only the scientific worker can determine the mode of application of science in industry; for this he must sit in the board room of management for the formation of policy, he must equally find his place in the joint production committee.

Integration, as was shown in those contributions to the first session which dealt with the basic industries of Britain, must be carried over the whole area of each industry and across the frontiers between industries; the separation of the generation of gas

from the generation of electric power and of both from the full utilization of coal is as artificial, irrational and wasteful as is the treatment of the coal industry as something apart from the chemical industry, of which coal is the very foundation.

Discussion on the coal industry was the most important single development of the mechanization theme, and it led to the conclusion, not from any devotion to nationalization as a good-in-itself, but from lessons in the long unhappy history of that industry in particular, that mechanization in coal-getting would not be attained without governmental control so firm and detailed as to mean nationalization. The inapplicability of any such simple prescription as 'American machinery everywhere' was recognized; but there was a clear conviction that a plan of mechanization measured to the geology and the degree of past working is of extreme importance.

The discussions, which brought in variations on the theme of mechanization, interwove it so intimately with the theme of standardization that an answer to criticisms of 'dullness through standardization' was specially important. It was pointed out that general availability of the products of industry depends on the wide extension of mechanization, that mechanization can only be reasonably effective if the production runs are long runs giving large numbers of one pattern, and that consequently the total number of patterns available to the total field of consumption would be reduced. This does not, however, mean that the average consumer, with limited purchasing power, has a reduced range of available patterns. He would, in fact, have access to a wider range of better models, brought within his reach by the economies in cost attained through mechanization.

The Conference was made notable by the resumption of personal international contacts on a scale only now becoming possible as the war situation improves. The Sunday morning session was marked by the enthusiastic reception of addresses by Dr. Marcel Matthieu, a member of the executive committee of the French Association of Scientific Workers, and by Prof. A. Danilov, chairman of the U.S.S.R. trade union covering scientific and ancillary workers in the laboratories of the universities, the academies of science and the research institutes. Prof. Danilov was accompanied by four other Soviet colleagues; it was noteworthy that the Soviet delegation to the World Trade Union Congress meeting in London included three scientific workers.

The Conference adopted at its closing session a resolution in the following terms:

"This public conference which has met to consider the tasks of science after the war, records its wholehearted admiration of the fighting forces of the United Nations whose great achievements are bringing peace nearer at hand. Their deeds are providing the foundations for a better world while the advance of science and technique are the tools with which it can be built. This conference declares its conviction that:

(1) The achievement of a progressive rise in the standard of living of mankind needs the fullest use of science and technique within the frame-work of a world expansionist economy.

(2) An expansionist economy policy at home implies assistance to the backward and undeveloped countries to raise their productive level by the establishment of modern industry and scientific agriculture.

(3) In this country the advanced and efficient application of science requires democratic planning largely by scientists themselves. For this we propose a central research and development council under the authority of the Lord President of the Council.

(4) The problems facing the manual workers in the future, arising from the effect on their working conditions, of scientific and technical advances, demand close collaboration between the organized scientists and the rest of the Trade Union movement.

(5) The closest collaboration must be achieved between the people of all nations, including the fullest interchange of scientific and technical knowledge based on the contacts now being built between the scientists in Great Britain and the Dominions, the U.S.S.R., France and the U.S.A."

NEWS and VIEWS

Chemical Engineering at Cambridge

THE period extending between the two World Wars has been remarkable for the advances made in what is usually termed 'technology', and it is especially in chemical technology that this development has been most rapid and spectacular. A scientific discovery in a chemical research laboratory may be the progenitor of a finished manufactured article, but the aims and objects of the discoverer and those of the manufacturer are quite different. Since the manufacturer is interested in producing an effect, and since also economics plays an important part in his considerations, it is clear that many steps alien to a pure research laboratory have to be taken after a discovery has been made before a plant is in actual operation. We are confronted with the problem as to the most suitable training for such workers in chemical technology. Prof. Haber, who was at Cambridge at the end of the War of 1914–18, when asked what English chemical industry needed, replied that our weakness lay in not applying the methods of physical chemistry to industry. There is more than a germ of truth in this. Chemical engineering may be regarded by some as a misnomer for chemical technology; and it is within the orbit of physics and chemistry rather than engineering that the new development should take place.

The larger industries in Britain can train their own men, but this is impossible in smaller units. The training given in the Technische Hochschulen on the Continent, or the Massachusetts Institute of Technology in the United States, has proved eminently successful in the respective countries. In Great Britain it appears that such further development as is required will take place in the universities. Hence the munificent gift of about half a million pounds by the Shell Group of oil companies to the University of Cambridge for the endowment of chemical engineering comes at an appropriate time. The University, in accepting this, has likewise incurred a great responsibility. It is generally recognized that we have much leeway to make up to survive in the post-war world as an industrial nation. The chemical industries of Britain are by no means

the least important contributors to the country's wealth and may well become a dominant factor. Increased burdens will be placed on the nation's chemists and chemical engineers, and their training must be such that they can achieve the tasks that lie ahead. Care must be taken that the new Department is continually nourished by its roots—the subjects of chemistry, physics, mathematics and engineering; and those who pass through it should then build on sure foundations.

U.S. Research Board for National Security

ESTABLISHMENT of the Research Board for National Security by the U.S. National Academy of Sciences was announced on February 11 by Mr. Henry L. Stimson, U.S. Secretary of War, Mr. James Forrestal, U.S. Secretary of the Navy, and Dr. Frank B. Jewett, president of the National Academy of Sciences. The Executive Committee of the new Board will be headed by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and the Board will consist of seventeen civilian men of science and nine representatives each from the army and navy, including Major-General Norman T. Kirk, Army Surgeon-General, and Vice-Admiral Ross T. McIntire, chief of the U.S. Navy Bureau of Medicine and Surgery. Civilian members include Mr. Herbert S. Gasser, director of the Rockefeller Institute for Medical Research, Prof. E. O. Lawrence, professor of physics at the University of California in Berkeley, and Prof. Isador I. Rabi, professor of physics at Columbia University. The Secretaries of War and Navy requested the president of the National Academy of Sciences under its congressional charter to establish the Board "to assist in providing for continued civilian participation in the longer-term scientific problems of national security when the Office of Scientific Research and Development proceeds to liquidate its activities as a temporary war-time agency. . . . The objective of the Board will be to continue, pending final consideration by Congress on creation of an independent agency, the close co-operation between civilian scientists and the armed services which has proven to be such a vital element in the prosecution of the war. Composed of high-ranking officers responsible for the needs and plans of the Army and Navy with an equal number of distinguished representatives of science, engineering, medicine and industry, this Board includes many of the features of the Office of Scientific Research and Development which has proven so successful as a war-time agency in mobilising civilian scientists and coordinating their work with the requirements and operations of the armed services. . . ." The announcement pointed out that "science is here broadly interpreted to include the employment of scientific method of analysis, experiments and tests in any branch of science or technology including engineering, medicine, psychology and biology."

Science and Planning

IN a memorandum "Science and the Real Freedoms" issued by the Association of Scientific Workers (price 3*d*.), Sir Robert Watson-Watt gives a very fair appraisal, under the title "Freedoms of Science", of the issue between planning and freedom, successfully avoiding the political prejudices with which the discussion is apt to become entangled. Sir Robert's article is based on a speech delivered in Manchester last October. He insists first on the necessity for clearly defining our terms. Science he regards as organized knowledge; but he considers that those constructive pursuits requiring for their prosecution, expansion and usefulness the application of a like process of thought are also properly covered by the term 'scientific'. The pure and applied sciences are in fact planned sciences. There is no human activity which is not a planned activity, and Sir Robert urged that we should consider whether organization in hope is not a nobler and more fruitful aspect of human endeavour than the organization of and through fear which has inspired our planning for war and even extended to the medical sciences. Asserting that the freedom to learn, to choose, to think, to work and to speak are the fundamental freedoms of the individual and the pillars of any tolerable society, Sir Robert urged that the real question is whether planning—which is inevitable—is to be open and public, or sectional, secret or selfish. He visualizes a structure in which the user who wants a definite result asks the research worker, the developer and the producer how best, by what particular kind of planning, he can attain his result; the research worker, the developer and the producer co-operate with the user, indicating to him the full possibilities. The greatest danger is over-simplification; but the planning of science in the application to national life is possible with no substantial risk to the freedom of fundamental science.

Education and Training for Engineers

IN a second report now issued by the Institution of Electrical Engineers, it is suggested that provision should be made for the education of craftsmen, technicians and professional engineers. There should be a three-year course for a craftsman certificate, followed by a more general course, lasting two years, in workshop administration. For the technicians group, the existing course for the ordinary national certificate in electrical and mechanical engineering should be co-ordinated as a basic course, and this should be followed, where necessary, by a course in advanced technology. Students who do well in the first two years of the ordinary certificate course should be combined with those who have reached the standard of a good school certificate in mathematics and physics, and these students should enter a two-year course leading to an intermediate national certificate designed to meet the requirements of the Section A examinations of the Institutions of Civil, Mechanical and Electrical Engineers. These courses would lead to the higher national certificates in electrical engineering and kindred subjects. Another section of the report contains proposals for the further education and training of electrical engineers returning from the Services.

University of Birmingham

THE Court of Governors of the University of Birmingham has nominated Mr. Anthony Eden for appointment as Chancellor of the University in succession to Lord Robert Cecil. The Pro-Chancellor (Mr. E. P. Beale) has announced that a public appeal for £1,000,000 will shortly be made to enable the University to proceed with urgently needed developments, especially the bringing together on one site of all the departments (some of which still remain in the centre of the city) and the building of additional halls of residence. Many of the donors to the appeal for £250,000 for rebuilding and re-equipping the Departments of Mechanical and Electrical Engineering have expressed the opinion that a great need of

the provincial universities is a fuller communal life for the students, such as can be secured by halls of residence.

Electric Discharge Lamps for Photography

MR. H. K. BOURNE presented a paper on this subject, illustrated by a comprehensive display of typical lamps, at a meeting of the Association for Scientific Photography on January 27. Photographically, electric discharge lamps have high actinic efficiency combined with low heating power; and they have a long life. Since the early days of the Cooper-Hewitt lamp, a glass tube several feet in length with a mercury pool at the end, development has proceeded along two divergent lines, low pressure and high pressure. In the modern low-pressure lamp, the pressure of mercury vapour is only a fraction of a millimetre; it emits considerable long- and short-wave ultra-violet radiation, which by means of fluorescent powders on the inside of the tube is converted to visible light of longer wave-lengths. It provides a well-diffused light-source closely resembling daylight and capable of giving accurate colour rendering. The high-pressure mercury vapour lamp consists of an inner glass tube containing the arc, sealed into an outer glass jacket. The arc tube pressure is about 1 atmosphere, and the arc is constricted into a narrow cord along the axis of the tube. The outer envelope is filled with an inert atmosphere. There is a wide range of types, the most powerful being in powers of the order of 10 kW. or higher, with a brightness ranging up to 100,000 candles per sq. cm. The spectrum is linear in character, and fluorescent powders cannot be used with the high brightness lamps; but with increasing pressure there is an improvement in the colour, the main lines broadening while the amount of continuous background increases. An amalgam of cadmium is sometimes used to improve colour. Brightness increases with increases of loading per unit length in the arc column, which has been made possible, first by the use of quartz tubes with molybdenum foil vacuum-tight seals, and later by the introduction of water-cooling, which dissipates approximately 70 per cent of the radiated heat. The author described a number of lamps including a compact source lamp with a maximum brightness of 18,000 c./sq. cm., a self-contained metal box-lamp which can be used without a lamphouse for the illumination of laboratory instruments, a 100-hour-life water-cooled high-pressure lamp with a luminous efficiency of 65 lumens per watt, a peak brightness of 30,000 c./sq. cm. and an internal pressure of about 75 atmospheres, and the B.T.H. syroposcopic tube which can give recurring flashes at a predetermined frequency or be employed as a synchronized flash-lamp for ordinary photography.

Resources of Ireland

IN celebration of the centenary of the publication of Sir Robert Kane's "Industrial Resources of Ireland", the Royal Dublin Society has published (price 2*s*. 6*d*.) a number of lectures delivered before the Society last August, under the general title of "The Natural Resources of Ireland". Prof. M. A. Hogan, in reviewing the fuel resources of the country, does not see much hope of increased coal production, but believes that resources of the limited coalfields are sufficient to last at least 250 years. He foresees, on the other hand, a great increase in the use of turf, provided that mechanized means of cutting it can be devised. This would entail the preliminary easy drainage of large areas of bog, in order to bear the weight of heavy cutting machines. Mr. J. A. O'Riordan discusses the possibilities of water power. The Shannon and Liffey schemes have made a notable beginning, and their theoretical capacity is estimated at 84,000 horse-power. Gauging stations on other rivers and possibilities, still unmeasured, of smaller streams, promise great accretion to these resources. Mr. O'Riordan thinks that the potential production of hydro-electric power could eventually be doubled. It is to her water-power resources that Ireland must clearly look for energy in the future. A review of the mineral resources other than fuel, by Mr. D. W. Bishop, shows little of importance except phosphates. The metallic mineral resources are very small. Some ores, in small supply, seem to have been exhausted.

Studies on Pollen Analysis

THE study of pollen has come much to the fore during recent years. The pollen analysis of peat has become one of the most important techniques used in the study of post-glacial vegetation. Partly in view of the necessity of studying such geological data in terms of processes now in operation and partly in order to obtain information relating to plant allergens, research is now being directed toward fundamental problems relating to the liberation, dispersal and deposition of air-borne pollen. The results will have obvious implications in the field of floral biology and should also be of value to the meteorologist. The pollen of insect flowers is receiving attention as a means of determining the source of samples of honey. All the above studies have, up to the present, been referred to under the general heading of pollen analysis. The need for a better name has been expressed in *Pollen Analysis Circular*, a cyclostyled research bulletin edited by Prof. Paul B. Sears, of Oberlin College, Ohio. Messrs. H. A. Hyde and D. A. Williams, of the National Museum of Wales and Llandough Hospital, Cardiff, respectively, in the October issue of that *Circular* suggest the term *palynology* (Gk. παλύνω (paluno), to strew or sprinkle; cf. πάλη (palē), fine meal; cognate with Latin *pollen*, flour, dust) for the study of pollen and other spores and their dispersal, and applications thereof. It is hoped that the sequence of consonants p-l-n (suggesting pollen, but with a difference) and the general euphony of the new word will commend it.

Motor Control-Gear

A PAPER read recently in London by D. Rudd before the Institution of Electrical Engineers reviews, in general terms, present-day practice in the design of industrial motor control-gear. The scope of the paper is limited to standard industrial equipment and the subject is approached from the user point of view. The first part reviews the principles on which modern design has been established, and the later sections discuss some of the factors that are likely to affect future development. The author states the case for the utmost simplicity in design and for greater latitude in the value of allowable starting-current peaks. Possible development in contact materials is discussed, and reference is made to the possibility of achieving some measure of standardization.

Veterinary Medical Institute

ACCORDING to the December issue of the *Anglo-Swedish Review* a new veterinary-medical institute has recently been inaugurated in the northern out-

skirts of Stockholm. One of the largest and most important departments is that for the production of horse serum. The stables with boxes for about eighty horses have been built with slanting lanternine roofs which let in the light above the boxes, and every box is provided with running water. Each of the horses produces about seven litres of blood, or raw serum, a week. Hot and cold air is supplied according to the season. In another and equally well-kept section are quarters for a large number of calves. The Institute comprises three sections: a pathological, a bacteriological and a serological section, which are supplemented by a mechanical and a parasitic laboratory. Altogether about 150 persons are employed. The new Institute provides increased facilities for effective combating of diseases of domestic animals, which still cause heavy losses.

American Birth-rate

ACCORDING to statistics of the Metropolitan Life Insurance Company (*J. Roy. Inst. Pub. Health and Hyg.*, Jan. 1945), young mothers between the ages of twenty and thirty having their first child have been the principal contributors to the rapid war-time rise in the American birth-rate. The chief factor in the rise at these younger ages has been the increase in the marriage-rate, but a good part of the rise has been accounted for by women who had delayed having children until economic conditions were more favourable. Although the general birth-rate increased rapidly during the war period, the trend towards small American families as well is still in evidence, and families with five or more children continue to decrease.

Bright Light Sources

A PAPER read by J. N. Aldington on November 14 last before the Illuminating Engineering Society gave a general survey of tungsten filament projector lamps, showing the trend of recent developments in this field. The paper embraces consideration of the characteristics of tungsten filaments *in vacuo* and in gas-lamps employing both single-wound and double-wound helices, multi-filament lamps, and symmetrical light sources. Various types of lamps are illustrated photographically, and lamp performance data are given in tabular form.

Dried Starfish as Chicken Meal

IT is reported (*J. Amer. Vet. Med. Assoc.*, 55, 151; 1944) that starfish, collected in the process of cleaning oyster beds, are now being dried and ground up to make chicken meal. An analysis of the meal showed that it contained 30·7 per cent protein, 17·6 per cent calcium and 0·35 per cent phosphorus. Tested against sardine fish meal of equal protein value, it proved its value as food; but its use had to be limited to 3·5–5 per cent of the total ration, because of the high proportion of calcium.

University of London

THE title of 'professor emeritus' in the University of London has been conferred on the following: Prof. R. H. A. Plimmer, who held the chair of chemistry at St. Thomas's Hospital Medical School during 1922–42; Sir Owen Richardson, who held the Wheatstone chair of physics at King's College during 1914–24 and the Yarrow Research professorship of the Royal Society attached to King's College during 1924–44; Dame Helen Gwynne-Vaughan, who held the chair of botany at Birkbeck College from 1921 until her retirement in 1944 and was a member of the Senate as a representative of the Faculty of Science during 1929–34; Prof. Eva G. R. Taylor, who held the chair of geography at Birkbeck College from 1930 until her retirement in 1944.

Dr. C. W. Shoppee has been appointed to the University readership in chemistry tenable at the Royal Cancer Hospital (Free). Since 1939 he has been working at the Pharmaceutical Institute in the University of Basle.

The title of professor of mathematics in the University has been conferred on Dr. Paul Dienes, in respect of the post held by him at Birkbeck College.

Announcements

THE Medical Research Council has appointed Prof. A. A. Miles, professor of bacteriology at University College Hospital Medical School, London, to the staff at the National Institute for Medical Research as from October 1, 1945, with the view of his becoming director of the Department of Biological Standards on the retirement of Sir Percival Hartley next year.

PROF. F. Y. HENDERSON, reader in timber technology in the University of London and assistant professor in timber technology in the Imperial College of Science and Technology, has been appointed director of Forest Products Research in the Department of Scientific and Industrial Research on the forthcoming retirement of Mr. W. A. Robertson, who has been director since 1933.

MR. V. M. WADSWORTH has been appointed assistant lecturer in agricultural economics in the University of Leeds.

M. TURGUT EREM, the first educational attaché to be appointed to the Turkish Embassy in Great Britain, has arrived in London; he will act as inspector of Turkish students in Britain, of whom there are now about a hundred, including eighteen holders of scholarships awarded by the British Council, with which M. Erem will be in close touch.

THE Institution of Civil Engineers, with the Institution of Municipal and County Engineers, have appointed a joint committee to draw up notes for the use of engineers on the best location of underground services. The Committee will consist of Mr. W. H. Morgan, county engineer of Middlesex, as chairman, and ten other members; representatives of electricity and gas supplies and post office services have been nominated by or in consultation with the Institution of Electrical Engineers, the Institution of Gas Engineers and the chief engineer, G.P.O. respectively. Communications should be addressed to the Secretary, Joint Committee, c/o Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1.

THE following appointments have been made in the Colonial Service: C. F. Charter, to be soil chemist, Gold Coast; R. W. Crowther and D. A. W. Walker, to be veterinary officers, Nigeria; Miss M. E. Broughton, to be marketing officer, Nigeria; F. E. Luscombe, to be agricultural officer, Tanganyika; C. Harvey, senior agricultural officer, Fiji, to be director of agriculture, Fiji; E. W. Leach, senior agricultural officer, Nigeria, to be deputy director of agriculture, Trinidad; F. S. Collier, conservator of forests, Nigeria, to be deputy chief conservator of forests, Nigeria.

LETTERS TO THE EDITORS

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

'Sensitizing' by Protective Colloids

THIS is the name given[1] to the following phenomenon. It was observed[2] that the addition of a quite small amount of a hydrophile colloid to a sol of a hydrophobe colloid caused the latter to be coagulated (precipitated) by a much smaller amount (at much lower concentration) of a precipitating electrolyte than in total absence of the protective colloid. However, suitable larger amounts of the latter made necessary larger amounts of precipitating electrolyte than in the absence of the hydrophile colloid, hence the term 'protective colloid' for the latter.

In a letter in *Nature* in 1921[3] I suggested that many of the properties of the so-called (at that time) 'emulsoid colloids', and particularly of proteins, derived from a duplex character of their molecules in respect of their possessing both hydrophile polar and hydrophobe but organophile non-polar atom-groups. The conception was developed more explicitly in a monograph on gelatin[4] to provide a basic *stratochemical* architecture for the micelles of proteins[5].

Experimental evidence was presented from the effect of gelatin on the interfacial tension between water and toluene and from the sorption of gelatin at this interface out of dilute solutions[6].

Recent investigations by me and my collaborators[7] have shown that the adsorption of many basic dyes to silver halides occurs in two stages. In the primary —and priming—stage, the dye molecules are deposited in a mono-layer, with the polar or ventral (to suggest an anatomical image) aspect of the molecule (ion) adhering to the silver halide surface, and the hydrophobe (or dorsal) edge projecting into the aqueous solution. After saturation is effected, a second mono-layer begins to build on. This does not form a rigid but a reversible layer, of the Langmuir type, because now the non-polar hydrophobe aspects of the dye molecules are attracted each to each between solution and primary adsorbate, while the polar, hydrophile groups of the secondary layer are attached to the water.

There are complications attendant on the formation of dimerized and polymerized aggregates of the dye molecules which need not detain us here. What is important is that we now have evidence from direct adsorption measurements from dilute solution, as well as from experiments on the coagulation and repeptization of silver halide sols by dilute gelatin solutions, that a quite similar process to that with dyes occurs in the adsorption of proteins to the silver halides and other little-soluble polar solids.

The electrophoretic and kindred investigations of H. A. Abramson[8] and many others have led to the general conclusion that: "The fact that not only the isoelectric points but also the electric mobilities of quartz particles covered with serum albumin or egg albumin [or gelatin] are very nearly identical with the values of mobility for the respective dissolved protein indicates that practically all the polar groups of the protein molecules are available even after adsorption has occurred". The apparent paradox whereby the polar force fields of the protein should be quite free even when the molecules are at one and the same time most tenaciously and strongly adsorbed[9] to a polar surface is now explainable by our new observations, and the stratochemical layering. The electrical behaviour of the protein-coated silica particles, etc., is due not to the primary mono-layer, but to the secondary reversible layer.

It should be noted that the arrangement required (of polar-nonpolar alternance, or 'amphipathy', to use Hartley's term) seems consistent with Astbury's X-ray diffraction conclusion that "polar and nonpolar side chains follow one another alternately along the main chains" in the protein structure[10].

The mechanism of 'sensitizing' evidently derives from the amphipathic character of the protective colloid, which is manifest not only in the proteins but also in such polyoses as the starches, dextrins, gums and pectins, and in kindred bodies, such as polyvinyl alcohol[11]. Some part of the initial precipitating effect of these hydrophile colloids can be replaced by an alternate electrolyte—and vice versa. In all cases, the primary monolayer furnishes lipoid surfaces, coherence of which is coagulation. This is followed by repeptization by addition of further hydrophile colloid[7].

With my colleagues I shall deal with the subject more fully in subsequent publications.

S. E. SHEPPARD.

Chemistry Department,
Research Laboratories,
Eastman Kodak Company,
Rochester, N.Y.
Dec. 19.

[1] Freundlich, H., "Kapillarchemie" (Aufl. 2, Leipzig, 1922), 799 *et seq.* Also for non-colloidal non-electrolytes, *idem.*, 636 *et seq.*
[2] Henri, V., *et al.*, *C.R. Acad. Sci.*, **55**, 1671 (1903).
[3] Sheppard, S. E., *Nature*, **107**, 73 (1921).
[4] Sheppard, S. E., "Gelatin in Photography". I. Monographs on the Theory of Photography, No. 3. (New York: D. Van Nostrand Company, 1923), 188.
[5] cf. also *Ind. and Eng. Chem.*, **13**, 37 (1921).
[6] Sheppard, S. E., and Sweet, S. S., *J. Amer. Chem. Soc.*, **44**, 2797 (1922).
[7] Sheppard, S. E., *Atti. X Congress Internat. di Chim.*, VI, 234 (1938); also Sheppard, S. E., Lambert, R. H., and Walker, R. D., *J. Chem. Phys.*, **7**, 265 (1939).
[8] Abramson, H. A., "Electrokinetic Phenomena" (Amer. Chem. Soc. Monog.), 1934.
[9] cf. Sheppard, S. E., Lambert, R. H., and Keenan, R. L., *J. Amer. Chem. Soc.*, **36**, 174 (1932).
[10] Astbury, W., *J. Chem. Soc.*, 337 (1942).
[11] cf. Sheppard, S. E., and Newsome, P. T., *J. Chem. Phys.*, also Pt. 2 (in the press, *ibid*).

Age of the Saline Series in the Punjab Salt Range

PROF. B. SAHNI'S important observations[1] have necessitated a reconsideration of this problem. In order to review the geological evidence on the ground, an excursion was arranged to examine several sections which had led E. R. Gee, of the Geological Survey of India, and other geologists to the conclusion that the Saline Series of the Salt Range is of Cambrian or pre-Cambrian age. Prof. Sahni was unfortunately unable to take part in the excursion, the party consisting of the undersigned.

The sections visited were near Khewra in the eastern part of the range, and in the Warcha-Sakesar area of the middle western portion. This examination showed that an Eocene or later age for the Saline Series is irreconcilable with the field evidence, which, in our opinion, indicates that this series is Cambrian or older.

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-8, do not apply.

METROPOLITAN WATER BOARD

(a) ASSISTANT BACTERIOLOGIST
(b) LABORATORY ASSISTANT

Applications are invited for the following temporary positions :

(a) Assistant Bacteriologist.

Candidates must hold a degree in natural science from a recognized University and must produce evidence of a thorough knowledge and experience of bacteriology. The duties of the officer appointed will consist of the bacteriological examination of water in all stages of purification, and such other duties in the Water Examination department as may be allotted to him by the Director of Water Examination. Basic salary £525 per annum, rising by annual increments of £25, to £625 per annum, plus cost of living bonus (at present £65 per annum).

(b) Laboratory Assistant in Bacteriological Section of Laboratories.

Candidates, preferably between the ages of 21 and 30 years, must hold a General Schools certificate or equivalent qualification. The fact of having passed one or more of the examinations of the Institute of Medical Laboratory Technology will be an additional qualification. Basic salary between £150 and £380 per annum, according to age and qualifications, with annual increments, plus cost of living bonus (at present £65 per annum).

The persons appointed will hold office on a temporary basis during the War and may be offered permanent appointments after the War, but no undertaking to this effect can be given.

The selected candidates for either appointment will be required to pass a medical examination by the Board's Chief Medical Officer, to devote the whole of their time to the service of the Board, and in the event of the appointments being subsequently made permanent to undertake in writing to join the Board's Superannuation and Provident Fund.

Applications for either appointment stating applicant's age, present position and salary, qualifications and experience and also position with regard to National Service, accompanied by copies of not more than 3 testimonials must be delivered to the undersigned (endorsed "Assistant bacteriologist" or "Laboratory assistant" as the case may be) not later than 10 a.m. on Saturday, March 31, 1945.

Canvassing, directly or indirectly, is prohibited, and candidates should state in their applications whether, to their knowledge, they are related to any member of, or the holder of any office under the Board.

C. W. STOKER,
Clerk of the Board.

Offices of the Board, New River Head,
Rosebery Avenue, London, E.C.1.

UNIVERSITY OF LONDON

Applications are invited for Research Fellowships founded by Imperial Chemical Industries Ltd. and tenable in the University of London and normally of the value of £600 per annum. The Fellowships will be awarded for original research in Chemistry, Physics, and allied subjects such as Biochemistry, Metallurgy and Pharmacology. A Fellow will be required to take a limited part in the teaching in the Department in which he works. Fellowships will be tenable from October 1945, but applications from candidates now on National Service who cannot take up appointment to the Fellowship until later, will also be considered. Detailed Regulations and application forms can be obtained from the Academic Registrar, University of London, at Richmond College, Richmond, Surrey, and applications must be received at that address not later than April 30, 1945.

BIRMINGHAM UNITED HOSPITAL

The General Hosp. The Queen Elizabeth Hosp.

Applications are invited for the post of an Assistant Biochemist at the General Hospital. Applicants should hold an Honours Degree in Biochemistry or an equivalent qualification. Salary will be not less than £250, according to experience. Applications should be sent to the undersigned not later than March 17.

P. CROCKER,
House Governor.

The General Hospital,
Birmingham, 4.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Appointment of
LECTURER IN SPINNING

The Governing Body invites applications for a Lectureship in Spinning in the College of Technology, with the title and status of Lecturer in the University of Manchester.

Salary : £425 per annum, rising by annual increments of £15 to £550 per annum, plus War Bonus (which at the present time is £52 p.a.). Commencing salary according to qualifications.

Applicants should hold a degree in Science or Technology, and should have had factory or research experience in some branch of the spinning industry.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester 1. The last day for the receipt of applications is March 28, 1945.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
Principal of the College.

ROBERT GORDON'S TECHNICAL COLLEGE, ABERDEEN

SCHOOL OF PHARMACY

Applications are invited for the post of Lecturer in Biology. Candidates should be graduates with honours in either Botany or Zoology and should have had teaching experience. Salary £300-£15-£450 plus war bonus of £49 8s. per annum, with initial placing according to experience.

Further particulars and form of application may be obtained from the undersigned, to whom completed applications should be returned by March 6, 1945.

A. C. WEST,
Director.

UNIVERSITY OF GLASGOW

Lectureship in Genetics

Applications are invited for the Lectureship in Genetics in the University. The Lectureship will be Grade IIa, the salary range of which is £540-£610 per annum. Applications, with the names of three persons, to whom reference may be made, should be sent to the undersigned, from whom further particulars of the appointment may be obtained. The latest date for receiving applications will be April 7, 1945. The appointment will take effect from October 1, 1945.

ROBT. T. HUTCHESON,
Secretary of University Court.

Applications are invited for the appointment of an Additional Officer for secretarial and organizing work. Applicants should be chemists with organizing and administrative ability. The commencing salary will be £500 p.a. and, after six months service, will be subject to the Association's Staff Pension Scheme. The successful candidate will be expected to devote his full time to the affairs of the Association. Applications in writing should state age, qualifications, experience, position as regards National Service, and be supported by copies of testimonials and the names of two referees. Envelopes should be endorsed "Additional Officer" and received by the Honorary Secretary on or before March 31st.

Signed, E. C. C. BALY,
Hon. Secretary and Registrar.

British Association of Chemists,
175 Piccadilly, London, W.1.

Physicist or Physical Chemist for research and development department age 25-30, salary £350/450 p.a. A graduate of a recognized University with some knowledge of surface chemistry and the nature of films is desirable together with a bent towards the mathematical treatment of the properties of fluid. Applications should embody full particulars of experience and qualifications to Box No. 317, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chemist for research and development department, age 25-30, salary £350 to £450 p.a. Graduate of a recognized university with experience in industrial organic chemistry will be preferred. Application should embody full particulars of experience and qualifications to Box No. 318. T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Biochemist, 39, British, reserved, M.Sc., Ph.D., F.R.S.E., experienced in Research, in physiological and medical chemistry, bacteriology, microrespirometry, and in staff control, desires post, research or otherwise, in public health hospital or industry.—Write, Box 310, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Analyst required for the permanent Laboratory Staff of a large glass works near Birmingham. Degree in chemistry or equivalent experience in inorganic analysis. Salary according to age and qualifications.—Chance Brothers, Smethwick.

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

Chemist required for manufacture of and research into fluorescent material. Experience in this field, or in inorganic analysis of traces, an advantage. Excellent post-war prospects. Salary according to qualifications. Write Box E.K.2, 105 Judd Street, London, W.C.1.

Experimental Physicist required, pre- ferably with experience in vacuum and gas discharge work. Excellent post-war prospects. Salary according to qualifications. Write Box E.X.2, 105 Judd Street, London, W.C.1.

Works Chemist, age 25 to 30, required as assistant to Works Superintendent. Practical experience with B.Sc. degree in chemistry or equivalent. Good prospects for suitable man. Applications in confidence with full particulars to Box No. 312, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Imperial Chemical Industries Ltd. have vacancies for an experimental zoologist and for a marine biologist. Details of these posts may be had on application, in writing, to Central Staff Department, Welwyn Garden City, Herts.

Plant Breeding Assistant required, man or woman. Preferably with experience in Fruit and Cytology. Good salary and prospects. Reserved occupation. Box 311, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Male Technician wanted for Anatomy Department with some knowledge of section cutting and staining. Salary according to age and experience. Apply to : Secretary, Medical School, St. Thomas's Hospital, London, S.E.1.

The British Welding Research Associa- tion, 2 Buckingham Palace Gardens, Buckingham Palace Rd., London, S.W.1, require two metallurgists to undertake research in the welding of light alloys. The salary to commence, according to qualifications and experience, £400-£800 p.a.

Required : Back numbers of Journals dealing with dairy science, bacteriology, biochemistry and other sciences bearing relation to dairying. Send particulars and price required to Box No. 316, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted to purchase first-class Micro- scope for urgent National Work. Excellent price. Box 314, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted urgently for essential research work rectangular mechanical stage for microscope. Displacements measurable by scales and verniers to 0.1 mm. Box No. 313, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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

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The junction of the Saline Series and the overlying Purple Sandstones (Cambrian or older) is in several sections conformable and transitional. This is well seen in exposures east of the Warcha Circuit House.

The junction of the Upper Carboniferous Talchir Boulder Bed with various stages of the Cambrian and the Saline Series was examined over several miles of its outcrop south of Sakesar. Here also our opinion is that this junction is normally an ordinary sedimentary overlap, thus precluding an age for the Saline Series later than Talchir.

Regarding the evidence of Tertiary to sub-recent fossils found by Prof. Sahni, we observed so many instances, even deep in the salt mines, of sub-recent material being enveloped in the salt and in the marls, that it seems possible Prof. Sahni's fossils had a similar origin, notwithstanding that in many cases they have every appearance of being *in situ*. Our conclusions were arrived at despite the recognition of certain difficulties, such as the occurrence of minute plant fragments of post-Cambrian age in the dolomites and oil shales, for which at present we have no clear explanation to offer.

The Foraminifera, formerly believed to indicate an Eocene age for the Saline Series[2], were later proved to be derived material embodied in outcrops as a result of subsequent movements.

J. COATES. P. K. GHOSH.
H. CROOKSHANK. E. LEHNER.
E. R. GEE. E. S. PINFOLD.

Warcha.
Nov. 10.

[1] Sahni, B., *Nature*, **153**, 462 (1944).
[2] Davies, L. M., *Nature*, **154**, 53 (1944).

Synergistic Effect of Cod Liver Vitamin D on Synthetic Vitamin D_3

ALTHOUGH the average vitamin D content of cod liver oil of authentic origin as produced by the world's fisheries in normal peace-time lies in the neighbourhood of 85 international units per gram, there are very wide limits of variation according to the season, condition of the fish in relation to spawning and the actual fishing ground on which the fish are caught. In our experience these natural variations cover a range from below 50 to above 500 international units per gram.

Experience with authentic cod liver oils shows that when oils of widely differing vitamin D potency are blended, the vitamin D content of the blend is in harmony with the calculated figure derived from the individual potencies of the components of the blend. This would be agreed as a matter of common experience.

On the other hand, we find that when synthetic vitamin D_3 is blended with cod liver oil, the assay in international units is higher than the calculated figure. Two typical results of tests using eighteen pairs of rats in each biological assay are given below:

Vitamin D content of the cod liver oil	Amount of synthetic vitamin D_3 added to 1 gm. of cod liver oil	Calculated vitamin D potency of the resulting mixture	Actual vitamin D potency of the resulting mixture
(I.U./gm.)	(I.U.)	(I.U./gm.)	(I.U./gm.)
90	80	170	206
84	81	165	245
89*	67	156	227

* Average figures for a comprehensive series of thirteen similar blends, using eighteen pairs of rats for each assay.

It is not the purpose of this letter to offer any final explanation of the apparent synergism between the vitamin D of cod liver oil and synthetic vitamin D_3. It is known, however, that the vitamin D of cod liver oil, often presumed to be a single substance, is really a complex. Bills[1] and other workers have shown that there are at least seven forms of vitamin D. Hickman and Gray[2] have demonstrated by short-path distillation the possibility of there being at least six different substances in cod liver oil with anti-rachitic properties. On the other hand, the known synthetic forms of vitamin D are apparently individual substances which can, in fact, be crystallized in the pure state.

If the full activity of vitamin D as a therapeutic substance used to cure experimental rickets in rats depends on the simultaneous presence of more than one component, then vitamin D_3 itself, by reason of its singleness of nature, would not exert its full curative action until one or more of the other essential components of the vitamin D complex are adequately represented in the blend.

These observations have very wide implications, especially in view of the different efficiencies for rats and chickens respectively of vitamin D_2 and various fish liver oils. In any event, vitamin D_3 can apparently become much more effective for rats if the vitamin D complex of cod liver oil is fed simultaneously to the experimental animals. It is a matter for further investigation as to whether the synergism of the type described between the vitamin D of cod liver oil and vitamin D_3 is general, or whether it is confined to the specific case of experimental rickets in rats.

W. STOTT.
CYRIL C. HARRIS.

Biological Testing Station,
British Cod Liver Oil Producers (Hull), Ltd.,
Hull. · Jan. 15.

[1] Cold Spring Harbor Symposia on Quantitative Biology, **3**, 328 (1935).
[2] *Ind. Eng. Chem.*, **30**, 796 (1938).

Diabetogenic Action of Alloxan Derivatives

THE finding of Shaw-Dunn and co-workers[1] that alloxan (and a styryl-quinoline) causes diabetes by damaging the pancreatic islet cells has since been amply confirmed in a number of laboratories, working with various animal species. Attempts to discover other substances with similar action have so far been unsuccessful, nor has any explanation been offered regarding the mechanism by which alloxan attacks the β-islet cells.

During an investigation of this question, a number of substances, all closely related to alloxan, were found to produce diabetes in rats when injected intravenously. These substances were: methylalloxan, alloxantin, dimethylalloxantin, dialuric acid, methyldialuric acid. Dimethylalloxan and dimethyldialuric acid (as sodium salt) were found to be highly toxic, the initial symptoms suggesting vagus stimulation, and did not cause diabetes in doses up to 100 mgm. per kgm. body-weight of rat. Renal damage, as judged by albuminuria and uræmia, which was more or less evident with all these compounds including alloxan, was particularly pronounced with dimethylalloxan. Other disubstituted alloxans are now under investigation.

Diabetogenic action was not caused by tartronic acid, dimethylalloxanic acid (in which the fissure of

the pyrimidine ring caused disappearance of the toxicity), alloxanic acid, violuric acid and murexide, the last three compounds having already been proved non-diabetogenic by several authors[2,3,4].

It is of interest that the minimum effective diabetogenic dose is about the same with all these compounds, including alloxan, namely, 50–70 mgm. per kgm. body-weight. This dose resulted in the development of extreme hyperglycæmia, glucosuria, polyuria and occasional ketonuria within 12–24 hours. These findings may indicate a very rapid conversion of alloxan to dialuric acid or vice versa, and an equally rapid decomposition of alloxantin. Alternatively, all these compounds might have some property in common, which enables them to interfere with processes within the pancreatic islet cells.

One of the best-known properties of alloxan and some of its derivatives is the decarboxylation and desamination of amino-acids, discovered by Strecker[5] in 1862. We have examined some other substances which give the Strecker reaction. Ninhydrin, which is very toxic, did not produce diabetes in rats, nor did isatin, which is very sparingly soluble.

All the above diabetogenic substances were found to react *in vitro* with hæmoglobin. The alloxans were methæmoglobin formers, while the alloxantins and dialuric acids rapidly converted oxyhæmoglobin into reduced hæmoglobin and blackish-green decomposition products, probably bilirubinoid in nature. The latter effect was also observed *in vivo* with some of the dialuric acids. The alloxans, on the other hand, when given in normal dosage, failed to induce noticeable methæmoglobin formation in rats.

In conclusion, it may be mentioned that Jacobs[2] and Goldner and Gomori[3] have reported negative results in attempts to produce diabetes with alloxantin and dialuric acid, using rabbits and dogs respectively. With a dosage of 150 mgm. (supersaturated solution) dialuric acid per kgm. we have, however, obtained diabetes in a rabbit after intravenous injection.

G. BRÜCKMANN.
E. WERTHEIMER.

Pharmacology Section,
The Hebrew University and Hadassah,
Jerusalem. Dec. 26.

[1] Shaw-Dunn, J., Sheehan, H. L., and McLetchie, N. G. B., *Lancet*, 244, 484 (1943).
[2] Jacobs, H. R., *Proc. Soc. Exp. Biol. Med.*, 37, 407 (1937).
[3] Goldner, M. G., and Gomori, G., *Endocrinology*, 35, 241 (1944).
[4] Thorogood, C., *Federation Proc.*, 3, 48 (1944).
[5] Strecker, A., *Ann. Chem.*, 123, 363 (1862).

Liberation of H^+, Al^{+++} and Fe^{+++} Ions from Hydrogen Clays by Neutral Salts

THE interaction between hydrogen clays and neutral salts gives rise to H^+ and Al^{+++} and, in a secondary measure, Fe^{+++} ions in the salt extracts. The mechanism of this reaction has been the subject of much discussion[1–8]. Some investigators[1–5] consider that the acid liberated by the salt dissolves Al^{+++} and Fe^{+++} ions from the sesquioxides present in the hydrogen clay, while others[6–8] postulate a direct exchange of Al^{+++} and Fe^{+++} ions for the cations of the added salt.

A number of publications[9–12] from this Laboratory have dealt with the liberation of Al^{+++} ions from hydrogen clays isolated from Indian soils by various neutral salts. At a constant *p*H the amounts of displaced Al^{+++} ions (A) have been found to increase with the concentration (C) of the added salt. The plot of A against C has the shape of the usual adsorption isotherm. At a given equilibrium *p*H, barium chloride liberates a much larger quantity of Al^{+++} than hydrochloric acid. All these observations indicate a direct exchange of Al^{+++} ions for the cation of the salt, instead of their liberation by a secondary dissolution process. A direct exchange of both H^+ and Al^{+++} has been observed. At low values of C, very few Al^{+++} ions and mainly H^+ ions are exchanged. With an increase in C, the amounts of both displaced H^+ and Al^{+++} ions increase, but that of the latter at a relatively greater rate than the former. A relation has been found between A and the base-exchange capacity (B), calculated at the inflexion points in the titration curves with sodium hydroxide, of subfractions of hydrogen clay isolated from the same entire clay fraction. Both A and B usually increase with diminishing particle size. Any deviation from this regular variation in A with the particle size is also reflected in similar deviations in the case of B [13]. Depending on the nature of the hydrogen clay, an increase as well as a decrease in A accompanied by similar variations in B have been observed on the removal of free inorganic oxides present in the hydrogen clays according to the method of Truog *et al.*[14]. The decrease in A and B probably indicates a decomposition of the absorption complex.

The amounts of H^+, Al^{+++} and Fe^{+++} displaced from hydrogen clays Satara-*F* and Jorhat-*F* prepared respectively from a black cotton and an acid soil decreased to almost negligible values on continued leaching with a normal solution of barium chloride. But the above cations were liberated, as often the barium clay thus obtained was rendered desaturated by treatment with 0·02 *N* hydrochloric acid and then leached with a solution of *N* barium chloride. Much smaller quantities of the cations were displaced from the desaturated clays compared with the original hydrogen clays. In the case of the hydrogen clay Satara-*F*, which contains the clay mineral montmorillonite, judged from X-ray studies[15], and certain viscous[16] and electrochemical criteria[17,18], the total amount of acid in its 'leachates' decreased progressively with successive desaturations. With the hydrogen clay Jorhat-*F*, containing mainly kaolinite and a very small quantity of montmorillonite, it tended to a constant value. The amount of Al^{+++} ions displaced from Satara-*F* decreased up to the fifth desaturation and then increased. In the case of Jorhat-*F* it decreased up to the fifth desaturation and then became constant. Very little (0·5 to 0·4 milli-equivalents per 100 gm. of oven-dry hydrogen clay) Fe^{+++} ion was displaced by *N* barium chloride from the two hydrogen clays. But with Satara-*F* its amount increased with successive desaturations up to the fifth one and then began to decrease. In the case of Jorhat-*F* it remained practically constant. The sum of the amounts of displaced Al^{+++} and Fe^{+++} ions decreased with progressive desaturations, tending to a constant value with both the hydrogen clays. After the full cycle of operations (eight desaturations in the case of Satara-*F* and six with Jorhat-*F*) a marked reduction[19] in base exchange capacity (B) of Satara-*F* was observed. Jorhat-*F* showed no material change[19]. The observed reduction in B indicates a decomposition of Satara-*F*. X-ray diagrams obtained by Mr. S. N. Bagchi[15] gave no lines characteristic of montmorillon-

ite in the hydrogen clays at the end of the above cycle of operations. A relation between the mineralogical composition of the clay and the quantities of displaced Al^{+++} and Fe^{+++} ions is indicated by the above results. Further work with pure clay minerals is in progress.

These investigations have been carried out with the aid of a grant from the Imperial Council of Agricultural Research, India.

J. N. MUKHERJEE.
B. CHATTERJEE.

Physical Chemistry and
Colloid Research Laboratories,
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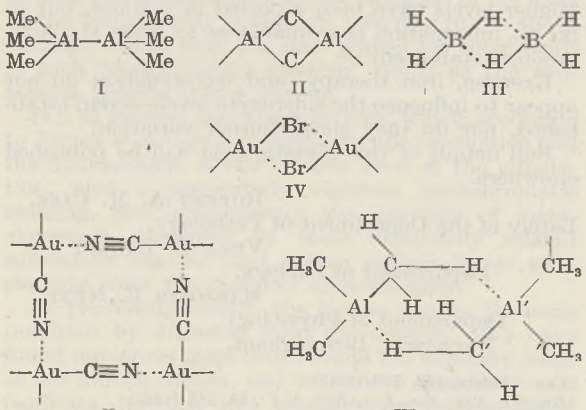
Structure of Aluminium Trimethyl

THE existence of the dimer aluminium trimethyl has aroused considerable interest. Electron diffraction determinations[1,2] are in satisfactory agreement with an ethane structure (I). However, this structure is for many reasons most unlikely: (1) it should differ from the bridge structures of the related aluminium halides[3] Al_2X_6, aluminium dimethylhalides[2] $Al_2Me_4X_2$, as well as of the boron and probably aluminium hydrides[4]; (2) it cannot be accounted for by any existing valence theory; no forces are available for joining the two $AlMe_3$ molecules; (3) it requires a shorter interatomic distance (about 2·20 A.) between the equally charged Al atoms than that of a covalent Al–Al linkage (> 2·48 A.); (4) the unstability (non-existence) of a dimer boron trimethyl cannot be explained.



Raman spectra favour a bridge structure[5], but that of type II is excluded by the results of electron diffraction determinations[2]. As shown elsewhere[6], the stability of B_2H_6 and Al_2H_6 can be accounted for on the basis of the bridge structure[4] by the formation of B . . . H hydrogen bonds (of an essentially electrostatic nature) (III). This also allows a bridge structure for Al_2Me_6, which has not yet been considered (VI). A six-membered ring is formed by Al . . . H hydrogen bonds. Owing to the inductive electron transfer from the positive Al atom, the negative charge on the H atom should be appreciable. The non-existence of B_2Me_6 can be explained by the much smaller electron transfer from the less-positive B atom, which is not compensated by the expected shorter interatomic distance. Al_2Me_6 is now no exception to the bridge structures of its related aluminium and boron derivatives. This is comparable to the dimer gold dialkyl halides and tetramer cyanides[7], where one atom (halogen) (IV) and two atoms (C≡N) (V) respectively form the bridge. No new valence theory is required, and the Al–Al distance is now longer than that of a covalent linkage.

It is noteworthy that the distances to be expected for structure VI are in qualitative agreement with the peaks of radial distribution curves derived from electron diffraction determinations, which are 2·07, 2·6, 3·42, 3·93[1] and 2·01, 2·58, 3·3, 4·05 A. respectively[2]. The C–H and Al–C distances within the six-membered ring will be near 1·09 and 2·01 A. respectively, the Al . . . H distance slightly longer than that of a covalent linkage and not very different from (1·7) 1·8 A. Making the reasonable assumption that the angles CAlH and AlCH in the ring are about 109·5°, the important distances mainly contributing to the radial distribution curve below 4 A. are Al–C 2·01 A., Al–C′ 2·73 A., Al–H 2·59 A., Al–Al′ 3·22 A., C–C 3·28 A., C–C′ (both in ring) 3·5 A., C (in ring)–C′ (outside ring) 4·0 A. These distances show a reasonable relationship to the observed peaks. This should justify new quantitative calculations, based on the suggested bridge structure, for testing such models and possibly establishing its actual dimensions.

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Mechanism of the Red Cell Changes in Non-hæmolytic Jaundice

CERTAIN characteristic changes are found in the erythrocytes in obstructive jaundice. The red cells are increased in diameter but not in thickness, so that they are relatively flat cells. Associated with this alteration in shape, target cells are seen in the blood in large numbers and the red cells are resistant to hæmolysis by hypotonic saline solutions. The volume of the cells may or may not be increased.

The same changes have been demonstrated in cases of toxic-infective jaundice. Here, in most

instances, the presence of some obstruction to the outflow of bile is indicated by the clinical features of dark urine and pale stools and a positive van den Bergh test in the serum.

It has been shown that the changes in the erythrocytes occur as the result of alterations in cells that are already circulating in the blood at the onset of the jaundice, and not because of altered erythropoiesis.

The changes in the red cells may be present to a marked degree as early as ten days after the onset of the jaundice. The possibility of this being the result of a new generation of cells is precluded by the fact that erythropoiesis would have to proceed at about ten times the normal rate, and yet no increase in the reticulocytes is seen. Likewise, in recovering cases the blood is restored to normal in as little as ten days, again without signs of rapid cell regeneration.

If red cells are transfused into a jaundiced patient, the transfused cells can be shown to take on the characters described above in about a week. Some mechanism, therefore, exists for producing these changes in circulating red cells.

The bone marrow in jaundice shows no abnormality that could be responsible for the alterations found in the circulating cells.

Detailed analysis of the changes in the chemical constitution of the blood in non-hæmolytic jaundice shows that none of these alterations is responsible for the changes in the red cells.

It is suggested by comparison with the red-cell changes found after splenectomy that the changes in the erythrocytes in jaundice of the non-hæmolytic variety are due to functional disturbance in the circulation of the spleen in jaundice.

Changes in circulating erythrocytes in the direction of roundness in cases of hæmolytic anæmia have received much prominence in recent years. It is suggested here that the opposite change, flattening, also results from alterations in cells as they circulate in the peripheral blood stream.

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Siderocyte Levels in 'Normal' Human Beings

FOLLOWING the partial elucidation of the physiological properties of the siderocyte as the normal ageing erythrocyte[1] and in view of pathological studies now in progress, it became desirable to establish 'normal' siderocyte levels in human beings, and to study the effects of sex, age, menstrual cycle, diurnal variation, iron therapy and exercise upon such levels.

Below are summarized the results of such an investigation carried out in the University of Birmingham.

The differences of the means between the age-groups in the female do not at any point attain statistical significance, but the first and last age-groups in the male do attain a significant difference of mean from their neighbouring groups. The difference between the means for the male and female is also significant. Both series, grouped in 0·1 per cent siderocyte-class intervals, approximate fairly well to 'normal' distributions.

Daily siderocyte counts throughout two successive menstrual cycles in each of two female subjects showed no cyclical tendency. Hourly siderocyte counts on six subjects revealed no evidence of diurnal variation. The exhibition of fairly large doses of ferrous sulphate (up to 1,500 mgm. iron daily) for periods up to 21 days did not affect siderocyte levels in four subjects.

AN ANALYSIS OF SIDEROCYTE LEVELS IN 279 'NORMALS' BETWEEN THE AGES OF 5 AND 65 YEARS.

Total series.

Age group	5–	15–	25–	35–	45–	55–65	All ages
Number of subjects	32	118	46	30	29	24	279
Mean (%)	0·37	0·52	0·48	0·56	0·52	0·48	0·50
S.D.	0·29	0·24	0·29	0·23	0·25	0·15	0·25
Coefficient of variation	77%	47%	62%	41%	48%	31%	50%

Male series.

Number of subjects	16	68	24	17	17	12	154
Mean (%)	0·32	0·50	0·41	0·53	0·51	0·40	0·46
S.D.	0·15	0·23	0·27	0·19	0·28	0·15	0·23
Coefficient of variation	48%	45%	66%	36%	57%	37%	50%
P for diff. of successive means		0·01	0·15	0·15	0·8	0·001	

Female series.

Number of subjects	16	50	22	13	12	12	125
Mean (%)	0·43	0·55	0·55	0·59	0·55	0·57	0·54
S.D.	0·29	0·26	0·31	0·25	0·21	0·10	0·27
Coefficient of variation	77%	48%	57%	46%	37%	17%	50%
P for diff. of successive means		0·15	0·9	0·65	0·65	0·8	

Grand mean: Male 0·46; Female 0·54; Difference 0·08. $P = 0·01$.

Moderately severe exercise (sprinting 440 yards) produced no change in level immediately afterwards in each of four subjects, but the injection of small doses of adrenalin, which is without effect on blood *in vitro*, produced an immediate but transient rise of up to 2 per cent, falling to normal in 1½ hours, in six subjects. In our view, this response is probably due to splenic contraction, since Granick[2] has shown numerous siderocytes in teased spleen preparations.

Siderocytes are thus shown to be normal and constant inhabitants of circulating peripheral blood in normal human beings, there being a slight sex difference in level. For most practical purposes, however, a value of 0·5 ± 0·3 per cent will serve as the 'normal' level for human beings above the age of five years. Higher levels have been reported in infants[3], but so far no information is available as to when the level becomes stabilized.

Exercise, iron therapy, and menstruation do not appear to influence the siderocyte levels herein established, nor do they show diurnal variation.

Full details of this investigation will be published elsewhere.

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Structure and Nutrition of the Cornea, Cartilage and Wharton's Jelly

WE have read with great interest the letter by Barcroft *et al.*[1]. Barcroft and his co-workers observed the passage of large molecules in Wharton's jelly of the umbilical cord of fœtal sheep, and they believe that there exists a non-vascular pathway through which nourishment travels along from the placenta towards the fœtus. While there seems to be every justification for this interpretation of the findings, we are of the opinion that this easy and relatively fast passage of large molecules may contribute to the nutrition of Wharton's jelly itself. With a few exceptions[2] (apart from the large umbilical vessels, which are not supposed to give off nourishment for the surrounding tissues) the substance of the umbilical cord is completely avascular. In this respect Wharton's jelly is closely similar to cartilage and the cornea. It is generally accepted that both cartilage and the cornea are nourished by diffusion from the surrounding tissues, and it seems to us that to assume a similar method of nourishment for Wharton's jelly is entirely justifiable. Both Wharton's jelly and cartilage are rich in two closely related substances, mucoitin sulphuric acid and chondroitin sulphuric acid respectively.

Some months ago our attention was directed to the work of Jorpes *et al.*[3] describing the presence of heparin in the substantia propria of the human and bovine cornea. This observation was based on the metachromatic staining reaction of the substantia propria corneæ after toluidin-blue staining. We repeated this method on sections of rabbit, guinea pig, rat and normal human corneæ, and we confirmed the presence of a metachromatic substance. The reaction in the rabbit's cornea, especially after the use of basic lead acetate as a fixing agent, was particularly intense. This staining reaction is strictly confined to the cornea and stops sharply at the corneo-scleral junction. While the real chemical basis of this reaction can be proved only by microchemical analysis, it appears justifiable to suppose that the substance responsible for the specific staining reaction is either heparin, which is a mucoitin polysulphuric acid, or a chemically allied substance, because only these substances give a metachromatic staining reaction with toluidin-blue.

The presence of metachromatic substances in the substantia propria corneæ is not given in standard histological descriptions, although muco-protein was found by Mörner[4] and mucoitin sulphuric acid by Levene[5] after chemical analysis. Krause[6] in his book on the biochemistry of the eye, referring to the above findings, states that the part played by these acids in such "metabolically inactive" tissue as the substantia propria is not known.

It is of interest that the mast cells, which, according to Jorpes *et al.*[3] are responsible for the production and the maintenance of the heparin level of the circulation, give a particularly vigorous metachromatic staining, and consequently the intensity of metachromasia displayed by these chemically related substances can be used within certain limits as a starting point for chemical differentiation.

As previously stated, the cornea derives its main nutrition by diffusion from the margin. We have found numerous mast cells around the capillary loops at the limbus corneæ, and we believe that these cells facilitate diffusion and nutrition by maintaining a high heparin concentration. The translucency of the cornea may also be maintained by and dependent upon the presence of heparin, or some chemically related substance.

The cornea, cartilage and Wharton's jelly are avascular structures, and they all contain similar or closely related metachromatic substances. They all bear the same peculiar relationship to their blood supply, and consequently their nutrition must be similar. Our assumption gains support from the findings of Barcroft *et al.*[1].

Finally, it is significant that the cornea is the only tissue with which successful homografting can be carried out, and the explanation may lie in its chemical structure and peculiar nutritional conditions.

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Mechanism of Bacterial Flocculation caused by Protozoa

WITHIN the last two or three years several investigators[1–4] have reported in these columns that certain Protozoa growing in sewage possess the power of causing flocculation of the bacteria on which they feed, a property which is obviously of value to the organisms themselves, since it facilitates the collection of food bacteria, and may also be of importance in sewage purification.

So far as I am aware, the mechanism of this peculiar phenomenon has not been described. In the holotrichous ciliate *Balantiophorus minutus*, the ability of which to cause such flocculation has already been recorded[5], it has been found that the feeding mechanism involves the production of mucus, secreted within the peristome, to which the food bacteria adhere before being ingested, and are thus prevented from being swept out of the peristome by the ciliary currents. This mucus has been found gradually to accumulate in the culture-fluid and, not being a diffusible substance, remains in the neighbourhood of the ciliates themselves. The resulting local increase in the viscosity of the culture medium causes the entanglement and flocculation of the bacteria. When floccula from *Balantiophorus minutus* cultures are examined under the microscope, the bacteria are seen to be cemented together by an amorphous substance which, upon staining with methylene blue, with mucicarmine and Delafield's hæmatoxylin, or with safranin, shows the metachromatic effect characteristic of mucin with these dyes. Control cultures of the same mixed bacterial flora which have not been inoculated with the ciliate show no flocculation ; and smears, upon staining, give sharp monochromatic coloration, no matrix being visible between the bacteria.

This matter is dealt with more fully in another publication at present in the press.

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[1] *Nature*, **151**, 642 (1943).
[2] *Nature*, **150**, 525 (1942).
[3] *Nature*, **154**, 179 (1944).
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Effect of Temperature on Fertility of the Male

EXPERIMENTAL work on many mammals, including dogs, rabbits, cats, rams and bulls, has shown that in those species with the testicles enclosed in an external scrotum, there is normally a significant temperature difference between the testicles and the body. This temperature difference varies in different species from 1° to 8° C. and is essential for the proper functioning of the testicles. If the temperature of the testicles is artificially raised to body temperature, sperm production is greatly lowered and the animals concerned may to all intents and purposes become sterile. There is, of course, no diminution of desire.

The experiments of Young[1] may be cited as typical of the work which has been carried out on this subject. Young ran hot water (46–47° C.) over the testicles of guinea pigs for periods of 15–30 minutes. He found that some degeneration of the germinal epithelium began immediately and that the consequent diminution of fertility was apparent for twelve days.

This knowledge has important practical application in animal breeding. For example, the sterility of a valuable strain of rams in Australia was shown recently to be due to nothing more than a thick growth of wool on the testicles. When this source of warmth was removed, the fertility of the rams was restored. The sterility of an undescended testicle is apparently due to its being kept at body temperature. If the testicle can be massaged down into the scrotum, it produces sperms.

McLeod and Hotchkiss have reported[2] experiments in this connexion on the human subject. Healthy young men were exposed in a fever cabinet to a temperature of 110° F. for a period of 32 minutes. For eighteen days after the experiment, their sperm counts remained at a normal figure of 300–400 million. The counts then fell to as low as 20 million and remained subnormal for sixty-seven days. Medical evidence quoted in the same paper indicates that with a sperm count less than 60 million a man is almost certainly sterile.

No mention was made in McLeod and Hotchkiss's paper of the possible adverse effects of hot baths on mature males. I investigated this important possibility. The matron of a London hospital told me that the temperature of a patient's bath is about 105° F., which is well above body temperature. The temperature of a domestic hot bath is nearer 110° F., the temperature of the fever cabinet experiments. Dr. John Hammond, with whom I discussed this problem, is of the opinion that such a temperature might reduce human male fertility. He added the interesting information that the fertility of white men is much reduced in the tropics, and that more native children are conceived there in the cooler months. Dr. John Baker, of the School of Comparative Anatomy, Oxford, has raised the question of the possible adverse effects of hot baths purely on the evidence of work on lower mammals[3].

It is not suggested that the hot-bath habit is the sole cause of male infertility, but it would seem to be a fruitful line of research, according closely as it does with the general rise in male infertility, the reduction of the birth-rate in 'civilized' as opposed to backward nations, the greater reduction of the birth-rate in the richer sections of the community, and the peculiar fillip given to the birth-rate by the present War and the War of 1914–18.

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[2] *J. Endocrin.* (1941).
[3] *J. Hyg.*, **27** (1928).

Naturally Occurring Polyesters

MAY I add to the recent note[1] on the isolation of a natural elastic polyester[2] ? The natural occurrence of polyesters was observed as early as 1908 by Bougault and Bourdier[3], who showed that the waxes obtained by extraction of the leaves of a variety of conifers are linear polyesters of hydroxy-acids such as juniperic acid (ω-hydroxypalmitic acid) and sabinic acid (ω-hydroxylauric acid). These polyesters, or 'etholides', have average molecular weights of the order 1,000–2,000, and were afterwards shown to have the same general properties as the synthetic polyesters obtained by heating ω-hydroxy-monocarboxylic acids[4]. The average molecular weights of the natural esters show that they belong to the α-polyester type rather than the ω- or linear superpolyester type synthesized by Carothers and Hill[5]; Bougault appreciated the analogy between the etholides on one hand and polysaccharides and polypeptides on the other.

The etholides (natural and synthetic), which are polyesters derived from the self-condensation of ω-monohydroxy-monocarboxylic acids, are to be distinguished from the second class of linear polyesters synthesized by Carothers and Arvin[6] by the condensation of dihydric alcohols and dicarboxylic acids. The properties of the natural elastic polyester constituting the skin enclosing the seeds of *Smilax rotundifolia* indicate that it is not a *linear* polyester but that a degree of cross-linking of the polymer chains occurs[2].

Kemp and Peters suggest that the principal hydrolytic product of the polyester, an acid of the approximate molecular formula $C_{18}H_{36}O_5$, is a trihydroxy-monocarboxylic acid; if this suggestion is correct, the elastic properties of the natural polymer may be reproduced in synthetic polyesters derived from polyhydroxymonocarboxylic acids.

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[2] Kemp and Peters, *India Rubber World*, **110**, 639 (1944).
[3] *C.R.*, **147**, 1311 (1908); **150**, 874 (1910); **186**, 1746 (1928); *J. pharm. chim.* [6], **29**, 561 (1909); **30**, 10 (1909); [7], **1**, 425 (1910); [7], **3**, 101 (1911).
[4] Lycan and Adams, *J. Amer. Chem. Soc.*, **51**, 635, 3450 (1929). Chuit and Hausser, *Helv. Chim. Acta*, **12**, 463 (1929).
[5] *J. Amer. Chem. Soc.*, **54**, 1559 (1932).
[6] *J. Amer. Chem. Soc.*, **51**, 2560 (1929).

Non-luminous Flame Gases

AFTER flame has travelled through a homogeneous inflammable mixture, the gases left behind ('flame gases') rapidly reach what is for all practical purposes a state of equilibrium. The flame gases (like ordinary open flames) are in general luminous, and their temperatures as determined by (i) calculation, (ii) fine platinum wires and (iii) quartz-covered platinum wires of the same overall diameter, differ by hundreds of degrees C. Typical temperature measurements made with combustible gas – air mixtures during the pre-pressure period in large closed-vessel explosions by means of wires of 0·0005 in. diameter are given in the accompanying table. We think that the explanation is that a proportion of the tri-atomic molecules formed during combustion holds in very stable fashion an excess of energy (probably in virtue of abnormal structure), and because of this an abnormal dissociation takes place, the products of which combine on the plain platinum surface[1,2].

	Temperatures (° C.)	
	28% Carbon monoxide	9% Methane
Calculated ..	2110	1860
Platinum ..	1790	1680
Quartz	1440	1360

In the special case of inflammable mixtures with a very large excess of combustible gas, the abnormal dissociation appears to be suppressed in the flame gases, for the plain and quartz-covered wires yield exactly the same temperatures. These temperatures are far lower than the calculated temperatures[1], and, of course, the flame gases are luminous. When, however, such mixtures undergo combustion in a tube, the flame gases, although luminous after the early stages of flame-front travel from the igniting spark, suddenly become non-luminous after further travel (due apparently to a sudden change in the mode of combustion in the flame front[1]). This rather remarkable phenomenon is vividly demonstrated in the flame photograph shown in Fig. 1, which was taken on a moving film during the explosion of a mixture (88 per cent carbon monoxide plus 12 per cent oxygen) in a glass tube.

We have recently completed a series of plain and quartz-covered wire temperature measurements with such mixtures in a closed iron tube 12 ft. in length and 4 in. in internal diameter. The wires were placed axially along the tube at various points up to 20 in. from the igniting spark. The results for a mixture (90 per cent carbon monoxide plus 10 per cent oxygen) are shown in Fig. 2. It will be seen that when the flame gases are luminous the wire temperatures are more than 200° C. below the calculated temperature, whereas after 15 in. (when the flame gases are presumably non-luminous) they are much greater and are nearly equal to the calculated temperature—indeed even more so than appears, for the wire temperatures are given as measured and have not been corrected for radiation loss either from the flame gases or from the wires. It would appear, therefore, that non-luminous flame gases, unlike ordinary flame gases, are just hot normal gases.

It may be of interest to point out that the flame photographs of Bone and Frazer suggest that non-luminous flame gases are also produced immediately after detonation is set up[3].

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[1] *Proc. Inst. Mech. Eng.*, **151**, 236 (1944) and other papers referred to therein.
[2] *Phil. Mag.*, **34**, 816 (1943).
[3] *Phil. Trans. Roy. Soc.*, **230**, 363 (1931), Photographs Nos. 5, 17, 22 and 32.

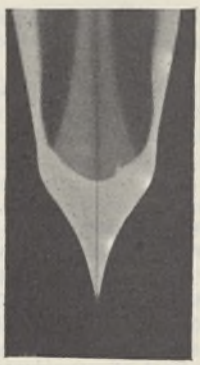


Fig. 1.

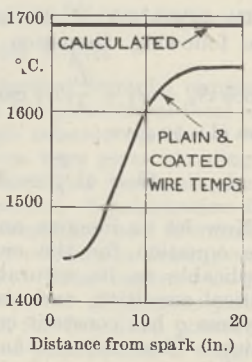


Fig. 2.

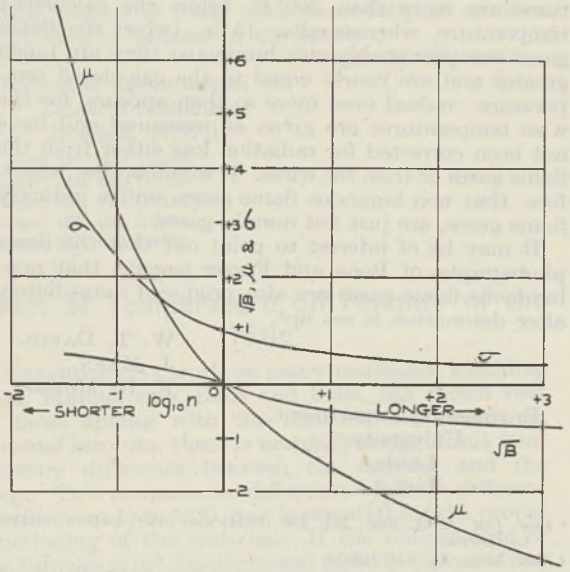
Effect of Length on Tensile Strength

THE results of a large number of tension tests on nominally identical test pieces can conveniently be represented by a frequency curve in which the ordinate gives the frequency of occurrence of test pieces the strength of which is represented by the abscissa. The frequency of occurrence of test pieces the strength of which falls between the limits $x + dx$ and x is given by $f(x)dx$. When the frequency curve is integrated with respect to x and between the limits $-\infty$ and x, an integral curve is obtained the ordinate $F(x)$ of which gives the proportion of test pieces with strength less than x. The proportion of test pieces with strength greater than x is given by $1 - F(x)$. Where the frequency curve does not depart greatly from normality, its characteristics can conveniently be summarized by its mean (μ), standard deviation (σ) and skewness $\sqrt{\beta_1}$.

It is of interest to derive the distribution of strength of rods the length of which differs from those tested. Consider first the strength of rods which are n times as long as those tested.

If the material is statistically homogeneous, such rods can be regarded as being composed of n rods of unit length chosen at random and placed end to end. Fracture will occur when the breaking load of the weakest of the n rods is reached. Owing to the predominance of low results, it would be expected that the mean strength would be lower and that the distribution would be more negatively skew than the distribution for the unit test pieces; and that the standard deviation would be lower. If $F_1(x)$ and $Fn(x)$ are the probability integrals for the strength of test pieces of length 1 and n units respectively, the distribution of the strength of the long test pieces is obtained by calculating the chance that n unit test pieces chosen at random shall all be stronger than a given strength; for this is the chance that the weakest of n test pieces shall exceed the given strength.

Thus $1 - Fn = (1 - F_1)^n$. This result was given by Pierce[4].



DISTRIBUTION PARAMETERS WHEN UNIT CURVE IS NORMAL.

The similar problem of determining the distribution of strength of test pieces shorter than the unit test piece does not seem previously to have been treated. Consider each unit test piece as divided up into m equal parts, and consider the distribution of strength which would be expected if each part were tested separately. Each strength figure, which had previously been obtained for the unit test pieces, would again be obtained, and associated with each of these strengths there would be $(m - 1)$ results of higher strength.

Owing to the predominance of high results, it would be expected that the mean strength and standard deviation of the distribution of the shorter test pieces would be greater than those of the distribution of the unit test pieces, and that the curve would be positively skew. The probability integral for the short test pieces ($F\ 1/m$) is obtained by stating that the distribution of the least of the strengths of m test pieces taken at random is the same as the distribution of strength of the unit test pieces. Thus

$$\left(1 - F\frac{1}{m}\right)^m = 1 - F_1,$$

$$\text{or } 1 - F\frac{1}{m} = (1 - F_1)^{1/m}.$$

It is thus seen that the same formula holds for n less than unity (equal to $1/m$) as for n greater than unity. In the special case in which the distribution of the strength of the unit test pieces is normal, the characteristics of the distribution for other lengths have been computed and are shown in the accompanying curve. For n integral the results given by Tippett[2] have been used, while for n fractional the results have been worked out using Sheppard's Tables[3]. Values of the normal distribution beyond the range given in these tables were required and these were evaluated by Sheppard's method. The unit of the ordinates of the curves of σ and μ is the standard deviation of the distribution of strength of the unit test pieces. To obtain the mean strength of test pieces of given length, the appropriate value of μ multiplied by the standard deviation of the unit distribution must be added to the mean of the unit distribution. From the graph it is seen that both mean and standard deviation increase rapidly for fractional lengths and decrease more gradually for integral lengths. For lengths greater than unity, the distributions are negatively skew; and for lengths less than unity, they are positively skew.

The practical use of these results requires very careful consideration and as it cannot be dealt with briefly, it will form the subject of a report to be published elsewhere.

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Nov. 22.

[1] Pierce, R. H., *J. Text. Inst.*, 17 (1926).
[2] Tippett, L. H. C., *Biometrika*, 17 (1925).
[3] Sheppard, W. F., "B.A. Mathematical Tables", 7.

Entropy of Saturated Liquid-Vapour Mixtures, and Trouton's Rule

IT is well known that the entropy of a saturated vapour usually diminishes continually as the saturation temperature and pressure increase up to the critical values. On the other hand, the entropy of the saturated liquid increases continually. At any equilibrium below the critical, the vapour entropy S_v is greater than the critical entropy S_c, while the liquid entropy S_l is less. Thus it is possible to define a mixture of saturated liquid and vapour, say, of dryness q, such that the entropy of the mixture will be equal to the entropy at the critical point. The defining equation will be

$$(1 - q)S_l + qS_v = S_c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For a number of substances, the value of q so defined varies but little over the whole range from the triple point to the critical point. Thus, for such substances, there is a particular mixture the entropy of which is approximately constant at the critical value. Table 1, obtained by examining tabulated data, shows mixtures the calculated entropies of which differ by no more than 10 per cent from the critical entropy over the whole range of available data, in some cases down to the freezing point, although the vapour and liquid entropies vary widely.

TABLE 1. MIXTURES GIVING APPROXIMATELY CONSTANT ENTROPY.

Substance	CH_3Cl	CCl_2F_2	CH_3Br	NH_3	CO_2	H_2O
q	0·63	0·89	0·29	0·554	0·61	0·50

Consideration of this circumstance has suggested the following discussion of a definable ideal case.

Since $S_v = S_l + \frac{L}{t}$, S_l can be eliminated from equation (1), to give

$$(1 - q)\frac{L}{t} = S_v - S_c \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now let us imagine an ideal substance such that the equation for the entropy of a perfect gas is applicable to its saturated vapour right up to a critical condition, and also such that its mixture of dryness q has constant entropy equal to the critical value. Then substitution in equation (2) will give the following expression for its heat of vaporization :

$$(1-q)\frac{L}{Rt} = \frac{5}{2}\log\frac{t}{t_c} - \log\frac{p}{p_c} \quad . \quad . \quad . \quad . \quad (3)$$

Assuming that real substances may be considered to approach this ideal, we can substitute in equation (3) experimental values of boiling points and heats of evaporation at a given pressure, say, atmospheric, and the critical temperatures and pressures, and so calculate values of q (Table 2).

TABLE 2. CALCULATED VALUES OF q FOR IDEAL CONDITIONS.

Substance	He	H_2	N_2	O_2	HCl	Cl_2	CO_2	CS_2
q	0·840	0·745	0·755	0·720	0·715	0·692	0·805	0·735

Substance	C_6H_6	C_6H_7N	NO	NH_3	C_2H_5OH	H_2O
q	0·742	0·741	0·752	0·720	0·768	0·693

It is immediately obvious from Table 2 that the values of q so calculated are nearly equal for all the substances. The average is 0·746, which is nearly equal to 0·75. This may be of significance, since it gives a whole number ratio, 3/1, of molecules in the vapour phase to molecules in the liquid phase.

Thus a number of real substances behave approximately in such a way that their heats of vaporization and boiling points at atmospheric pressure are related to their critical temperatures and pressures as would be those of an ideal substance having the perfect gas laws for its saturated vapour, and a constant entropy for its mixture containing 3 molecules of vapour to 1 of liquid. The 3/1 ratio may be related to the packing volume of spherical symmetry.

It will be clear that use of this idea, and consequently substituting $q = 0{\cdot}75$ in equation (3), will predict values of $\frac{L}{t}$, so that the suggestion gives something corresponding to Trouton's rule. But Table 3, which compares experimental values of $\frac{L}{t}$ with values calculated on $q = 0{\cdot}75$, shows it is more accurate than Trouton's rule.

TABLE 3.

Substance		He	H_2	N_2	O_2	HCl	Cl_2	CO_2	CS_2
$\frac{L}{t}$	Expt.	5·1	10·8	17·3	18·1	20·7	19·2	31	21
	Calc.	3·3	11·0	17·1	20·2	23·7	23·6	24·3	22·1

Substance		C_6H_6	C_6H_7N	NO	NH_3	C_2H_5OH	H_2O
$\frac{L}{t}$	Expt.	20·8	21·9	26·7	23·4	27·2	26·0
	Calc.	21·5	22·7	26·5	26·2	25·2	32·0

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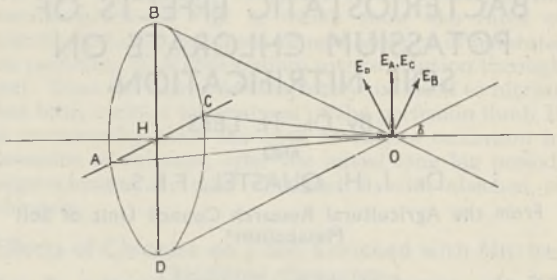
Resolving Power of the Microscope using Polarized Light

IN a recent paper[1] I derived formulæ expressing the distribution of light in the geometrical focal plane of optical systems of high relative aperture; and, using these formulæ, curves were given showing the distribution of light in directions perpendicular to, and parallel with, the direction of polarization for a system fulfilling the sine-condition, and of numerical aperture equal to 0·77. A conclusion drawn, on the basis of this work, was: "The curves . . . have bearing on the resolving power of microscopes. A variation of the resolution for two fixed points with rotation of the direction of polarization is suggested by them".



A paper has now come to my notice which confirms the existence of such a variation. In "An Application of Polarised Light to Resolution with the Compound Microscope"[2], Stump refers to a note in Carpenter's "The Microscope and its Revelations" (p. 325, 1891 edition) which records, as an unexplained fact, that by placing a Nicol analysing prism over the eyepiece "the effect [of resolution] is much strengthened". Stump examined a number of objects having minute periodic structure, and "it was found that in all cases where the prism was set so as to pass light vibrating in a plane parallel to the striæ being shown, a clearer image was formed than when the prism was not used". This is fully in accord with the results I obtained mathematically, of which there seems possible a simple physical explanation.

In the diagram, HB is the direction of vibration of the light vectors in the incident plane-polarized wave; and $ABCD$ is an annulus of the emergent converging spherical wave. Elements of the wave passing through A, B, C, D proceed to the focus at O along the ray-paths AO, BO, CO, DO. At O the disturbances associated with A, B, C, D are E_A, E_B, E_C, E_D; of which E_A, E_C have full effect; whereas E_D, E_B cancel along the direction HO, and along the direction of E_A, E_C have effective magnitudes $E_D \cos\delta$ and $E_B \cos\delta$, where δ is the angular semi-aperture of the annulus $ABCD$. Thus, relative to the meridian HC, the effective amplitude along HB is attenuated; and in the direction HC there is a greater concentration of energy in the outer parts of the wave. This state of affairs leads to a narrower diameter of the Airy disk in the direction HC, and a (relatively) broader diameter in the direction HB. That is, striæ with their lengths in the direction HB will be better resolved than those along HC.

Evidently the resolution with the prism in its position of maximum effect will be greater than that using non-polarized light. This was found to be the case by Stump (*loc. cit.*): ". . . a clearer image of the striæ was formed than when the prism was not used".

Stump attempted a very inadequate and tentative explanation of the phenomenon, and urged the use of as many separate beams as there were structural elements—claiming that the final image "would then be a composite, formed by the blending of several independent images, each showing some particular element in the structure". A photograph of the surface structure of *Amphipleura pellucida* is given in support of the claim.

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[1] *Proc. Phys. Soc.*, **55**, 116 (1943).
[2] *J. Roy. Mic. Soc.*, 264 (1922).

BACTERIOSTATIC EFFECTS OF POTASSIUM CHLORATE ON SOIL NITRIFICATION

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AND
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From the Agricultural Research Council Unit of Soil Metabolism*

IN the course of studies on the kinetics of soil nitrification, using our perfusion technique[1], we have observed a remarkable inhibitory effect of potassium chlorate on the conversion of ammonia into nitrate. We propose briefly to describe some of our main findings concerning the effects of chlorate on this important metabolic process in soil.

Technique

Our technique consists in perfusing a column of soil with oxygenated fluid by a circulatory process. The fluid, which contains in solution the substances the metabolism of which is being investigated, is made to percolate through the soil into a flask where it is mixed and aerated, and whence it is made to drain again through the same soil. The process is continuous and may be maintained for an indefinite period. The soil is left intact throughout the experiment, and analyses are made only on the soil perfusate. The rate of perfusion is such that no waterlogging of the soil takes place. The soil is well aerated and experiments in which oxygen is substituted for air have shown that aeration of the soil is, under our normal experimental conditions, optimal for nitrification.

The kinetics of metabolic events in the soil may be accurately studied by this technique, since it ensures constancy of oxygen supply and water content throughout the soil. The temperature is kept constant at 70° F. by thermostatic control. Substances, the effects of which on the course of soil nitrification are being studied, can be added to the perfusion fluid at any time in the experimental period without handling or disturbance of the soil, and the subsequent rates of nitrification can be accurately measured.

The soil is, in fact, treated throughout the experiment as a biological whole, every effort being made to ensure constancy of the environment in which the soil is exercising its metabolic changes, except in so far as changes in the environment are brought about by the products of metabolism.

The soil is usually air-dried at room temperature and sieved. The fraction 4–1 mm. is found convenient for perfusion purposes, and although any quantities may be used, depending upon the nature of the experiment, we have usually used 30–50 gm. in these studies.

Effects of Potassium Chlorate on the Velocities of Nitrite and Nitrate Formation in Soil

When ammonium sulphate solution is perfused through a soil, nitrification commences after an initial lag period, and nitrate accumulates until all the ammonia has been utilized. Traces of nitrite also appear in the early stages but disappear again as nitrification proceeds. When, however, a mixture of ammonium sulphate and potassium chlorate is perfused through soil, nitrite accumulates instead of nitrate. The sum of the nitrite and nitrate, formed by the ammonia oxidized, is only slightly affected by the chlorate when this is used in relatively small concentrations. Typical results are shown in Table 1. They show that chlorate exercises a specific inhibitory influence on the conversion of nitrite into nitrate, and that the mechanisms concerned with the initial oxidation of ammonia are practically unaffected. The results also supply direct proof that oxidation of ammonia in soil to nitrate proceeds *via* the intermediate formation of nitrite. While few have seriously doubted that nitrite is an intermediate in this process, the evidence so far has been indirect and could not be regarded as supplying satisfactory proof of the essential intermediate role of nitrite.

TABLE 1. INITIAL RATES OF NITRITE AND NITRATE FORMATION DURING PERFUSION OF 200 ML. OF *N*/100 AMMONIUM SULPHATE SOLUTION THROUGH 30 GM. OF AN ARABLE SOIL, IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE.

Time in days from start of perfusion	Nitrite γ N/ml. perfusate		Nitrate γ N/ml. perfusate		Nitrite + Nitrate γ N/ml. perfusate	
	In absence of $KClO_3$	In presence of *M*/2000 $KClO_3$	In absence of $KClO_3$	In presence of *M*/2000 $KClO_3$	In absence of $KClO_3$	In presence of *M*/2000 $KClO_3$
1	2	3	4	2	6	5
3	5	8	12	10	17	18
4	5	13	17	8	22	21
5	5	23	28	5	33	28
7	2	44	55	2	57	46

Effects of Potassium Chlorate on Nitrite Oxidation in Soil

When sodium nitrite is perfused through soil, rapid oxidation to nitrate takes place after an initial lag period due presumably to the slow development of nitrite-oxidizing organisms in the soil. The presence of chlorate at so low a concentration as $M \times 10^{-5}$ markedly inhibits the process. Typical results are given in Table 2, which show that sensible inhibitory effects occur with $2{\cdot}5 \times 10^{-6}$ *M* chlorate.

TABLE 2. RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML. OF *M*/280 SODIUM NITRITE SOLUTION THROUGH 30 GM. OF GARDEN SOIL IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE. INITIAL VALUE OF NITRITE *N* = 333 γ/GM. SOIL.

Concentration of $KClO_3$ added to perfusate	Time in days from start of perfusion							
	3	4	5	6	7	8	9	11
	Percentage nitrite oxidized							
Nil	0	60·6	98·7					
$2{\cdot}5 \times 10^{-6}$ *M*	0	43·2	71·7	95·4	98·1			
$5{\cdot}0 \times 10^{-6}$ *M*	0	20·7	38·1	59·1	89·1	96·9		
$10{\cdot}0 \times 10^{-6}$ *M*	0	22·2	35·1	50·4	57·6	65·7	76·8	96·0

Effects of Potassium Chlorate, at Low Concentrations, on Ammonia Oxidation

Perfusion of ammonium sulphate through the soil in presence of very small concentrations of potassium chlorate has given results which show that although nitrite accumulates, it disappears in time. This disappearance is apparently not due to destruction of chlorate, because chemical and biological tests have indicated that chlorate is still present when nitrite oxidation has been completed. This phenomenon of nitrite accumulation is shown in Fig. 1. It will be observed (from Curves 4 and 5) that when relatively high concentrations of nitrite are formed, a long

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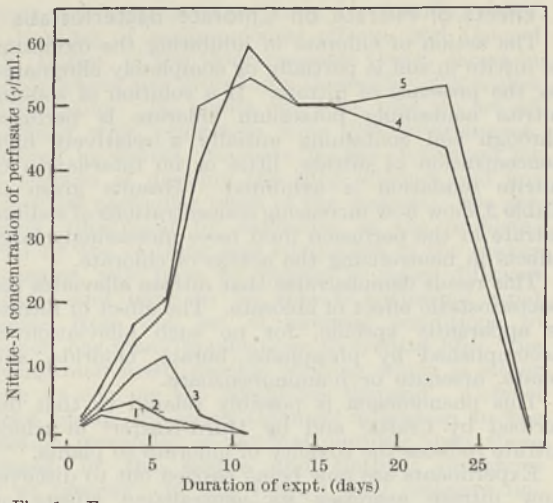

Fig. 1. EFFECT OF POTASSIUM CHLORATE ON NITRIFICATION OF 200 ML. *M*/200 AMMONIUM SULPHATE BY 30 GM. OF ALLOTMENT SOIL. Conc. of potassium chlorate present: Curves 1, nil; 2, *M*/540,000; 3, *M*/180,000; 4, *M*/60,000; 5, *M*/20,000.

latent period of about fourteen days elapses before the nitrite disappears. After this period the rate of nitrite oxidation is normal. Since chlorate is still circulating at the end of the experiment, it follows that the oxidation of nitrite takes place in spite of the presence of the chlorate.

This result is consistent with the view that the chlorate does not markedly retard the actual chemical process of nitrite oxidation in the soil to nitrate, but rather that it inhibits the proliferation of those cells responsible for this oxidation. The initial burst of nitrite formation is due to the fact that the development of the ammonia-oxidizing organisms is unaffected by the chlorate, whereas that of the nitrite-oxidizing organisms is very greatly reduced. The latter do, however, develop slowly, presumably during the long latent period, until sufficient cells are produced to account for the final fast phase of nitrite oxidation.

It is, in fact, characteristic of the action of chlorate that it causes an initial lag, of variable duration, in the rate of oxidation of nitrite. This is seen in the results given in Fig. 2, which show the rates of nitrite oxidation, in presence and absence of chlorate, on perfusion of *M*/280 sodium nitrite solution through soil. That the nitrite is completely oxidized to nitrate has been verified by analyses of the perfusion fluid. It is noteworthy that the rate of nitrite oxidation in presence of chlorate, *after* the initial long lag period, approximates to that obtained in the absence of chlorate.

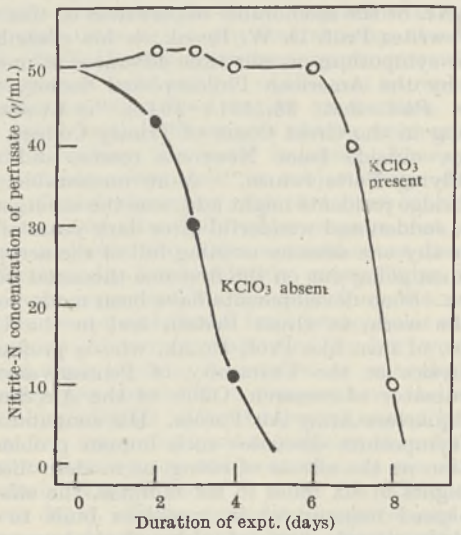

Fig. 2. NITRITE OXIDATION IN THE PRESENCE OF *M*/10,000 CHLORATE (FRESH SOIL).

Effects of Chlorate on a Soil Enriched with Nitrite-Oxidizing Organisms

If the view is correct that chlorate exercises its inhibitory effect largely by retarding the proliferation of nitrite-oxidizing organisms and not by poisoning the oxidative mechanism involved in nitrite utilization, it follows that chlorate should not prevent nitrite oxidation in a soil which has been enriched with the appropriate organism.

For experiment, soils were perfused with water alone and with sodium nitrite solution containing 50 γ of nitrite nitrogen per ml. for four days (until the nitrite was completely utilized). After this period, the perfusion fluids were changed, the soils were thoroughly washed with water and re-perfused with fresh solutions of sodium nitrite, with and without the addition of potassium chlorate. The velocities of nitrite disappearance were measured and are shown in Fig. 3. They show that chlorate exercises a small inhibition of the rate of nitrite oxidation in a previously nitrite-perfused soil, but that there is no initial lag period in the rate of nitrite disappearance. The same phenomenon occurs with soil previously perfused with water, though the subsequent rates of nitrite utilization are somewhat less. These results are consistent with the view that nitrite perfusion in a soil (in absence of chlorate) enriches it with nitrite-oxidizing organisms, which can then bring about their oxidations even in the presence of chlorate. Water perfusion of a soil results in a similar (though smaller) enrichment of these organisms owing to the fact either that traces of undecomposed nitrites are present in the soils, or that nitrite is being formed from the nitrogenous matter still in soil. A soil, however, initially perfused with chlorate (and con-

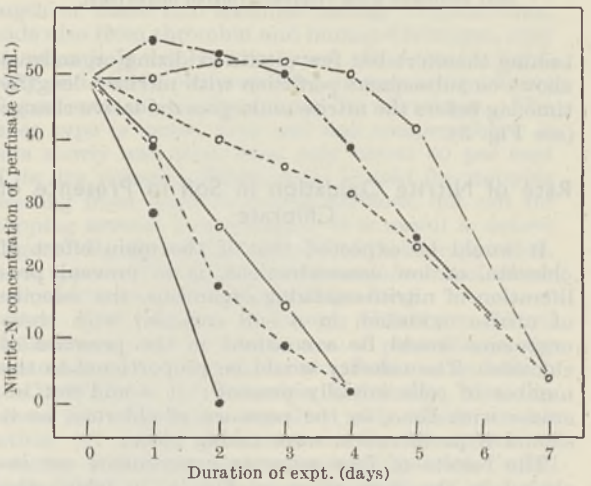

Fig. 3. INITIAL PERFUSION: – – –, WATER; ——, NITRITE; – · –, CHLORATE. SECOND PERFUSION: ●, NITRITE ALONE; ○, NITRITE PLUS *M*/10,000 CHLORATE.

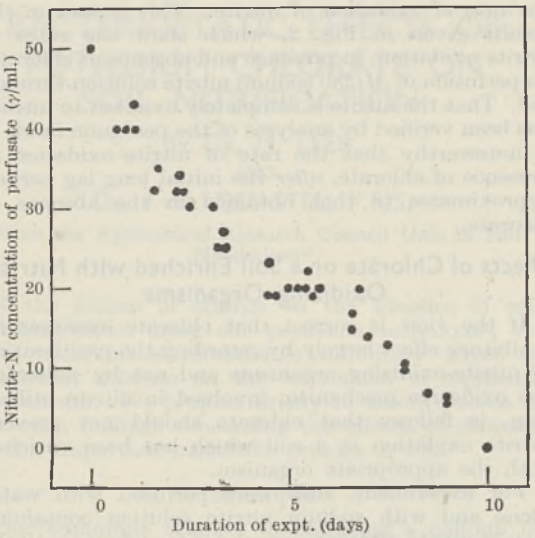

Fig. 4. NITRITE OXIDATION IN THE PRESENCE OF CHLORATE (SOIL ENRICHED WITH NITRITE-OXIDIZING ORGANISMS).

taining therefore but few nitrite-oxidizing organisms) shows on subsequent perfusion with nitrite a lengthy time lag before the nitrite undergoes oxidative change (see Fig. 3).

Rate of Nitrite Oxidation in Soil in Presence of Chlorate

It would be expected that if the main effect of chlorate, at low concentrations, is to prevent proliferation of nitrite-oxidizing organisms, the velocity of nitrite oxidation in a soil enriched with these organisms would be a constant in the presence of chlorate. The velocity would be proportional to the number of cells initially present; it would not increase with time, in the presence of chlorate, as it should if proliferation were taking place.

The results of four separate experiments are included in the data given in Fig. 4, in which the nitrite content of the perfusion fluid at any moment is plotted against time. The soils were enriched with nitrite-oxidizing organisms by initial perfusion with sodium nitrite, and then they were perfused with $M/280$ sodium nitrite solution containing potassium chlorate. Three concentrations of chlorate, $M/10{,}000$, $M/20{,}000$, $M/40{,}000$, were used, but much the same results were obtained with all three.

Fig. 4 should be a straight line if the velocity of nitrite oxidation is constant. It will be seen that there is a close approximation to linearity, indicating the largely bacteriostatic action of chlorate.

TABLE 3. RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML. $M/280$ SODIUM NITRITE CONTAINING $M/2000$ POTASSIUM CHLORATE THROUGH 50 GM. GARDEN SOIL, IN THE PRESENCE AND ABSENCE OF NITRATES.

Concentration of sodium nitrate added initially to perfusate	Time in days from start of perfusion								
	0	3	5	7	10	12	14	17	19
	Nitrite N, γ/ml. perfusate								
Nil	50	54	51	55	55	56	52	52	50
$M/400$	50	54	50	54	51	48	45	25	0
$M/200$	50	53	50	50	48	45	36	14	0
$M/100$	50	56	47	40	20	0			
$M/50$	50	39	29	20	0				

Effects of Nitrate on Chlorate Bacteriostasis

The action of chlorate in inhibiting the oxidation of nitrite in soil is partially or completely eliminated by the presence of nitrate. If a solution of sodium nitrite containing potassium chlorate is perfused through soil containing initially a relatively high concentration of nitrate, little or no retardation of nitrite oxidation is exhibited. Results given in Table 3 show how increasing concentrations of sodium nitrate in the perfusion fluid have increasingly large effects in neutralizing the action of chlorate.

This result demonstrates that nitrate alleviates the bacteriostatic effect of chlorate. The effect of nitrate is apparently specific, for no such alleviation is accomplished by phosphate, borate, chloride, sulphate, arsenate or *p*-aminobenzoate.

This phenomenon is possibly related to that described by Crafts[2] and by Hurd-Karrer[3] in which nitrate reduces the toxicity of chlorate to plants.

Experiments are now being carried out to discover how nitrate exercises its neutralizing effects on chlorate inhibition.

Summary

Potassium chlorate at low concentrations (*c.* $M \times 10^{-5}$ to $M \times 10^{-6}$) exercises a bacteriostatic action on soil organisms oxidizing nitrite to nitrate. The effect is specific, as chlorate at these concentrations has little or no effect on the conversion in soil of ammonia into nitrite. Chlorate administration to a nitrifying soil thus results in nitrite accumulation. Chlorate has little or no effect on nitrite oxidation in a soil which is rich in nitrite-oxidizing organisms. Its effect at low concentrations seems almost wholly concerned with the inhibition of the proliferation of these micro-organisms.

The bacteriostatic action of chlorate is specifically neutralized by the presence of nitrate, the alleviating action of which increases with its concentration.

[1] Lees and Quastel, *Chem. and Ind.*, 238 (1944).
[2] Crafts, *J. Agric. Res.*, 58, 637 (1939).
[3] Hurd-Karrer, *Amer. J. Bot.*, 28, 197 (1941).

WAR-TIME MEDICAL PROGRESS IN AMERICA

"ONE of the memorable experiences of this war," writes Prof. D. W. Bronk, in his contribution to the symposium on war-time advances in medicine held by the American Philosophical Society (*Proc. Amer. Phil. Soc.*, 88, 151; 1944), "is to stand at evening in the Great Court of Trinity College, Cambridge, outside Isaac Newton's rooms, and watch the Flying Forts return." More memorable, some Cambridge residents might add, was the unforgettable sight, sudden and wonderful after dark years of trial, of the sky one summer evening full of the aeroplanes and men going out on the first one-thousand bomber attack. Such developments have been made possible by the work, in Great Britain and in the United States, of men like Prof. Bronk, who is professor of biophysics at the University of Pennsylvania and co-ordinator of research, Office of the Air Surgeon, Headquarters Army Air Forces. His contribution to this symposium discusses such human problems of aviation as the effects of rising, as modern fliers do, to heights of six miles in six minutes, the effects of high-speed manœuvres in machines built to withstand the stresses involved (although the human body is not) and problems of night flying and vision.

Such problems could no doubt be classified under the heading of environmental effects, and Colonel G. F. Doriot, of the Quartermaster Corps, shows in another article how profoundly these affect the soldier and the sailor. He points out, also, that we are all concerned with protection from the environment. Clothing, he thinks, has been largely developed for the purpose of dressing the shop window and not to suit the particular tasks of the wearers. His discussion, illustrated by diagrams, of the problems raised by the clothing and equipment of the soldier and sailor, who have to operate in many different climates and have to be able to withstand rapid changes from one set of external conditions to another, has many applications to civilian life. The fighting man needs flexible clothing which is either warm or cool as the conditions demand. Colonel Doriot pleads for more technical education in the scientific principles of rational clothing than those engaged in the textile and clothing industries get at present; in this respect they compare unfavourably, he suggests, with a number of other industries. Fundamental researches are required. To select only one detail, Colonel Doriot rightly considers the problem of boots of great importance, and this point is also emphasized by Prof. E. A. Strecker, of the University of Pennsylvania, in his article on neuropsychiatry. The foundations of morale, Prof. Strecker says, are simple and obvious things, such as satisfactory living conditions, good, appetizing and well-cooked food, comfortable and nice-looking uniforms and, above all, easy-fitting shoes. Sport and diversion are also important. His discussion of fear, which can, he says, no more be suppressed than the heart-beat can be stilled, is full of common sense. Important for those at home is his statement that morale fell when soldiers heard of strikes in the coal and other industries.

Another problem of the environment is discussed by Prof. J. L. Gamble, of Harvard Medical School, in his article on the water requirements of castaways, a subject which has been much studied in Great Britain as well as in the United States (see, for example, Macdonald Critchley's Bradshaw Lecture on "Shipwreck Survivors" (London: J. and A. Churchill, 1943) and the work sponsored by the Medical Research Council Committee on the Care of Shipwrecked Personnel). Assessing the water requirement during fasting with little or no physical activity at about 700 c.c., Prof. Gamble describes experiments which indicate that at least 100 c.c. of this can be replaced by glucose or other food sugars or starches, with all the physiological advantages of this replacement, without disturbing the water balance. There was an appreciable water gain in subjects who drank 500 c.c. of sea water every day (3–4 litres would be needed to cover the daily water requirement of a castaway and even 500–600 c.c. would cause disturbing effects). In these subjects extracellular fluid volume was conserved by the gain from sea water and by increased withdrawal from intracellular water. Experiments done near Cape Cod in hot weather indicated that periodic immersion or wet clothing completely prevented loss of water above the basal rate. Solar radiation without a breeze caused loss of water at ten times the basal rate (more than 2 litres were thus lost by one subject, who, in six hours, thus wasted enough water to cover his intake need for three days). Shade, periodic immersion and wet clothing completely prevented this. Most impressive of all was the protection from water loss afforded by a breeze (fortunately rarely absent). The castaway's great risk is therefore hot, wind-less weather.

Dr. E. J. Cohn, of Harvard Medical School, contributes a valuable article on blood, blood derivatives and blood substitutes, with a bibliography of forty-eight references, mostly American. The contents of this paper can only be briefly indicated. It discusses plasma proteins, the dimensions in Angstrom units of these proteins and those of suggested blood substitutes, the equilibrium between the albumins and globulins of plasma and the tissues, the dissociation of the globulin molecules of plasma, the separation and concentration into fractions of the plasma albumins and globulins and their stability when separated. The article also discusses the use of gamma globulin antibodies for the prevention of measles and of isohæmagglutinins in the typing of blood. The remarkable properties which the long, rod-shaped molecules of fibrin confer on fibrin films, made from fibrinogen and thrombin, are described. These films can be used as substitutes for the dura mater in neurosurgery of the brain. Their mechanical properties recall those of plastics; they can, for example, be stretched to twice or three times their original length or made into seamless tubing. Fibrin foam, made also from thrombin and human fibrinogen, may be, when it is dry, of two types. One type is light, fluffy and highly compressible; it wets easily, losing 90 per cent of its dry volume by shrinkage. The other type is dense, firm and less compressible; it wets slowly and then loses only about 50 per cent of its dry volume. Fibrin foam is used for stopping bleeding from veins or oozing surfaces, but not for stopping arterial hæmorrhage; it is useful in neurosurgery. By appropriate control of their preparation, other types of fibrin-clot can be made, some of which are used in surgery or for skin-grafting.

Prof. C. S. Keefer, of Boston University School of Medicine, deals with the use of penicillin in the treatment of various bacterial infections, and Prof. A. O. Whipple, of Columbia University, also discusses this substance, together with others, in his article on recent advances in the treatment of wounds. R. E. Dyer, assistant surgeon-general, United States Public Health Service, writes about immunology. He directs attention to recent improvements in the immunizing potency of typhoid vaccine and the discovery and improvement of vaccines against yellow fever and typhus fever and of tetanus toxoid. Compulsory use of tetanus toxoid has removed the menace of tetanus from the United States military and naval forces; we are informed that tetanus is, for the same reason, no longer a menace to British fighting men. Further improvements in these and other immunizing procedures may be expected before long.

Perhaps the most thought-provoking article in the symposium is that contributed by Prof. R. J. Dubos, the discoverer of gramicidin. Drug therapy, he argues—and many experienced observers will agree with him—constitutes only one facet of the complex problem of infection, and we should not be led away from these other aspects by the spectacular and popular appeal of recent chemotherapeutic achievements. Our difficulty is not to prepare more and more antibacterial substances, but to find out how they act in the body. They do not act as gross protoplasmic poisons, but selectively inhibit some vital process in the parasite's life. We need much more work on the problem of how they act.

There have been, on the other hand, important epidemiological and immunological advances towards

the control of such serious diseases as smallpox, yellow fever, diphtheria and infestations with such animal parasites as the hookworms and the schistosomes. We should study the host-parasite relationship much more, including micro-organisms among the parasites, and get away from the rather narrow channels into which the very rapidity of the success of serological and immunological research has directed investigation. The whole picture should be studied by resuming broad biological and biochemical studies of the host and its bacterial and animal parasites. So far as the bacteria are concerned, the study of the complex property of parasites which we call virulence is important. A given parasite can cause epidemics or disease only when it has been able (1) to reach a susceptible host, (2) to overcome the cellular and humoral defences of that host, (3) to multiply in it, and (4) to damage it. Each of these factors can vary independently of the others. In order to cause an epidemic, the parasite must possess them all at the same time. A highly pathogenic strain of hæmolytic streptococci, for example, may have only a low degree of communicability, and the converse may be true of other strains. The study of the resistance of the host is likewise very important, and there are other factors which the epidemiologist must consider. Prof. Dubos believes that we shall eventually be able to predict the course of epidemics and to organize 'listening posts' which will detect qualitative and quantitative changes in the number of infectious agents and in those of their properties which affect their virulence. A beginning in this direction has already been made.

It is a matter for conjecture, Prof. Dubos considers, whether preventive chemotherapy will ever become advisable or effective, but preventive immunological treatment can certainly be effective, as immunization against smallpox, typhoid, diphtheria and other diseases has shown. High degrees of immunity produced by means of killed bacterial cultures are, however, very specific and do not protect against related organisms of another immunological type, so that type-specific immunity protects against only the particular organisms concerned. For this reason, effective immunization of whole populations with type-specific vaccines may be impossible. It is, nevertheless, possible in some instances, for example, the pneumococci, to direct the immune response against a component of the bacterial cell which is common to all types of pneumococci. Possibly bacterial cell components will be found in all bacterial groups which can be attacked in this way, so that we may eventually be able to immunize against all the types of each group. The non-specific immunization of this kind which has so far been achieved is, however, lower than that produced by type-specific vaccines; but more research into it might enable us to raise its potency. We have hitherto studied type-specific immunization almost exclusively. Immunization techniques, moreover, have been up to now primitive in their principle of killing the pathogenic organism with heat or antiseptics. It is certain that a very large percentage of the material injected in anti-typhoid vaccination has no immunological value at all and even causes unfavourable reactions in those to whom it is given. It is very important to isolate the chemical components of the cell which do produce the immunity. If we could do this, we might, in the distant future, prepare artificially the substances required to produce the immunity.

G. LAPAGE.

ORGANIZATION OF INDUSTRIAL RESEARCH

FUTURE historians will no doubt record that the opening decades of the twentieth century were characterized by the beginning of a systematic application of the results of scientific research to everyday life and the consequent foundation of research organizations, both large and small, mainly devoted to the best utilization of new knowledge in the service of commerce and industry. Moreover, these organizations, staffed by professional research workers together with technicians and other assistants in considerable numbers, stood out in striking contrast to the research conditions of the days of Faraday, Joule and Kelvin, when even advanced technological research was an entirely private venture. It is often forgotten to-day how young in years organized industrial research really is, and that while there are certain industries, such as heavy chemicals and electrical engineering, which have expanded on a vast scale with laboratories widely distributed over Great Britain, there are also other industries, deeply rooted in history, having as yet no medium for the exploration of fresh ideas and wholly dependent on traditional techniques.

At a meeting of the London Branch of the Institute of Physics on February 17, Dr. R. E. Slade, speaking from a wide practical experience, dealt with those factors which he regards as essential to the successful organization of research in the laboratories of manufacturing firms where most industrial research is now done.

Dr. Slade began by pointing out that the laboratory must be a well-run unit constituting an integral part of the firm's activities and in full sympathy with the industry which it is trying to serve. Research is admittedly an individualistic operation, and its success is not a mere question of organization, though organization can facilitate the performance of the work; for this reason, the director or research manager should himself be an experienced researcher, able to inspire the workers under him, but suiting his methods to the personalities of the various section leaders. "There is room in every laboratory for a scientifically trained organizer to do the administrative work for the director, so as to relieve him of as much administrative work as possible." The ideal chemical research laboratory would thus consist of a director and an administrator with six section leaders, five having charge of researches and the sixth looking after services including the library, analytical department and workshop. Probably the most efficient size of industrial chemical laboratory would have sixty to a hundred university-trained workers and up to four hundred other workers. There is always a tendency for a laboratory to increase in size, but while it is cheaper to allow this rather than start a second new laboratory, it is not advisable to let the laboratory become so big that the director cannot know all his men and be prevented from exercising his personal influence and encouragement. "Not only do we want laboratories with distinctly different outlooks, but we want in each laboratory men with different kinds of training who will look at problems in different ways and tackle them in different ways, too."

Dr. Slade does not believe that the direction of a laboratory can be carried out effectively by a committee; he admitted the utility of advisory panels, but

emphasized that the success of the laboratory depends upon the director being a research worker, capable of directing the laboratory, and having also the capacity of making a committee believe that it is directing the work when he is in reality leaving it to the common sense and ability of the section leaders. Moreover, if a company is to gain full value from its research department, there must be a director on the board of management who knows what research might do for it, and this director should himself have had research experience.

Industry must be alive to developments which may take place in any of the sciences; for example, the chemical industry needs to employ mathematicians, physicists, metallurgists and biologists. In regard to physicists, it would seem that they have not in the past been used to full advantage, for they have often been engaged as narrowly specialized technicians such as X-ray crystallographers and spectroscopists, instead of being given the opportunity of examining industrial problems in their entirety and so determining how best physical knowledge may be applied and what factor needs to be measured and to what degree. Similarly, the metallurgist should not be brought in, for example, when pipes have already corroded and broken down, but should be given the opportunity to see that industry has pipes that will stand up to manufacturing conditions.

One of the great problems of present-day industrial research lies in the difficulty of acquiring new specialized techniques as they appear. No laboratory is big enough to keep a specialist in every possible technique, and so workers have to be sent to the originator of the technique as students. This method is too slow for industry, and Dr. Slade thinks that a national central laboratory of scientific techniques should be set up to serve industry in this field.

The cost of research is £1,500–£3,000 per annum per university-trained research worker employed, including assistants, mechanics, glass-blowers and services. Though high, the cost is fully justified by the results. Those carrying out research should have some authority to purchase equipment up to a reasonable sum, otherwise absurd cases will occur where men earning perhaps £600 a year or more are kept on unimportant work for weeks while a committee decides whether to spend £60 on a piece of apparatus.

Great importance should be attached to the linking of the research laboratory to the utilization of the products by the consumer; hence the director should learn to look at his problems from the point of view of the production manager and of the sales manager, and orient some of his researches accordingly.

After referring to the way in which the thirty research associations of Great Britain assist the special industries to which they are attached, Dr. Slade then described in detail a method of linking research and industry, as carried out at the Mellon Institute in America, where manufacturers may have a specific piece of work carried out by endowing a fellowship for a number of years; in this way valuable work has been done on such diverse materials as limestone products, furs and their by-products, plastics, solvents, pesticides, rosins, high-boiling products, etc.

It is not in general desirable for university departments to carry out technological research; though industry has obtained its scientific outlook from the men it has recruited from the universities, and while important discoveries may be made in industrial laboratories, we shall always be dependent upon the universities for the most fundamental work and for new ideas, so nothing should be permitted to limit this vital function of the universities.

Dr. Slade concluded by stating that research thrives in an atmosphere of freedom, enthusiasm and achievement, and the aim of the organization of industrial research should be that of creating the best conditions for the individual workers with the view of applying knowledge and research to improve the arts of industry.

A particularly vigorous discussion followed the address, from which the following points, expressed perhaps in somewhat disjointed form, may be noted. Many good men are lost to research through promotion to administration. The researcher should have knowledge of what is practically possible in the craft of his industry; industry is suffering because problems are not being dealt with on a large enough scale, and there is need for co-operative research on a bold and comprehensive plan. Pooling of ideas will not result in lack of competition. A spirit of national service is requisite for industry in peace-time as well as in war-time. Workers should not be handicapped by having to write regular detailed reports of their work while it is in progress, but it is better to write a comprehensive report at the end. The cost of development and advertisement of results is bound to be relatively high in relation to the cost of the original research; it has therefore been suggested that exploratory research be limited by allocating, say, 20 per cent of research grants to original work and 80 per cent to development. The workshop is vital in research laboratories, and all workers should be able to carry out certain simple operations themselves and be able to make sketches of new apparatus, though very complicated drawings may be left to a draughtsman. Several speakers, including Dr. Slade, deplored any suggestion that a central committee should decide what fundamental work each laboratory should undertake; though the opposite view was also expressed that in the interests of humanity some direction should be given as to what are socially desirable researches.

H. LOWERY.

FORTHCOMING EVENTS

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

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly London, W.1), at 2.30 p.m.—Annual General Meeting. Mr. A. S. Kennard: "The Early Digs in Kent's Hole, Torquay, and Mrs. Cazalet" (Presidential Address).

Monday, March 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Mr. J. M. Wordie: "North-West Greenland and North Baffin Island" (Kodachrome Film).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. D. Tiranti: "The Need for Administrative Engineering".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.45 p.m.—Mr. E. A. Roth: "Technical and Economic Problems of Post-War Agrarian Policy in Central Europe".

Tuesday, March 6

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. S. A. Huzayyin: "Further Light on the Upper Palæolithic of Egypt".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres.R.S.: "Nerve Endings and Chemical Transmitters", (1) "Actions of Involuntary Nerves and of Substances which Mimic or Paralyse their Effects".

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the small Physics Theatre, Imperial College of Science, Prince Consort Road, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. G. I. Finch, F.R.S.: "Electron Diffraction".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Dr. L. Northcott and Mr. D. McLean: "The Influence of Centrifugal Casting upon the Structure and Properties of Steel".

Wednesday, March 7

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. F. Wilson: "Colour as a Factor in Industrial Design".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Mr. Henry W. Robinson: "Robert Hooke and the Importance of his Work in Medicine and Biology".

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S.W.7), at 3.30 p.m.—Dr. W. E. Ripper: "Recent Advances in the Control of Agricultural Pests".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. K. R. Sturley: "Frequency Modulation".

Thursday, March 8

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. G. O. K. Sainsbury: Photograph of a remarkable specimen of *Pseudopanax crassifolium* C. Koch—an Adult Tree with a Reversionary Shoot on the Trunk: at 2.50 p.m.—Prof. J. McLean Thompson: "The Study of Plant-Behaviourism: a Common Meeting-Ground for future enquiries by Morphologists, Geneticists, Anatomists, Systematists and Physiologists Alike".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Some Physical Problems of the Solid State".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. S. Atkinson: "Modern Electric Lift Practice".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. C. G. Woodford: "Electrics for Aircraft".

Friday, March 9

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 10.30 a.m.—Conference on Surface Finish. (A series of twelve Short Papers in five Groups: Group 1, Physical Aspects; Group 2, Methods of Measurement and Representation; Group 3, Considerations of Rational Specification and Requirement in Surface Finish; Group 4, Production Methods and Results of Modern Practice; Group 5, Effect of Surface Finish on Production.)

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3.15 p.m.—Annual General Meeting; at 4 p.m.—Mr. S. Ernest Melling: "Water and Water Supplies" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5 p.m.—Mr. W. E. Ballard: "The Formation of Metal-sprayed Deposits"; Mr. R. F. Bishop, Mr. R. Hill and Prof. N. F. Mott, F.R.S.: "The Theory of Indentation and Hardness Tests".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. David Brunt, F.R.S.: "Climate and Human Comfort".

Saturday, March 10

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Swansea), at 2.30 p.m.—Inaugural Meeting. Dr. C. Sykes: "Physics in Metallurgy".*

APPOINTMENTS VACANT

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

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Municipal Offices, Town Hall Street, Blackpool (endorsed 'Borough Electrical Engineer') (March 10).

ASSISTANT TEACHER OF MATHEMATICS at the School of Building, East Ham Technical College—The Chief Education Officer, Education Department (T), Town Hall Annexe, Barking Road, East Ham, London, E.6 (March 10).

RESEARCH ENGINEER immediately to organize and control Laboratory and Experimental Department of progressive manufacturing company, situated in N.W. London area—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2462.XA) (March 12).

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2894.XA) (March 12).

TEACHER OF ELECTRICAL ENGINEERING SUBJECTS, a TEACHER OF MECHANICAL ENGINEERING SUBJECTS, a TEACHER OF MATHEMATICS, and a TEACHER OF CHEMISTRY (to teach PHYSICAL and INORGANIC CHEMISTRY to Honours Degree standard)—The Principal, Acton Technical College, High Street, Acton, London, W.3 (March 12).

SENIOR (Reference No. C.2485.A) and JUNIOR (Reference No. C.2486.A) ENGINEERS (mechanical and electrical) to carry out work of national importance in a Government Department (location London)—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (March 16).

SUPERVISORS (PRODUCTION ENGINEERS, 3) for TELEGRAPH WORKSHOPS at Calcutta, Jubbulpore and Bombay, for manufacture of stores connected with Telecommunication Development—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2484.A) (March 17).

ADDITIONAL OFFICER for Secretarial and Organizing work (applicants should be chemists with organizing and administrative ability)—The Hon. Secretary and Registrar, British Association of Chemists, 175 Piccadilly, London, W.1 (endorsed 'Additional Officer') (March 31).

GARDEN STEWARD (woman) with responsibility for the upkeep of about 50 acres of gardens and grounds—The Secretary, Girton College, Cambridge (April 10).

MALE TECHNICIAN, with some knowledge of section cutting and staining, for Anatomy Department—The Secretary, Medical School, St. Thomas's Hospital, London, S.E.1.

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Hall, Kendal, Westmorland.

GRADUATE IN BIOLOGY (candidates must be able to teach CHEMISTRY and PHYSICS in relation to BIOLOGY and HYGIENE) at the Folkestone Day Technical School for Girls—The District Secretary, Kent Education Committee, at the Technical Institute, Ashford, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Tyroglyphid Mites in Stored Products, 1: A Survey of Published Information, Supplement 1944. By M. E. Solomon. Pp. 8. (London: H.M. Stationery Office, 1944.) 2*d*. net. [12

Royal College of Physicians of London: Social and Preventive Medicine Committee. Second Interim Report, January 1945: Industrial Medicine. Pp. 24. (London: Royal College of Physicians, 1945.) [12

Imperial Bureau of Animal Health. Review Series, No. 2: Modes of Spread of *Streptococcus agalactiæ* Infection in Dairy Herds; a Report on Co-ordinated Observations organised by the Agricultural Research Council of the United Kingdom. Pp. iii+27. (Weybridge: Imperial Bureau of Animal Health, 1944.) 3*s*. [12

Monographs of the Quekett Microscopical Club. The Discovery of the Uses of Colouring Agents in Biological Micro-Technique. By Dr. John R. Baker. Pp. 22. (London: Williams and Norgate, Ltd., 1945.) 1*s*. 6*d*. [22

British Rubber Producers' Research Association. Publication No. 55: The Structure of Polyisoprenes, Part 2: The Structure of β-Guttapercha. By G. A. Jeffrey. Pp. 4. (London: British Rubber Producers' Research Association, 1944.) [22

Hannah Dairy Research Institute. List of Publications, 1928–1944. Pp. 16. (Ayr: Hannah Dairy Research Institute, 1944.) [52

British Electrical and Allied Industries Research Association. Twenty-fourth Annual Report, October 1st, 1943, to September 30th, 1944. Pp. 127. (London: British Electrical and Allied Industries Research Association, 1945.) [72

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 180: Studies on Deglutition in Sheep. 1: Observations on the Course taken by Liquids through the Stomach of the Sheep at Various Ages from Birth to Maturity, by R. H. Watson; 2: Observations on the Influence of Copper Salts on the Course taken by Liquids into the Stomach of the Sheep, by R. H. Watson and I. G. Jarrett. Pp. 126+7 plates. Bulletin No. 181: Sheep Blowfly Investigations—The Attractiveness of Sheep for *Lucilia cuprina*. By I. M. Mackerras and M. J. Mackerras. Pp. 44+2 plates. (Melbourne: Government Printer, 1944.) [181

Government of Travancore. Administration Report of the Government Museum for the Year 1118 M.E. Pp. 8. (Trivandrum: Government Press, 1944.) [241

South Australia: Department of Mines. Mining Review for the Half-Year ended 31st December 1940. (No. 73.) Pp. 96. Mining Review for the Half-Year ended 30th June 1941. (No. 74.) Pp. 56. Mining Review for the Half-Year ended 30th June 1942. (No. 76.) Pp. 98. Mining Review for the Half-Year ended 31st December 1942. (No. 77.) Pp. 81. Mining Review for the Half-Year ended 30th June 1943. (No. 78.) Pp. 138. Mining Review for the Half-Year ended 31st December 1943. (No. 79.) Pp. 128. (Adelaide: Government Printer, 1941–1944.) [241

South Australia: Department of Mines, Geological Survey of South Australia, Bulletin No. 19: The Underground Water of the South-Eastern Part of South Australia. By Dr. L. Keith Ward. Pp. 56. Bulletin No. 20: The Structural Control of Ore Deposition in some South Australian Copper Fields. No. 1: A. The Wallaroo-Moonta Field, B. The Dome Rock Copper Mine, C. The Mount Gunson-Pernatty Lagoon District, D. The Burra Burra Mine, E. The Callington-Mamantoo District. By S. B. Dickinson. Pp. 99. Bulletin No. 21: The Structural Control of Ore Deposition in some South Australian Copper Fields. No. 2: F. Kapunda Mines, G. Blinman Mine, H. Sliding Rock Mine, I. Lady Lehmann Mine. By S. B. Dickinson. Pp. 6. (Adelaide: Government Printer, 1941–1944.) [241

Derris Agronomy: an Annotated Bibliography and a Critical Review. By R. E. Moreau. (Reprinted from the *East African Agricultural Journal*.) Pp. 24. (Nairobi: Government Printer, 1944.) [241