Vol. 158, No. 4012 SATURDAY, SEPTEMBER 21, 1946 ONE SHILLING & SIXPENCE

NATURE

No. 4012 SATURDAY, SEPTEMBER 21, 1946 Vol. 158

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

Registered as a Newspaper at the General Post Office

FUTURE ORGANISATION OF SCIENTIFIC RESEARCH

IN giving the University Grants Committee new terms of reference, as announced by the Chancellor of the Exchequer in a written answer to a question in the House of Commons on July 30, the Government has taken a first step to implement the findings of the Barlow Committee. That Committee, while considering that the expansion programme envisaged did not call for the replacement of the University Grants Committee by any new organ of government, expressed the view that circumstances demanded that the University Grants Committee should increasingly concern itself with positive university policy and that it might be desirable for this purpose to revise its terms of reference and to strengthen its machinery. Under the new terms of reference, the University Grants Committee is now empowered, in addition to inquiring into the financial needs of university education and advising the Government as to the application of grants made by Parliament towards meeting them, "to collect, examine, and make available information on matters relating to University education at home and abroad; and to assist, in consultation with the Universities and other bodies concerned, the preparation and execution of such plans for the development of the Universities as may from time to time be required in order to ensure that they are fully adequate to national needs".

With the strengthening of the personnel of the Committee already announced, the Government has gone some way to meet a need which has been urged in successive reports from the Parliamentary and Scientific Committee, the British Association's Committee on Post-war University Education, the Association of Scientific Workers and the Association of University Teachers, as well as in Parliament itself. The responsibility for co-ordinating the development of the universities from the national point of view is placed fairly on the shoulders of the University Grants Committee. It may indeed be open to doubt whether that Committee, as at present constituted, can effectively discharge the duties as well as the responsibilities of a planning body. Sir Ernest Simon has argued that the membership of the Committee should be modified so as to include more members in touch with the national need for graduates in public life, in the professions, in industry and in commerce. Whether the University Grants Committee is to be the sole instrument for the maintenance of relations between the Government and the universities in the period of radical development immediately ahead, or whether it is to be assisted by a University Advisory Council or other central body established by the universities themselves to represent their co-ordinated views, it will be necessary to provide the Committee with an adequate secretariat. Without that the Committee cannot even start on its task of preparing and executing the much-needed development plans, and an early Government announcement on that point will indicate the measure of urgency with which the Government regards action

on the report of the Committee on Scientific Manpower.

It may well be that when the reconstituted University Grants Committee, equipped with an adequate secretariat, gets to work, it will consider first the man-power aspect of university development and attempt to arrive at a closer overall target figure for the student population than was given in the Barlow Report. Nevertheless, with that report in front of it, the Committee should scarcely need strengthening in the way that Sir Ernest Simon suggests to enable it to deal with the detailed quantitative planning of university expansion in accordance with the recommendations of the Barlow Report. What is much more important than experience outside the universities is the presence of members of wide university experience and sound judgment, capable of appreciating the difficulties and danger, as well as the possibilities, of university expansion, and of the standing that will command the respect and secure the co-operation of the university authorities. It is already clear that any programme of university expansion adequate to meet the needs of the nation in the next fifteen or thirty years will involve on the part of certain universities a much bigger effort than they appear at present either to contemplate or to be disposed to make.

Any strengthening of the University Grants Committee should for this reason look to the statesman-like qualities which will be required to win co-operation in such circumstances, and knowledge of the universities from inside may be a far more important qualification than actual experience of many walks of life. The main value of the reconstitution of the University Grants Committee two years ago to allow the association with it of persons not actively engaged in university life is that it permits such qualities of statesmanship to be sought for the Committee over the widest possible field. To plan the provision of an adequate supply of trained man-power and woman-power for the nation's needs and to secure the execution of an appropriate policy, with all that is involved in the determination of the right priorities and of securing the most effective use of that man-power and woman-power, will call for statesmanship of a high order. The Goodenough Report on Medical Schools observed that a community that wished to promote research had to do two things: "First and foremost, it must find and train the men who have the ability and impulse for scientific inquiry. Secondly, it must create the most favourable conditions for their work and give them the tools they need." No two principles could form a better guide for the University Grants Committee in dealing with its new responsibilities.

Quantitatively the man-power situation and the expansion of the universities to provide teachers, buildings and equipment involved may be the more urgent and immediate task confronting the University Grants Committee. But in formulating its plans for long-term development the Committee may well be expected to probe for itself some of the assumptions and statements of both the Barlow Committee and the Hankey Committee, which have been questioned, for example, by Sir Cyril Norwood and Mr. Kenneth Lindsay, as to the country's capacity to absorb a greatly increased number of graduates. That task in itself involves some attention to the country's needs of research as well as in other fields, and in respect of the former the Committee should derive considerable help from a report from the Royal Society on the "Needs of Research in Fundamental Science after the War", to which attention was directed at the recent Empire Scientific Conference.

This report is based on the reports of a number of committees appointed or invited to consider post-war needs as a sequel to a letter from Sir Ralph Fowler and Prof. P. M. S. Blackett in October 1943, directing attention to the danger that development in fundamental physics might be relatively neglected in comparison with applied physics, the development of which is now being actively pursued by various bodies. In urging the Council of the Royal Society to set up a committee to consider the post-war needs of fundamental research in physics, they suggested that the development of fundamental physics in Great Britain could no longer be left entirely to the local initiative of the universities, but that some central guidance on major matters of policy was essential if the case for increased resources was to be put adequately before the relevant government authorities. It was realized that the universities would be making their individual claims to the University Grants Committee, but nevertheless it was highly desirable to present the claims of the fundamental sciences from the point of view of the advance of research on a national scale. Moreover, the welfare of research in the universities has become a national interest, and its support should be on such a scale as to ensure that the scientific departments of the universities are free to devote themselves to the search for new knowledge and to the training of students in the sciences and in methods of research.

Accordingly the Council of the Royal Society set up on November 30, 1943, a committee for post-war fundamental research in physics, and later other committees for chemistry, for biology and biochemistry, for geology, for geophysics and for geography. The Gassiot Committee was charged with the duty of considering the needs of meteorological research, while oceanography was covered by the report of a sub-committee of the National Committee for Geodesy and Geophysics. Of subjects commonly included in the medical group, only biochemistry is covered in this report; research in physiology, anatomy, pathology and medicine was not specially reviewed, partly on account of the support already given by the Medical Research Council, and partly because the needs of these subjects have been considered in the Goodenough Report on Medical Schools. For a like reason the needs of research in agriculture and engineering are not dealt with, government support in those fields being regarded as primarily the concern of the Agricultural Research Council and the Department of Scientific and Industrial Research.

With those exceptions, this report of the Royal Society represents an attempt to survey the broad field of fundamental research in the way that has been repeatedly advocated in recent years, with the view of seeing that no important field is neglected and that some concerted effort is made to secure that the advancing front of science is more evenly balanced and without gaps. In this survey distinction is drawn, moreover, between 'ordinary' expenditure involved in the normal running of a research laboratory, including all expenses which would ordinarily be met out of departmental funds and grants (including maintenance grants) to students, and 'extraordinary' expenditure such as that involved in the purchase or construction of special items of apparatus or equipment, erection of special buildings or acquisition of special staff necessitated by specially important or expensive fields of work in particular centres or by unexpected developments in research for which no budget would have been possible. These two categories are discussed separately in the report, and recommendations are made under both headings.

Dealing first with ordinary expenditure, the Council of the Royal Society regards maintenance grants to students in training for research, grants for laboratory staff, and general equipment, etc., as the special concern of the universities; but it is convinced that there should be available a very substantial increase in the number of maintenance grants allotted to students for training in research, and suggests that the whole question of the administration of such grants should be reviewed. The Council would favour a scheme by which the University Grants Committee included in each block grant allotted to a university an earmarked sum sufficient to cover the needs of the different scientific departments within that university for maintenance grants for students in training in research, machinery being created within the university for the allocation of grants to the students in the several scientific departments. A similar arrangement is favoured in regard to the normal costs of research in the various departments, and in this connexion, while the Council has not specifically studied such questions as the desirable increase in academic staff, the extension of buildings or the financial provision for meeting standing expenses of university scientific departments, it attaches much importance to more ample provision for the payment of adequate laboratory staff and special technical assistants, and especially to an increase in the number of combined teaching and research posts so as to provide teachers with time for research and to enable them to give due attention to those in training for research.

The Council estimates that, excluding mathematics, engineering, medicine and the medical sciences—the social sciences are not mentioned in the report—the normal ordinary expenditure which will be required for maintenance grants to students in training in research, grants to senior research workers, costs of research equipment and materials, and of laboratory staff, technical assistants and mechanics will amount to about one million pounds per annum. Of this, £300,000 is for physics, £400,000 for chemistry, £75,000 for geology, and £225,000 for biology and biochemistry, while for geophysics and meteorology an additional grant of between £15,000 and £20,000 per annum is required.

A few other points of detail deserve to be noted in the Council's discussion of the various committees' reports in relation to ordinary expenditure. A figure of £225 per annum is adopted as a reasonable average maintenance grant for a student living away from home, while for senior research workers the committees agreed in recommending that the value of such grants should be between £400 and £600 a year, the Council urging that the main financial support for these grants should be on a national scale, with a total number of grants about twice that provided in a pre-war year, or about 300–350 awards. Again, the Council endorses the recommendation of the committees that the increase in senior personnel engaged on fundamental research in universities should be effected mainly by increasing the number of teaching posts giving adequate time for research, as well as the general desire of the committees for the provision of more technical assistants of the trained specialist type and also of the more general laboratory assistants, better workshop equipment and more laboratory mechanics. On such tactical matters bearing on the more efficient use of trained research workers the Council is far more alert than the Committee on Scientific Man-power, the report of which passed over the importance of this aspect, the opportunity which is presented in the release of technical staff from the Forces, or the value of providing centres of training for such laboratory staff.

Passing now to 'extraordinary' expenditure, the Council concludes that such needs should be met by grants made by the Treasury on the advice of the Royal Society for sums over £2,000, and for smaller sums by very substantially augmenting the Parliamentary Grant in aid of Scientific Investigations administered by the Royal Society. As much flexibility as possible should be introduced into the system of administration so that demands can be met at any time without undue delay. The larger grants direct from the Treasury are intended to provide new institutions, or large and expensive equipment, and the staff required for such equipment, or to meet the expenses of special new projects or expeditions. The report points out that it is often on the borderlines between the sciences, such as biochemistry, that most activity occurs, and from time to time demands arise for special departments, laboratories or institutes to develop certain fields of activity. Another example is oceanography, where a National Oceanographical Institute is needed, establishment of which at Liverpool is recommended by the sub-committee.

Some permanent organisation to consider the requirements for fundamental research in biology, as well as a research institute for ecological studies and the establishment of an institute of general microbiology which should be the focal point for microbiological research in the Empire, and the establishment of a Meteorological Research Institute, are among the concrete proposals from the committees;

and the reports from those considering the needs of biology, geophysics, geology and meteorology give more precise indication of the specific subjects requiring fundamental investigations than those from the remaining committees. Again it is pointed out that there is at present in Great Britain no properly equipped laboratory devoted to biophysical research. The Council, however, considers that in general the systematic converging attack on a single problem by several branches of science which in some countries is conducted in special research institutes would here be more economically accomplished through the close contact of, and freedom of movement within, the existing university laboratories and research institutions. While some indication is given of the requirements in this category—the International Seismological Summary is instanced as one example requiring Treasury assistance—it is considered impossible to state them precisely. The needs are likely to be unusually great during the first few years after the War, when many new projects must be started if Great Britain is to regain its position in the van of scientific progress.

The Council recommends that the annual government grant for scientific investigations should be at least three times its pre-war size, or about £20,000 to £25,000 per annum. This grant should be used to initiate and further specially promising researches, to assist scientific expeditions and collections, or for any purpose or means which helps the progress of research in the fundamental sciences. Besides this it is anticipated that government departments and scientific establishments will continue the collaboration and assistance in the prosecution of special scientific researches which have proved so valuable in the past. The Council also endorses a recommendation from one of the committees regarding the allocation of scientific instruments and equipment from surplus government stocks after the War as an immediate assistance to research, in the placing of which the Royal Society could assist.

Here the report is concerned with matters of tactics rather than of strategy, and in its remaining recommendations the Council deals with a number of questions in that field to which the Empire Scientific Conference also devoted some attention. The Council considers, for example, that there is great need for a travel fund to enable scientific research workers to go from one centre of research to another in order to further their work, and to provide closer scientific collaboration, particularly within the Empire. For this purpose a sum of at least £15,000 per annum is desirable.

In accordance with the specific recommendation of the Council of the Royal Society, this matter, which has been frequently discussed in a number of other reports in recent years, was fully considered at the Empire Scientific Conference. Contributions, in which not merely the interchange of scientific workers but also the value of the scientific liaison officers established during the War are discussed, were received from Dr. W. M. Hamilton of New Zealand, Dr. B. F. J. Schonland of South Africa, and from Sir S. S. Bhatnagar, Sir J. C. Ghosh and Prof. P. C. Mahalanobis. While very little that was new emerged from the deliberations of the Conference on this subject, thought was clarified and the way cleared for action in a matter of the utmost importance if economy of effort is to be secured and the most efficient use made of the limited resources of scientific man-power of the British Commonwealth. Dr. Schonland, who gave a concise statement on existing travel grants and facilities for visits by scientific officers in South Africa, indicated the specific needs which require examination, while the New Zealand and Indian delegates were concerned more specifically with the potentialities of the scientific liaison offices.

There was no disposition on the part of the delegates to encourage the over-organisation of such interchange or movement of scientific workers. Dr. Hamilton, for example, suggested that the advantages of a centralized liaison office in peace-time might prove less real than war-time experience appeared to indicate. Informal as well as formal contacts are required, but in both, the contribution of the Government is important in creating the conditions favourable to movement, whether as Dr. Schonland suggests by arranging reduced air or other travel charges for scientific conferences, the travel grants recommended by the Royal Society, and especially in the report of its Geography Committee, and earlier by the British Commonwealth Science Committee, or by the superannuation and pension schemes stressed in the recent Colonial Office paper on the organisation of the Colonial Service. The recommendations of the Empire Scientific Conference on this question of interchange of scientific workers are clearly designed to promote such conditions, and it is to be hoped that they will receive careful attention by the universities and research institutions as well as by the University Grants Committee, the Lord President of the Council and the Chancellor of the Exchequer. No standard of staffing of the universities or research institutions which does not allow for such special leave without undue burdens on the remaining scientific staff, or financial or other obstacles to travel, can be regarded as making adequate use of the Commonwealth's precious asset in scientific man-power.

Beyond this the Royal Society envisages that in the interests of scientific progress it may often be desirable to invite foreign research workers to Great Britain, and funds should be available for this purpose. Finally, the Council comments on the need for grants for publication. Owing to the rise in the cost of publication and the large volume of work that has accumulated for publication during the War—the report estimates that in physics and chemistry alone, at least 2,000 separate papers will be released for publication—substantial further assistance will be required from the Treasury. The Council estimates that the annual Parliamentary grant for scientific publication should be increased to about £10,000 for the years immediately following the end of the War.

The importance of attention to this question of publication if duplication of effort is to be avoided and full economy of man-power achieved need scarcely be stressed further, but here the Royal Society report touches on the question of scientific

information services to which the Empire Scientific Conference devoted some attention. That is an important question of tactics rather than research strategy but cannot be discussed further here, though it may be said this report should help to stimulate the action called for in the British Commonwealth Science Committee's report in 1943 and more specifically in the recommendations of the recent Conference. Generally, in fact, it may be said that the recommendations of the committees, in so far as they have not fallen within the general category adumbrated by the Council of the Royal Society as indicated above, fall rather within the sphere of tactics than of strategy, and give less indication of what effort is required or of the specific subjects to be explored than might be expected from the broad title of the report to which they are appended.

Certain specific fields are indicated in the report; and in the recommendation of the Empire Scientific Conference directing attention to this report, reference is made to the shortage in the Commonwealth of scientific workers in such fields as taxonomy, genetics and microbiology. That the quantitative needs in terms of man-power and finance should be thus assessed is, of course, all to the good and a step that should prove of material assistance to the University Grants Committee under its new terms of reference as well as to the Committee on Scientific Man-power and the Hankey Committee. In its latest broadsheet, "Manpower Stocktaking", P.E.P. has emphasized once more the importance of forecasting the requirements of the professions and the upper ranks of industry, commerce and the Civil Service to ensure that there is no shortage of persons trained for these occupations. Equally it is clear from the terms of the recommendation of the Empire Scientific Conference that the report is only a first contribution to the planning that has still to be done to foster fertile research in all important subjects. The real work lies ahead, and the omissions from the report, the responsibility for like surveys which by implication is placed upon the Medical Research Council, the Agricultural Research Council, the Colonial Research Council, and the Advisory Council for Scientific and Industrial Research, indicate that as yet only a preliminary move has been made in the survey and planning of resources required if the advance of science is to proceed on a more even front and the gaps in knowledge are to be filled. Moreover, there are still the social sciences to be considered, and the recent report of the Clapham Committee on the provision for Economic and Social Research has indicated another big demand on the universities for trained man-power and another wide field in which our research effort needs to be co-ordinated and planned to secure the most effective use of limited resources.

When that has been said, the findings of the Royal Society's report and the recommendations of the Empire Scientific Conference on this matter of post-war needs in fundamental research and in the ancillary question of the interchange of scientific workers throughout the Empire give further point to ideas which are already common ground in most discussions on scientific and industrial research to-day. These ideas are now expressed in a form more suitable as a basis for the government action required. Some parts may indeed require further examination and study, from scientific workers individually as well as by their professional and learned societies and by such bodies as the universities and the University Grants Committee. Their full implications may require elaboration, but it is to be hoped that scientific workers as a body will rally to the task of education and interpretation, as well as investigation, which has still to be done before appropriate government action can be secured even on lines thus authoritatively commended both by the Royal Society and the Empire Scientific Conference. Beyond this there is the question, on which neither the Royal Society nor the Empire Scientific Conference makes comment, of the authority or means for determining the distribution of our scientific effort as between teaching and research as well as between different branches of science and between fundamental and applied research. Until the further surveys indicated have been made, no decisions as to distribution can be taken beyond the broad priorities indicated in the Barlow Report. But while such surveys are proceeding and until some appropriate authority or machinery for reviewing the results of the whole survey is established, we remain in danger of dissipating our resources of man-power, of duplicating effort and of neglecting important fields while permitting activities which are less efficient or less fruitful from the point of view of scientific advance or national welfare.

MODES OF MATHEMATICAL THOUGHT

Die mathematische Denkweise

Von Andreas Speiser. (Wissenschaft und Kultur, Band 1.) Zweite Auflage. Pp. 122+9 plates. (Basel: Verlag Birkhäuser, 1945.) 14.50 Schw. francs.

THIS is a remarkable book. Sometimes it is a brilliant book, at other times an infuriating book. For all these reasons it must be reckoned with, and its author congratulated upon achieving a result by no means out of proportion to his labour, which must have been prodigious. The reader, however, will only appreciate what lies before him if he has the requisite patience to pick his way amid what looks occasionally like an almost impenetrable jungle, so thick, in fact, that whatever it is like outside, the sun seldom gets through.

Such an impression of obscurity arises not because we are facing a rather formidable treatise in German; it is inherent in the way that the author thinks. And to a considerable extent he is perfectly right. An error of to-day is over-simplification, and he will have none of it. It follows, perhaps, that scarcely anybody will read this volume with the care it deserves. If that proves indeed to be the case, it will be a pity, for in these pages is much hidden treasure. However, now to their contents.

After some preliminary matter comes a chapter on the symmetry of ornament, then one on musical form. We are next confronted with discussions upon the natural philosophy of Dante, the position of Proclus with regard to mathematics, together with

space and time in Neoplatonism. Then follows a section on Goethe's colour-theory, and another on astrology, rounded off by a summary. This is a little disconcerting, as we soon start off again (having naïvely imagined, perhaps, that a *Zusamenfassung* implied the end) upon a delightful quest for new significance in Kepler's world-harmony. Which done, back we go once more to music (some actual scores this time), finishing up with a beautiful series of plates, illustrative of the chief architectural and ornamental patterns mentioned in the text.

Now all this is very exhausting, and productive of a literary species of 'museum fatigue', which may well lead, in any but the hardiest, to premature collapse.

No useful purpose would be served by selecting here and there a passage from this book, and commenting upon it ; in matters of this kind a reviewer may perhaps more profitably try to appraise the author's outlook and to present it—as in Gestalt-theory—as more than the mere sum of its parts. We see the synthetic process at work in the way the Logos problem is handled, and in the attempt to equate whole-number relationships to the harmony of the spheres. The former concept is boldly identified with group-theory (as we now understand it), thus paving the way for the suggestion that symmetry at least may be, and possibly is, the cause of beauty. This line of inquiry is taken up again later ; meanwhile it is interesting to see some of the parallels which present themselves as soon as the writer's position regarding the Logos is accepted, and its influence upon physical speculation discerned. For Heraclitus, for example, the Logos is a relation, whereas for Philo the same mental construct is more of a bridge, a span in fact, between Judaism and Hellenism. Later, the Logos appears in an applied form, as in the Fourth Gospel, but with the stress upon word rather than upon reason. The present author's position is essentially of this nature in the use he makes of the Logos—indeed, none other than Philo's—for his own ends, namely, to establish the cardinal point occupied first by groups, next by symmetry, and lastly by beauty. It is of little avail to be impatient with the complexity of all this, or to take refuge in some positivistic formula : mankind surely craves for beauty, and if so be it is forthcoming, the question whence it comes will always be asked. For the mathematician, beauty may be paramount in deciding which road he shall take in future investigations (as Dirac once pointed out), even to the extent of claiming it as a discriminant for "the more excellent way". And assuredly symmetry is close at hand. Köhler and some psychologists would probably fasten upon this as an example of 'requiredness'. What matter if they do ? As things stand at present, we use the word 'inevitable' far too often, and without a full sense of responsibility. If æsthetic satisfaction could be taken less grudgingly than in some quarters it is, the end-state would be more likely to correspond to a true repose of mind. This, be it noted, is not what Prof. Speiser actually says ; it is what his particular *Methodik* implies.

All this is very much to the good ; the misfortune is how hard it is to make use of it here and now. Inherent in such a philosophy is the condemnation of that degree of specialization which makes people excellently equipped for (say) technology, but relatively incapable of sensing the beautiful. In a word, the Logos bids us beware of professionalism run riot, and the neglect of knowledge for its own sake.

To return for a moment to symmetry. The kaleidoscope, as the author points out, provides a crucial experiment by which to test the dependence of beauty upon orderly arrangement. The phenomenon itself is well known ; what is valuable is the frank recognition that hereabouts, at deep psychological levels, lie the dispositions vital to artistic activity, and in so far as they may be traceable to number, they tend to emerge as the basis of music. This approach seems preferable to the more common, and somewhat erroneous, remark that architecture is frozen music. Of course, there is some degree of unconscious strife between the visual and the auditory, which Speiser is, for the moment, inclined to blanket. It does not matter very much except that, for example, sound has far to go to catch up with sight in experimental psychology. The integrative faculty may be very much a virtue in the right place. In the meantime, the omission of these cognate questions is something of a weakness, which seems to indicate a tendency to work too much in a vacuum.

While on this subject of symmetry, the author reminds us of a number of things not so well known as they might be. For example, the architect of Santa Sophia contributed notes on the angles of regular polyhedra, and the great artist Piero della Francesca a discussion of much the same kind. Pacioli wrote on the Golden Ratio, and, perhaps rather more surprising, Albrecht Dürer surveyed the regular partition of planes. In addition, Archimedes seemed to have had considerable influence over the rise of mosaic decoration, while finally comes the outstanding case of the assemblage of stone elements into a pattern representing the theorem of Pythagoras. In this last instance, the physicist of to-day will recognize a familiar theme, namely, the difference between the 'ideal' and the 'real', for it was due to the putty in making good the imperfections that the design could be accomplished. How familiar all this seems to the crystallographer, forced to concede some kind of 'Lockerstellen' to his theoretically perfect architecture. So the process goes on, in a continuous effort to adjust, and to take up the slack.

Seen at a wider angle, the effect of some of these early efforts upon creative minds is very significant. Leonardo da Vinci was fascinated, literally fascinated, by the works of Archimedes, and made great sacrifices to study them. One result was to induce a veneration for natural law which went far to dominate Leonardo's later years, and to shift his interests away from painting. Or so, at least, his contemporaries said. Altogether, one is left with the impression that 'pure knowledge' and 'applied knowledge' are inextricably interwoven, and that much of the controversy concerning their respective positions is somewhat meaningless. What stands out is the importance of the study of the history of science : those who have given marked attention to this discipline have been among the most fruitful in original research and discovery.

From here it is an easy step to see what the author has to say on the subject of Goethe's colour-theory, and the unavoidable conflict with Newtonian philosophy. On the whole, the approach is conventional : Goethe's view is not physics at all, but a description of what he sees. For him, colour is akin more nearly to a circle than to a line ; the visible spectrum alone is conceived as important, in contrast to the scientific worker's attitude towards it as a mere portion of electro-magnetic phenomena to which the human eye happens to be sensitive. And Goethe disliked mathe-

matics particularly. All very true, but Sherrington has said as much, nay more, and with a very tender touch in his Deneke Lecture at Oxford in 1942. The book before us is actually a second edition (the first was published in 1932), so one cannot reasonably complain; but this habit of self-limitation is one which it would be good to see removed in any future impression. Incidentally, the innate lack of humility (the late Prof. Collingwood would have called it 'inevitable' whether innate or not) of the virtuoso is thoroughly exposed in Goethe: it is what *he* sees and feels that matters; he and his are at the centre of the universe. Nevertheless, the great man's comprehensiveness knew no bounds, and mathematicians will gladly share his passion for Nature, "a numinous presence . . . operating the gates of birth and death" (Sherrington).

A brief reference to Prof. Speiser's outlook on Dante's natural philosophy must suffice. He notes the use of geometrical symmetry, and the attempt to apply it to the moral sphere. Certainly, nobody has seriously contested the success of the *Weltanschauung* of the Divine Comedy in certain spiritual aspects of Platonism.

A good example of the author's originality of mind, and of his resilience, is displayed in his discussion of the horoscope, which follows upon a detailed résumé of the main tenets of astrology. The question is bluntly asked: Why is the horoscope in many cases so successful? In view of the fact that no causal connexion exists between it and mankind, such a query is very pertinent, and the suggestion is that in the theory of *déjà vu* a solution may be found. This is a reasonably well-known psychological effect according to which, as the name implies, one has a wholly convincing sensation of having 'already seen', heard, taken part in, or experienced, a situation in which one is actually involved (nominally for the first time) at the moment. Clearly there are instances in which such a conviction cannot possibly be accepted; but in the matter of *judgments*, the evidence is more favourable. An attempt to probe this now would scarcely be appropriate: men so far removed from each other in time and space as Plotinus and Bergson have each been aware of this profound property of human schemata. Actually, several occurrences have been investigated in recent years by Pickford, with scientific rigour, including a remarkable painting, executed by one of his students, and called "Abstraction".

It remains now to notice the admirable series of plates with which Prof. Speiser's book ends. They are so not merely because they represent technical skill on the part of the printer—their æsthetic appeal is to the mind as well as to the eye: in this they reflect 'the beautiful' of the mathematician. Spirals, polygons, contacts of various orders, space-groups, rotation-axes, glide-planes, all are there "for delight", as the Song of Solomon would say. (On p. 122 appears to be a misprint, namely, "VII" for "VIII", which is a little confusing.)

The reader, if he is to enjoy all this to the full, needs two other books at his elbow, namely, Prof. Speiser's own "Theorie der Gruppen von endlicher Ordnung" (Berlin, 1927) and Birkhoff's "Aesthetic Measure" (Harvard, 1933). Then he can be really happy.

To sum up. The volume before us is not exactly a composition in the grand manner; it is more like a lovely little symphony made up of a number of movements, as unexpected as they are revealing.

F. Ian G. Rawlins

DEMOCRATIC VALUES

The Quest of American Life

By George Norlin. University of Colorado Studies Series B. Studies in the Humanities, Vol. 2, No. 3. Pp. xvi + 283. (University of Colorado, 1945.)

American Interpretations

Four Political Essays. By David Mitrany. Pp. v + 124. (London: Contact Publications, Ltd., 1946.) 6*s*. net.

The Development of the Soviet Economic System

An Essay on the Experience of Planning in the U.S.S.R. By Alexander Baykov. (National Institute of Economic and Social Research: Economic and Social Studies, 5.) Pp. xv + 514. (Cambridge: At the University Press, 1946.) 30*s*. net.

Our Threatened Values

By Victor Gollancz. Pp. 157. (London: Victor Gollancz, Ltd., 1946.) 5*s*. net.

WITH a year of peace behind us and the high hopes of victory replaced by a mood which must in frankness be called one of disillusionment, this seemingly haphazard collection of four volumes presents a stimulating survey of some of the background of the ideological differences that mark the relations of Britain with the two leading powers of the world, the United States and the U.S.S.R. It would have been naïve to imagine that the comradeship of war could have removed these differences or even have contributed to their mitigation; but there was from 1941 a widespread hope in Britain that a greater mutual understanding would arise, and if public goodwill could have created that understanding it would certainly have come. In the event, however, the joint victory has served but to emphasize the differences. True, there is at this time, in all probability, a greater appreciation among British people of the American outlook than has ever existed before, and a greater patience with what seem to the Briton the vagaries of American political life. But with the U.S.S.R., on the other hand, a closer acquaintance has thrown into relief a fundamental difference of outlook. With the best will in the world to understand and to work in common partnership for peace, the British people are frankly puzzled, and it has become clear that many of the formulæ of Allied unity issued during the War were face-saving devices that served to conceal what they could not cure. By 'democracy', for example, the Russians obviously mean something far removed from the Anglo-American conception of the word. The fundamental distinction can be expressed quite simply. The Russian view of democracy is essentially collectivist: it is government in the interests of the many, the proletariat, how exercised, or by whom, being details of lesser importance provided that the interests of the majority are genuinely served. "Democrats," Mr. Vyshinsky has said, "are those who give their efforts to the service of the people, who are ready to sacrifice even their lives, who work for the people." It is a definition that has little relevance for Britain and America. For them democracy is essentially individualist: it exists to give the citizen the fullest possible scope for his development as an individual rather than as a unit in a collective grouping.

The two conceptions have their origins in different conditions—religious, political, social, economic, historical and geographical, and they can only be understood in the light of these conditions. It is urgently necessary not only that we should endeavour

to understand those conditions, but also that we should re-examine our own creed in the face of the Russian challenge and determine what modifications are demanded by the changed circumstances of the modern world. A static creed has little chance of survival, and little to offer to peoples who have yet to attain a measure of political maturity and who are seeking guidance. Hence, in part, some of our present difficulties in the international sphere.

For Americans the response to the challenge of modern conditions has been a re-assertion of traditional values, but a re-assertion that has taken heed of present-day needs and has found in traditional values themselves both the means for change and the will to use them. Prof. Norlin's "Quest of American Life" is a historical re-statement of the idealism that has always coloured American development, of the resistance to tyranny and to government control that took the Pilgrim Fathers to the New World and gave mankind the Declaration of Independence. The Americans, as Prof. Norlin points out in a striking phrase, have been a *protesting* people, and the conditions under which they lived, in a vast continent over which they were able to expand freely, enabled them to develop from its grounding in religion their individualist conception of political liberty. To this conception Prof. Norling gives the name of humanism, arguing that such alternatives as 'liberalism' and 'democracy' have become spoilt by use. He does not pretend that American life has often attained the ideal of humanism, but he is able to show that at every stage in the growth of the American nation the spirit of humanism has inspired active protest against abuses, whether from outside or from within. Thus, the same spirit encouraged resistance to British rule, to secession, and, at the end of the nineteenth century, to trusts and corruption. In the main, humanism has stressed individualism against government control, but government intervention in defence of the individual has frequently been necessary, and in an increased emphasis upon 'the common welfare' Prof. Norlin sees the salvation of American democracy.

Prof. Mitrany, whose work is well known to English readers, takes up the story where Prof. Norlin breaks off. "American Interpretations" consists of four essays on related themes—the New Deal, the American labour movement, U.S. relations with Latin America, and American opinion on foreign policy. In all four the important changes that have taken place in American life since the great depression are well brought out, and though the essays are short they are closely reasoned and reveal clearly the underlying vigour of American democracy that made possible the achievements of the Roosevelt era. The New Deal is shown to be both a revolutionary and a traditional movement ; revolutionary in aiming at greater social justice, traditional in that greater social justice had always been the ideal of American endeavour. "American history," says Prof. Mitrany, "is in effect the story of a never-ending quest for a new deal. . . . The New Deal one might say was the magnificent response of a people bred in self-reliant democracy to a crisis in their social outlook and life." The theme is developed in a manner to stimulate thought, and of particular interest in the first two parts of the book are Prof. Mitrany's comments on the passing of "rugged individualism" and on the increasing centralization of government which has revolutionized traditional conceptions of the American constitution.

From these two books it is possible to form some estimate of the American response to contemporary problems. The third, Dr. Baykov's "Development of the Soviet Economic System", carries us into the world of planning, and provides a mass of statistical material on the economic evolution of the Soviet Union. Dr. Baykov's justification for adding to the formidable literature on the subject of the U.S.S.R. is his view that the economic organisation of the country can only be understood in the light of the whole process of development since 1917, and that, in particular, it is only through study of the whole period that the error of regarding passing phases of the system as permanent features can be avoided. Although Dr. Baykov is concerned only with economic aspects of Russian life the warning is a salutary one, and a reminder that certain features of war-time experience are also no more than passing phases. From the book it is possible to form a detailed impression of the sweep of Soviet economic life, and the magnitude of the achievement is made clear. It is, perhaps, irrelevant to complain that the book never comes to life, for it is not intended to be more than an introduction to a study of theory and statistics ; but it is well to endeavour to interpret it in terms of human life and livelihood—to recall, for example, what was entailed in the laconic statement from an official publication on the subject of the First Five-Year Plan, which Dr. Baykov gives in a footnote, "The financing of this plan is like putting a steel ring on consumption" ; or the price paid in human suffering for the success of the policy of agricultural collectivization, to which Dr. Baykov barely refers. And at this present moment the use, in 1927, of the argument, which he mentions without comment, that the Plan was necessary in view of the possibility of a British attack, is of particular significance.

Dr. Baykov is chary of drawing conclusions, preferring to leave them to his readers, but he commits himself to some generalizations of surprising naïveté. On p. 360, for example, he writes that "the history of labour relations and the development of the U.S.S.R. economy . . . have shown that even in the economic sphere of human activity, motives other than material can be driving and creative forces", a truism which we scarcely need a communist revolution to teach us.

It is to be regretted that Dr. Baykov has not attempted any critical assessment of the achievements of the Soviet Government ; but the book is intended for the specialist reader who can form his own views. Mr. Gollancz, on the other hand, addresses his pamphlet, "Our Threatened Values", to the general reader, and with great moral warmth—and rather more ability than he modestly claims for himself—he upholds the Christian-Liberal tradition, which Prof. Norlin would call 'humanism', against the present tendency towards lowered standards. Mr. Gollancz is particularly concerned with our treatment of Germany, and he makes an impassioned plea for a more liberal, and more enlightened, treatment of that country of despair. But his fundamental concern is with the moral crisis of Western civilization, with the diminished "respect for personality" of which he sees alarming evidence around us, and in giving his evidence he is especially critical of the policy of communism. In the matter of respect for personality, he argues, communism and Western civilization are, in practice, totally opposed : Soviet Russia has so exalted the means of power that the liberal ends of Marx's original doctrine have been thrust into the background. It is an important point of view that

must not be overlooked, though Dr. Baykov might retort that Mr. Gollancz was misinterpreting a passing phase. But Mr. Gollancz is on unchallengeable ground when he makes a plea for the "moral leadership" of which he believes Britain to be still capable. America produced a Roosevelt to revitalize its democracy in an hour of crisis. Can we produce another Gladstone? Mr. Gollancz would probably agree that something of the Gladstonian moral fervour is required.

MAURICE BRUCE

A SURVEY OF SEX

Sex, Life and Faith

A Modern Philosophy of Sex. By Rom Landau. Pp. 319. (London: Faber and Faber, Ltd., 1946.) 21*s*. net.

MR. ROM LANDAU nowhere claims to speak as an 'authority' on sex and is none the worse for that. His publishers, however, do him no service by describing this volume as "possibly the most outspoken, provocative and comprehensive book on sex to appear since *The Psychology of Sex* by Havelock Ellis" for, by the bright light of Ellis, Landau looks rather dim. But then, who would not? Take Mr. Landau at his own valuation as one who has frequently been asked to advise people on their sex problems and who has read rather widely in the literature of sex, and one must admit that his advice is on the whole sound and his reading well digested. Mr. Landau, moreover, *can* write—which is more than may be said of some so-called 'authorities'.

The book certainly justifies the description of "outspoken", for whatever the author's failings may be, mealy-mouthedness is not among them. In these days of polite understatement it is a joy to read his forthright denunciation of "miscellaneous religious circuses and revivalist kindergartens", of the "semi-dressed, silk-stockinged nymph errant of the strip cartoon" as "the little man's daily safety-valve, and symbolic of our whole attitude to sex", and of the "panvirilist aspirations of the 'suffragette' type"—although in this last case Mr. Landau is perhaps carried away by his enthusiasm when he finds himself agreeing with St. Paul that "man was not created for the sake of woman, but woman for the sake of man".

In somewhat similar fashion, the author's generalizations are occasionally rash. It would, for example, be difficult to justify such statements as "It appears that those who show the healthiest attitude to sex are the British seamen", or "the German has hardly begun to gain mastery over his sexual instincts"—or even "more often than not people are sexually attracted by types not similar but opposite to their own".

The claim to comprehensiveness is also justified. The author ranges over the physiology, psychology and anthropology of sex; sex in politics and art; marriage, fidelity and polygamy; homosexuality and sublimation; the attitudes to sex of the various churches; and the contribution which religion can make to the solution of the problems of sex behaviour. Herein, indeed, lies one limitation. When so many topics are discussed in so few pages, none of them can be discussed exhaustively. This, however, is not a condemnation of the book, for reconnaisance has its function as well as consolidation.

In brief, this volume is a well-written survey of sex in many of its manifestations, which may be read with some profit by any interested person. This review cannot close, however, without a protest at Mr. Landau's ascription to the late Dr. Temple of the view that sex is "man's greatest sin". One need not rely on one's own conviction that this is totally out of the late Primate's character, for we have his own words. In "The Church Looks Forward" (Macmillan, 1944), Dr. Temple wrote: "Sexual sin is not the only sin nor the worst kind of sin; the supreme sin and the fountain-head of all the others is pride, not lust"—which statement seems sufficiently unequivocal.

CYRIL BIBBY

MODERN ASPECTS OF PLANT NUTRITION

Trace Elements in Plants and Animals

By Prof. Walter Stiles. Pp. xi + 189 + 7 plates. (Cambridge: At the University Press, 1946.) 12*s*. 6*d*. net.

THE part played by minor or trace elements in the economy of plant life has only become apparent since the beginning of this century, and most of the work on the subject is comparatively recent. Nevertheless the literature on the subject is now so voluminous that it is very difficult to survey the present position, putting the right emphasis on the different aspects of the problem. This difficulty is specially acute in the case of biological students, who are expected to have some insight into such an important subject, but have neither access to much of the literature, nor the critical knowledge to enable them to select the most essential features of the work that has been done.

Prof. Stiles has outlined the subject in such a way as to meet the needs of such students, and also to provide a useful reference volume for research workers in the same field. His historical introduction includes a priority list giving the names of workers who first realized that particular minor elements were favourable to the growth of certain species; but he is careful to insist that these are not all claims that the element is essential. Some account is also given of methods of purification of salts used in nutrient cultures, the methods of estimating the minor elements in plant material, and the way that mineral deficiencies can be diagnosed. The discussion of trace-element deficiency diseases in plants is wisely confined to a small group of elements on which considerable work has been done, and the results generally accepted as proving the case. Manganese, boron, copper, zinc, and to a less degree molybdenum are all recognized as being necessary in small amounts for the well-being of many, if not all, species of plants, diseased conditions or failure to develop normally resulting if the element is not present or is in too short supply. The actual function of trace elements in plants is still a matter of much controversy, and only in a few cases can any dogmatic statement be made. The various hypotheses and claims are indicated; but much work will need to be done before definite proof can be obtained.

A short account is also given of the study of trace elements in animals, though far less work has been done in this connexion. Certain diseases are recognized as due to excess of trace elements, and the value of traces of copper, iodine, manganese, and cobalt for healthy growth is also clear, but here again much research is needed. An index and a selected bibliography of about 450 references provide useful guides to those who wish to follow up the subject.

W. E. BRENCHLEY

Co-operative Living in Palestine

By Henrik F. Infield. (International Library of Sociology and Social Reconstruction.) Pp. xii + 145 + 8 plates. (London: Kegan Paul and Co., Ltd., 1946.) 7*s*. 6*d*. net.

VISITORS to Palestine have been greatly impressed by the achievements of the 'Kvutza' ('group') settlements which are described in this book, settlements of Jewish immigrants who have surrendered everything they possess to the community and who work together in a fully co-operative enterprise. The idealism that has inspired these settlements is one of the finest aspects of the Zionist movement, a sense of a historic mission "to prove to the world that given an equal chance the Jew could be as 'productive' as anyone else"; hence the work on the land, the extreme simplicity of life in the settlements, the communal ownership, the effort to be self-supporting. Dr. Infield, after escaping from Nazism, spent some time in Palestine making a systematic study of these settlements, and has endeavoured since he settled in the United States to form some conclusions about them which might be of wider application. On the whole his conclusions are not encouraging. Without the driving force of Zionist idealism, and without material aid from the Zionist movement itself, the 'Kvutzot' could scarcely have succeeded: should Zionism fail, Dr. Infield points out, they would vanish. Yet an idealism that enables its devotees to face hard work and poverty—and even to allow the community to dictate how many children may be born!—is a force to be taken seriously: it is the other, brighter side of the picture of fanatical violence that is now all too familiar.

Dr. Infield has little to say about the problem of Palestine in general, but he makes a few revealing comments, as when he notes the despair of some 'Kvutza' members who, struggling to understand the Arab point of view, find "how far removed the fellah's sentiments are from theirs". To the British administration Dr. Infield is quite unsympathetic. It is a pity that when preparing the book for publication he overlooked the fact that since he had written the first draft the McMahon–Hussein correspondence of 1915–16, to which he refers on p. 99, had, in fact, been published. MAURICE BRUCE

Handbook of Infectious Diseases

With Notes on Prophylaxis, Serum Treatment and Vaccination. By the staff of the Cantacuzène Institute under the direction of Prof. C. Ionescu-Mihaesti and Prof. M. Ciuca. Pp. 331. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 5*s*.

THIS useful book, which has been brought up to date with the aid of information collected during the recent war by the Health Section of the League of Nations' Secretariat, is intended for medical practitioners or public health experts; but it will be useful to many others also. Small in size—it measures only about 6 in. × 4 in.—it contains a great deal of information. Part I gives essential facts about the infectious and parasitic diseases of man, whether these are caused by bacteria, filter-passers, viruses, protozoan and metazoan parasites or fungi. The cause, methods of infection, symptoms, diagnosis, prognosis and treatment of each disease are given and a valuable feature is the list of names given in various languages to each disease. The reader is, for example, safely steered through the possible confusions between English "epidemic typhus", often loosely called "typhus", and German "typhus", a word which means in English the disease called typhoid fever; he also avoids confusion between the Italian "Tifo abdominalis" (typhoid fever) and "Tifo petecchiale" (epidemic typhus fever). Part II is devoted to an outline of general and specific immunology. It contains a useful account of the biological tests used for diagnosis, such as the tuberculin and Schick tests, and chapters on preventive vaccination, vaccine treatment, treatment with bacteriophage, treatment of infectious diseases by transfusion and by sulphonamides, with a section on antibiotics. Part III deals with the collection of pathological specimens, the capture of insect vectors of diseases and includes brief directions for the bacteriological examination of water.

There are few books upon these subjects which summarize in so small a space and so convenient a form so much information as this 'pocket edition' contains. There are fewer still, if any, which give so much for so moderate a price. G. LAPAGE

The Sulphonamides in Theory and Practice

By Dr. J. Stewart Lawrence. Pp. vii+126. (London: H. K. Lewis and Co., Ltd., 1946.) 9*s*. net.

THIS small book, founded upon the author's own experience and a survey of 324 references, presents the subject from a very practical angle. "Theory" is included in the title, but this aspect is dealt with only briefly, and though the presentation is interesting and instructive to the clinician, it will have no appeal to the laboratory worker or to anyone seeking advanced knowledge on chemotherapeutic theory. Indeed, recent work, which has shown that the *p*-aminobenzoic acid substitution theory is by no means a full explanation of the mode of action of sulphonamides, is not described. The pharmacology of the group is well done, but the author is obviously most at home when dealing with the clinical aspect, which occupies three quarters of the book. This section, which has a remarkably good index, should be of the greatest use to the clinician. Starting with general considerations and principles, there follows, rationally, a description of the various organisms susceptible to sulphonamides, before regional affections are approached. One chapter is devoted to toxic effects and another (which every practitioner should read and learn) to the common abuses of the sulphonamides, with emphasis on indiscriminate use. This book can be recommended to all those engaged in the active practice of clinical medicine.

On the Nature of Value

The Philosophy of Samuel Alexander. By Milton R. Konvitz. Pp. viii+119. (New York: King's Crown Press; London: Oxford University Press, 1946.) 13*s*. 6*d*. net.

DR. KONVITZ'S exposition will do little to help anybody to understand Alexander's theory of value, since it lacks the admirable clarity and order of the original. He does, however, have some pertinent criticisms to make and some most interesting suggestions towards a theory of his own. If he can work them out systematically he will have something important to say. While differing in other respects, he evidently retains one excellent feature of Alexander's thought. He sees that the scientific, æsthetic and moral forms of judgment are distinct species and yet closely interrelated.

H. G. WELLS: A SURVEY AND TRIBUTE

By Sir RICHARD GREGORY, Bart., F.R.S.

CREATIVE ideas, and the influence of their expression, constitute a measure of material and intellectual advance displayed in the works of science and literature. Science is now commonly understood to be systematic and formulated natural philosophy; but with achievements in these fields of human understanding are also associated moral and social forces which, though not of a physical kind, are observable in their effects and admit of rational analysis and judgment.

This is the domain of what Wells defined as human ecology; and all his works—novels, fantastic and imaginative romances and books upon social, religious and political questions—are concerned, directly and indirectly, with individual and social factors involved in the biological whole. As a philosophy of matter, life and mind and their relationships to one another, he may be said to have expressed independently much the same evolutionary principles in diverse ways as those presented by General Smuts in his "Holism and Evolution", published in 1926. Moral as well as material values enter into this new humanism, and the adaptation of them to worthy conditions of life must continually create new problems for civilized societies to face and to solve, the tendency always being towards integrations of increased complexity and therefore of increasing difficulty of adjustment.

This was consistently the attitude taken by Wells towards human thought and action. In a Friday Evening Discourse at the Royal Institution in 1902, on the "Discovery of the Future", his thesis was "that mankind was at the dawn of a great change-over from life regarded as a system of consequences to life regarded as a system of constructive effort. . . . We should be less and less bound by the engagements of the past and more and more ruled by a realization of the creative effect of our acts". He did not say that the future could be foretold, but he held that its conditions could be foretold.

Thirty-four years later, in another Discourse at the Royal Institution, Wells again expressed what was always dominant in his mind—to relate effects to causes and arrive at generalizations and syntheses. His temperament and endeavour were those of a scientific inquirer into individual experiences and their collective relationships, with the same independence of customary authority as that of the Horatian motto *Nullius in verba* of the Royal Society, but with much greater perplexities to study than those of the concrete natural sciences. The subject of the Discourse at the Royal Institution was "The Idea of a World Encyclopedia", and the object was the collation of all published knowledge in the world by, with and for the world.

The conspectus of such a vast undertaking can be found in Wells's "Outline of History", "The Science of Life", with his eldest son, G. P. Wells, and Julian Huxley as joint authors, and "The Work, Wealth and Happiness of Mankind", successively published from 1920 to 1932. The "Outline" is a story of the earth as the abode of man from his earliest appearance on the planet to the Peace of Versailles; the "Life" deals with biology and social structures; and "Work" with ways in which humanity earns its living. As contributions to the history of man and his activities, these three works constitute a supreme achievement which could not have been conceived and constructed by any historian without his scientific credentials. He was as aware as anyone of certain weaknesses and deficiencies; but he welcomed suggestions to remedy them as well as to include new discoveries relating to human evolution and history, particularly in revised editions of the "Outline".

To have mastered such a vast body of human thought and action, and to have kept abreast, as Wells did, of current knowledge and opinion on many technical subjects, was an intellectual feat which no other modern man of letters could possibly have achieved. Referring to these historical surveys and attempts to bring economic, financial and social life into rational relationship, he said at the Royal Institution ten years ago that he had been engaged in the "still more desperate struggle to estimate the possible consequences of this or that set of operating causes upon the future of mankind". His imaginative romances, as well as his works on social, religious and political questions, reflect his reactions to historical or visionary influences upon modes of human existence. On the magic carpet of his mind he could travel backward or forward in time and space and live in ideals so vividly that they became convincing realities in narrative.

The first scientific fantasy of this kind was "The Time Machine", a rough draft of which appeared in the *Science Schools Journal* when Wells was a young man of twenty-one years. He had acquired a sound knowledge of the fundamental facts of astronomy and was able, therefore, to describe accurately the rapidly changing celestial scenes presented to the time traveller. The moon passed in an instant through all its phases, the sun became a band of fire and swayed up and down, from solstice to solstice again in a minute or less, with spring and winter merging into one another in the picture. Wells knew, better than any other man of letters, what such natural events and processes had been and that they were due to forces acting continually and uniformly. It was this scientific knowledge, combined with brilliant powers of expression, that made him unique in his own particular field.

After "The Time Machine" came "The War of the Worlds" as the second of a series of a dozen imaginative romances in which physical and biological factors were cleverly used. Lowell's work on the planet Mars, and his conclusions that the so-called canals had been artificially constructed by intelligent beings, had been published three years earlier, so Wells had a good basis for his story. The Martians he conceived to invade the earth brought novel heat-rays and a heavy gas with them as devastating means of conquest, but after a short time they themselves became masses of corruption due to insidious germs of disease which they had eliminated in their own planet and to which their bodies were, therefore, not immune. This end of the Martian invaders is a characteristic example of the application of scientific knowledge to forms and conditions of life woven into a story having also strong emotional appeal.

"The First Men in the Moon", published in 1901, again revealed his genius for producing a story rich in human interest without disturbing the sensibilities of critical scientific minds. In this respect, Wells's novel was far in advance of Jules Verne's "Journey to the Moon", which had many scientific blunders and inconsistencies. Moreover, Verne's travellers did

not reach the moon, whereas Wells's landed upon our satellite and found beings living inside it with thoughts and feelings which made contacts with human hearts.

So it was with the story "In the Days of the Comet", published in 1906. Several years earlier a remarkable new star appeared, visible to the naked eye, and expanding at such a rate that it was thought by many people to be a minor planet approaching the earth. Wells had a much better basis for his fancy when he made a comet cross the earth's orbit at a point near enough for us to pass through its tail, as actually happened in 1861. He let his imagination play with the idea that human nature might be changed by the introduction of a new spiritual element in the earth's atmosphere, represented by a peculiar greenish radiation from his comet's tail. After passing through the tail, the whole race was transfigured. Jealousy and hatred vanished, and with it war and poverty, in the vision of a world lifted out of acquisitive greed into a condition of celestial harmony. This poetic dream of what mankind might become by following paths of truth and righteousness and suppressing animal instincts is displayed in a number of Wells's works, often with hope but always conscious of the prevalence of evil tendencies in human nature.

In "The World Set Free", the transformation from old to new and better conditions of life and government was reached not through the swish of a comet's tail but as the result of a world war. The book was published early in 1914, but in substance and outlook it describes the Second World War even more closely than the First. The book was dedicated to Prof. Soddy's "Interpretation of Radium", published in 1909; and the theme is that of the disintegration of the atom and the use of atomic bombs and thousands of aeroplanes in modern warfare. As a story of the discovery and use of natural power to supplement man's animal strength, the first chapter of the book, entitled "The Sun Snarers", states these developments with crystal clearness. It outlines the conquest of external power in the industrial applications of fire, steam, electricity, and new chemical elements, leading up to radium and the release of the energy locked up in atoms, for use first with devastating effects in what was called "The Last War" and then, in 1956, to liberate the race from obsessions and entanglements which impede moral and material growth.

"Already before the release of atomic energy the tensions between the old way of living and the new were intense" are words used in the last chapter to introduce the assembly summoned to place social organisation upon a new and nobler footing. This council was constituted in the spirit of the United Nations Organisation, and it eventually led to the planning of a new common social order for the entire population of the earth. How close the realities will approach to Wells's ideals remains to be seen.

Other works in which the possible future of the human race was forecast are "The Sleeper Awakes" (1899), "Anticipations" (1901), "Mankind in the Making" (1903), "The Food of the Gods" (1904), and "A Modern Utopia" (1905). Of "Anticipations" Sir Ray Lankester said, in a five-column review in *Nature* of March 13, 1902:

"This is a profoundly interesting and suggestive book by a very remarkable man. Mr. Wells was educated at the Royal College of Science; he has a thorough knowledge of, and considerable training in, the great branches of science—physics, chemistry, astronomy, geology and biology. This course of study operated, in the case of Mr. Wells, upon a mind naturally gifted with an extraordinarily vivid imagination and the aptitude for true literary art."

This kind of encouragement from scientific friends was highly appreciated by Wells from the very beginning of his literary career to the end of his life. He was trained to become a science teacher, and during this formative period, as well as for several years later, his closest contacts were with workers in scientific fields. He knew that when he entered the world of letters, in which he afterwards attained international fame, he lost his place on the ladder on which he had been moving upward; but the fact that he continued to be regarded as a great scientific educator by leaders of his own generation, and an inspiration to the new, kept him continually in touch with advancing knowledge and contributed in no small measure to the remarkable responses represented in his works.

"Anticipations" projected the present into the future from the outlook tower of modern science. It was an indictment of many existing customs and structures and a prophecy of what changes might be expected in the near future. On the mechanical or inventive side, the predictions made in the book revealed an insight which was truly marvellous. Motor-cars and motor-roads were largely to replace railway traffic. Land ironclads, armoured trains, armoured tortoises or tanks and flying machines with folded parachutes for escape were to be used in warfare. Forty years after this forecast all these machines were in action, but their development has not been accompanied by the changes of heart and social structures which Wells hoped for but had not the same scientific reasons to expect to be fulfilled.

In "A Modern Utopia" (1905), faith in the principles of a rational social biology is expressed in practical terms with hope as well as ingenuity. The system presented resembles that of the Platonic Republic, save that insistence is given to the preciousness of individual freedom and to toleration. Family allowances were to be made to women, but criminals and certain other groups were not to be allowed to reproduce their kind, though they were free to follow their own proclivities in their own separate communities. The main idea was to keep learning and the applications of it progressive instead of fixed and pedantic, the spirit being, therefore, that of "The Discovery of the Future". This kind of idealistic Utopia is found again in "Men Like Gods" (1923). It makes man the master of his own house and conceives the birth of a new race with noble qualities of mind and great physical strength, devoted to the understanding of Nature in all its aspects and its control for the progressive welfare of humanity.

Such projections as these into the future of man and society are not satires like Swift's "Gulliver's Travels" and Samuel Butler's "Erewhon", or parodies of science found in novels of our own times. They rank with Plato's "Republic", Thomas More's "Utopia" and William Morris's "News from Nowhere" in their social philosophy and as vivid literature. The world of science has every reason to be proud that its spirit and service should have been translated so genuinely and loyally into "Thoughts that breathe and words that burn" with such unsurpassing power and influence as those possessed by Wells. He presented scientific workers to his readers as human beings and not as the travesties in which

they figure in novels and romances written without his intimate knowledge of them and their impulses. That is why homage has always been gratefully paid to him in these columns and in other scientific periodicals.

"By science," Wells once said, "is meant a process of human intellectual energy which is exhaustively and reverently criticized, leading, it is hoped, to action exhaustively criticized before it is exhaustively planned." In these words he expressed the whole of his faith, the whole of his belief in human life. How and why he acquired this faith and proclaimed it is comprehensively stated in the two volumes of his "Experiment in Autography" (1934), the sub-title of which reads "Discoveries and Conclusions of a Very Ordinary Man". He looked at people and their actions against a background of knowledge never used before to paint pictures of aspects of individual and social life ; and his insight as well as the breadth of his experiences made all the scenes and figures stand out with convincing reality, even when they were fanciful.

From first to last the characters in all Wells's works represent growing experiences and the responses of thought to them. Following scientific methods, he observed ways and means of life independently, described faithfully what he saw and deduced principles from this evidence. "Love and Mr. Lewisham", "Kipps", "Mr. Polly", and "The Wheels of Chance" are stories in which he himself lived and struggled and thought. So it was with most of his other novels. When he left this field for that of scientific romances, literary critics deplored the change of front and his re-entry into a field in which he became the supreme interpreter.

Mention has already been made of the lines of these perspectives of space and time, and of some other adventures into the domain of human ecology. It is sufficient here to refer, in addition, to "The World of William Clissold", three volumes (1926), "The Way the World is Going" (1928), "The Open Conspiracy" (1930), "After Democracy" (1933), "The Anatomy of Frustration" (1936), "Star Begotten" (1937), in which the idea is used that cosmic rays directed towards the earth might induce mutation of genes in human nuclei, "The Fate of Homo Sapiens" (1939), "The New World Order" (1940), "The Outlook for Homo Sapiens", and "The Conquest of Time" and "Phoenix" (both in 1942), " '42, '43, '44 : The Happy Turning", which is a supplement to the "Autobiography", and "Mind at the End of its Tether" (1945).

These, with other books already noted, comprise only a selected list of Wells's contributions to the study of social biology. They state the essential ideas of his life and draw the perspective of a world liberated from sectionalism, with men and women of goodwill and wide outlook co-operating in the task of constructing and maintaining conditions and ways of life worthy of human powers and the availability of the natural resources of the universe.

In "Ann Veronica" (1909)—a novel which provoked a storm of indignation from a group of critics, because of its frank discussion of sex relationships—Wells makes one of the characters say : "Find the thing you want to do intensely, make sure that's it, and do it with all your might. If you live, well and good : if you die, well and good. Your purpose is done." Before he wrote these words, Wells had had several reminders that his physical system was weak in several parts and liable to breakdowns. It was his indomitable spirit that urged him on to carry out his purpose for a much longer period than anyone who knew him when he began his literary career would have expected. This was maintained to the day of his death on August 13. A few weeks before his heart ceased to beat, he had planned to work hard at the scenario of a film to be "The Shape of Things to Come" brought up to date with the new ideas and curiosities due to the popularization of the principles of the nuclear disintegration of the atom and the manufacture of the atomic bomb.

To have had such an intention at seventy-nine years of age and after producing about a hundred notable volumes is an impressive example of the mental alertness and perseverance of purpose of Wells's life, the spirit of which remains in his works to enlighten the world for many generations. From his early days he was eager to learn and to master his circumstances. His father was a small tradesman at Bromley, Kent, where Herbert George Wells (familiarly known as "H.G.") was born on September 21, 1866. His mother was a typical representative of the lower middle class of Victorian times, with fixed regard for the established order and its conventions. This led to Wells being sent to a local 'academy' as a child instead of going to a national school.

With the same maternal desire that Wells should occupy a 'respectable' place in the social order, he was twice placed in drapery establishments, from both of which he came away with resentment at the life imposed upon him. Between these two experiences he was sent for a month's trial as an apprentice to a pharmaceutical chemist at Midhurst, Sussex ; but this new start in life was abandoned for financial reasons. He began there, however, the study of Latin with lessons from the headmaster of the small grammar school, at which he became a boarder for a couple of months in the interim between the two drapery adventures. After breaking away from the second of these trials, he wrote to this headmaster, who, as the result, offered him a post as an usher in the Preparatory Department of Midhurst Grammar School.

It was at this place and under this influence that Wells made his first systematic acquaintance with modern science. There he attended evening classes under the Science and Art Department, and was so successful in gaining grant-earning certificates in a number of subjects that in 1884 he was accepted as a science teacher in training at the Normal School of Science, South Kensington, which later became the Royal College of Science.

After three years at the College, Wells left without being awarded the associateship, having failed in the examination in advanced geology. Even without this qualification he was able to obtain a post in a small private school in Wales, where he had his left kidney crushed during a football game and was wrongly pronounced to be consumptive, but later to be diabetic, which proved to be true. In 1889 he became an assistant master in a private school at Kilburn, where Alfred Harmsworth (Lord Northcliffe) had been a pupil, and Wells taught mathematics and science to a class which included A. A. Milne, the novelist and playwright, son of the headmaster of the school.

While at this Henley House School, Wells passed the London Intermediate B.Sc. examination with honours in zoology and was awarded the licentiateship of the College of Preceptors with the three prizes in theory and practice of education, mathematics and

natural science. These successes led to the offer of a post on the staff of the University Tutorial College, where he went to teach biology and also geology to students at Red Lion Square working for the University of London examinations. While there he took his B.Sc. degree in 1890 with first-class honours in zoology and was first in the second class in honours in geology. He also obtained the fellowship diploma of the College of Preceptors with honours in two subjects and gained the Doreck Scholarship for theory and practice of education, thus getting in front of university teachers in their own examination.

His career as a professional teacher came to an end in 1893 with another breakdown of health. It was then that he began to earn his living by writing articles for the periodical press on common subjects in his own whimsical vein of reactions to them. His "Select Conversations with an Uncle" (1895) is a collection of such contributions from scores of other unsigned articles and tales. He also contributed a number of reviews to *Nature*, including one on Podmore's "Apparitions and Thought Transference". His first book was, however, Part 1 of a "Text-book of Zoology" (1893), with an introduction by G. B. Howes, assistant professor of zoology at the Royal College of Science, followed two years later by Part II, and Gregory and Wells's "Honours Physiography". In the same year (1895) "The Time Machine" was published, and Wells found himself recognized, at twenty-nine years of age, as a bright star rising above the horizon of the world of letters to radiate a new penetrating light before men.

The honorary degree of D.Lit. was conferred upon Wells by the University of London in 1936 ; and in 1943 he was awarded the D.Sc. degree for a thesis on "The Quality of Illusion in the Continuity of the Individual Life in the Higher Metazoa, with Particular Reference to Homo sapiens". He was president of the Educational Science Section of the British Association at the Nottingham meeting in 1937, when he gave an address on "The Informative Content of Education", which led to the publication of two reports upon the subject by a research committee of the Association. He was elected an honorary fellow of the Imperial College of Science and Technology in 1943, just fifty years after the publication of "The Time Machine", the first of the imposing series of works by which Wells became the greatest international scientific educator of his times.

SEVENTY-FIFTH ANNIVERSARY OF THE CORDOBA OBSERVATORY

By Dr. E. GAVIOLA
Director

THE Cordoba Observatory owes its creation to the happy and trustful collaboration between a great Argentine statesman, President Sarmiento, and a great American astronomer, Director Gould.

During the nineteenth century, astronomy endeavoured to take possession of the sky by making an inventory of its stars. Bessel demanded already in 1822 to know the precise position and brilliance of all stars down to the ninth magnitude. He himself measured the positions of 62,380 stars between 45° north and 15° south. Argelander extended the limits to 80° north and 31° south, adding 50,000 stars. The English astronomer Carrington filled the gap at the north pole. In the south, the American naval officer Gilliss had made many observations at Santiago de Chile (1849–52) between −65° and the south pole, but he died in 1865 and it was uncertain if and when the positions would be reduced and published. (They were in 1895, adding 16,748 stars to the inventory.)

Gould felt it was his mission to fill the great southern gap. He wrote in 1865 to Sarmiento, then Argentine envoy in Washington, asking for permission and protection for leading an astronomical expedition to Cordoba, supported by the friends of science in Boston. Sarmiento offered more than was asked. But the expedition had to be delayed : Gould could not obtain sufficient private funds ; the Argentine Government regretted not to be able to help much at that time, on account of having all its energies devoted to the Paraguay War (1866).

Sarmiento became President in 1868 and in the following year Gould was invited to organise an Argentine National Observatory. Gould accepted promptly, ordered a fine 5-in. meridian circle from Repsold in Hamburg, and sailed for Cordoba in 1870. On his arrival he heard that the Franco-Prussian War was delaying his instrument in Hamburg. When it finally arrived in Rosario, it was held up again by a quarantine due to an epidemic of yellow fever. The "Uranometría Argentina", a census of all the naked-eye stars from 10° north to the southern pole, owes its existence to these delays. It contains 7,756 stars down to the seventh magnitude.

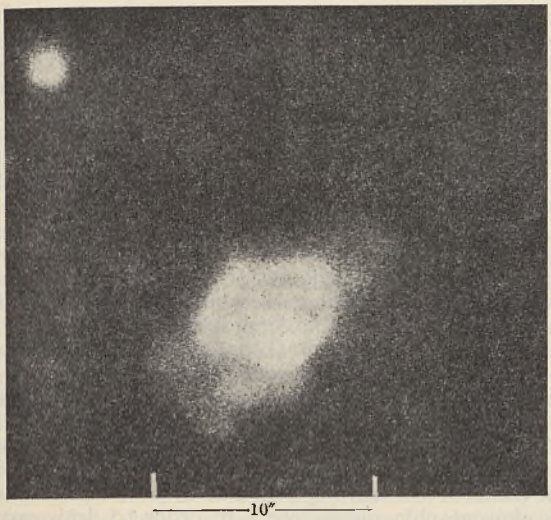
Seventy-five years ago, on October 24, 1871, the Cordoba Observatory was solemnly and officially inaugurated with speeches by President Sarmiento, Secretary Avellaneda and Director Gould.

The planned observations with the meridian circle were begun in September 1873 and continued by Gould until 1885, when he considered his mission in Cordoba fulfilled and returned to the United States. The main fruits of this period were the "Zone Catalogue", published in 1884, containing 73,161 stars between 23° and 80° south and the "Argentine General Catalogue" (1886) of 33,500 southern stars measured repeatedly with the utmost precision. The gap in the southern skies had been closed and the Cordoba Observatory had won a place of honour in the annals of world astronomy.

Under the direction of John M. Thome, the meridian observations continued and led to new catalogues, but the main work of this period (1885–1908) is undoubtedly the monumental "Cordoba Durchmusterung". It contains 613,718 stars between −22° and the southern pole. Thome himself could not finish it. The first three parts were published by him, the fourth was completed by his successor, Charles D. Perrine, in 1914. The fifth was observed and reduced by José Tretter, appearing in print in 1932, twenty-four years after Thome's death.

The Cordoba Durchmusterung contains all the stars down to the tenth magnitude, and many even fainter (to mag. 11·5) observed with a 5-in. equatorial refractor. It is still to-day the basis for the identification of southern stars.

Thome undertook in 1890 to continue the series of catalogues known as the zones of the "Astronomische Gesellschaft" from −22° south. He measured with the meridian circle the positions of 44,000 stars (−22° to −37°) between 1891 and 1900, but did not live to see the catalogues published. They appeared in 1913, 1914 and 1925. The La Plata Observatory has measured and published the zones −47° to −72°.



η CARINÆ. DIRECT PHOTOGRAPH TAKEN AT THE CASSEGRAIN FOCUS OF THE 60-IN. REFLECTOR OF THE CORDOBA OBSERVATORY WITH AN EQUIVALENT FOCAL LENGTH OF 31·5 M. ENLARGED 20 TIMES FROM ORIGINAL. SCALE 10 ARC SEC. = 38 MM. UPPER LEFT: FIELD STAR

The zone −37° to −47° has been reduced lately in Cordoba, and should appear in 1947. The zone −82° to −90° has been re-measured recently by Jorge Bobone with the 190-mm. Repsold meridian circle and is being reduced.

Cordoba has contributed to "La Carte du Ciel" with eight volumes published between 1925 and 1932, covering the zones −24° to −31°. The work was begun by Thome but carried out mainly by Perrine.

The need of catalogues of high precision of a limited number of selected stars was met by Meade L. Zimmer, who measured, reduced and published the "First Fundamental Catalogue" in 1929 and the "General Fundamental Catalogue" in 1941. They contain 761 stars reduced to the mean equinoxes of 1900 and 1950 respectively.

Juan José Nissen, the first Argentine director of the Observatory, made an important contribution to the exact determination of the orbit of Eros, as part of the campaign led by the Astronomer Royal of Great Britain for the improvement of the solar parallax. The first places, according to statistical weights attributed to the results, were accorded to two southern observatories—the Cape and Cordoba—among thirty-six throughout the world.

When Perrine came to Cordoba in 1910 the 36-in. Crossley reflector at Lick Observatory and the 60-in. Ritchey reflector at Mount Wilson Observatory were opening new vistas to astrophysics. He obtained ample funds from the Argentine Government; he ordered a 60-in. mounting by Warner & Swasey, moulded glass blanks by St. Gobain, and he built a mechanical and an optical shop in Cordoba. Perrine desired to pioneer in stellar spectroscopy of the south as Gould did in astronomy. But the task of making large astronomical mirrors was beyond the skill of the personnel he could obtain at the time. The 60-in. parabolic mirror was figured finally by Fecker in Pittsburgh in 1939; the Newtonian and Cassegrain secondaries by the optical shop of the Cordoba Observatory in 1941 and 1942.

The 154-cm. reflector was erected in Bosque Alegre, the Astrophysical Station of the Cordoba Observatory, and inaugurated in 1942.

A spectrograph with a dispersion of 40 A. per mm. built in Cordoba, with a Wood grating, makes it possible to take spectra of stars down to the eleventh magnitude. A fast, 'nebular' spectrograph with a 60° quartz prism and *f*/1 Schmidt camera is being built.

Current work consists of the determination of radial velocities in the Magellanic Clouds (Ricardo Platzeck), the discovery and study of variable stars in the same (Martin Dartayet), investigation of spectroscopic binaries (Jorge Sahade), study of η Carinæ and other stars with emission line spectra (Enrique Gaviola), theoretical astrophysics (Guido Beck), search for white dwarfs among stars of large proper motion (Martin Dartayet and David McLeish). Programmes of systematic determinations of radial velocities of southern stars are planned.

During the past seventy-five years astronomy has substantially completed the inventory of the sky. The intense and precise study of particular stars and phenomena, using the most refined methods of theoretical and experimental physics, is now demanding increasingly the attention of the astronomers. Cordoba hopes to be of service also in this new field.

NEW DEVELOPMENTS IN RELATIVISTIC QUANTUM THEORY

By DR. C. MØLLER

Institute for Theoretical Physics, Copenhagen

THE ordinary quantum mechanics which, in principle, was completed in the middle of the 'twenties, gives a correct account of a very large number of experimental results. Still, it was from the beginning quite clear that this theory is an approximation to the truth, since it does not satisfy the requirements of the theory of relativity. Non-relativistic quantum mechanics would, therefore, be expected to give correct results only in those cases where the velocities of the elementary particles are small compared with the velocity of light.

However, at that time it was a general opinion among physicists that the adaptation of quantum mechanics to the requirements of relativity was more or less a mathematical question which would not give rise to any physical difficulties. In fact, Dirac was able to develop a relativistic theory of one electron in an external field; and this theory was in very good agreement with experiments also in cases where the velocity of the electron approaches the velocity of light.

Nevertheless, as one tried to give a relativistic treatment of the interaction between two or more elementary particles, one met with a characteristic difficulty which could not be removed in a satisfactory way by any mathematical trick. Since the development of the theory of relativity, the field concept had become of special importance in physics. In order to account for the finite propagation velocity of all forces, which is a fundamental consequence of the theory of relativity, it seemed absolutely necessary to describe the interaction between elementary particles by means of an intermediary field, and this field has to be treated as a special physical system in accordance with quantum mechanics.

This was done in 1929 for the first time by Heisenberg and Pauli in the case of electromagnetic forces

between charged particles. These authors developed a theory which formally satisfies all relativistic requirements of covariance. However, this theory already contained the well-known divergence difficulties which manifest themselves as soon as one tries to use the theory for the calculation of special problems. For example, the theory gives infinite values for the energy in all stationary states of a system of charged particles, and a reasonable physical result can be obtained only after subtraction of an infinite quantity—the self-energy of the particles.

Similar difficulties arise in all quantum field theories; also, for example, in the theory of the so-called meson fields which were introduced by Yukawa in order to account for the forces acting between the nucleons in the atomic nuclei. In order to get reasonable physical results from these theories, one has to have recourse to special assumptions in the application of the formalism. For some time it was hoped that the divergencies were due simply to the mathematical procedure which was applied in the solution of the field equations, and some divergencies certainly are of this origin. However, it can be shown that the field equations themselves implicitly contain infinities from the beginning, so that the divergencies are not all introduced by the method of solving the field equations. This may be seen from an argument by Heisenberg[1]. On account of the commutation rules for the field variables, which contain singular functions of the type of a δ-function, the eigenvalues of a field variable in a definite point in space-time are infinite, in contrast to the mean value of a field variable over a finite region which has finite eigenvalues. Now, in all relativistic field theories the interaction terms in the Hamiltonian contain the product of two, or more than two, field variables at the same point, and the field equations are therefore of the type of differential equations with infinite coefficients.

Thus, the infinities are intrinsic difficulties of all relativistic quantum field theories. It seems that the frame offered by quantum mechanical principles is too narrow and that the difficulties can be removed only by a radical change in these principles. Now it is difficult to imagine any change in the fundamental concepts following from the principle of superposition, that is, the general mathematical scheme describing the relations between states and observables, and the whole transformation theory must be supposed to hold in the future theory also. It is different, however, with the equations of motion, which in the Schrödinger picture are represented by the Schrödinger equation

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi.$$

This equation determines the variation of the physical state ψ in time, if the Hamiltonian operator H is given. In quantum mechanics, the physical system considered is *defined* by H or by the set of all regular solutions of the Schrödinger equation.

Now, it seems very doubtful that in any relativistic theory of the future a Hamiltonian and a Schrödinger equation will exist at all in general. For, if the interaction is introduced in the same way as in the ordinary field theories, the above-mentioned difficulties arise and, if we try to avoid the infinities by introducing in some way a finite particle radius or a minimal length, the symmetry between the space and time variables, following from the theory of relativity, will require the introduction also of a minimal time, and this seems to make a continuous time displacement, such as that given by a Schrödinger equation, impossible. The problem then arises how to describe the experimental results in those cases where the systems considered have no Hamiltonian and, consequently, no Schrödinger equation. In other words, we have to find the quantities which in the future theory will take over the part played by the Hamiltonian and the Schrödinger wave function in quantum mechanics.

In this connexion, Heisenberg[2] has made a decisive step forward in a recent series of papers. In these papers, he tries to single out those quantities of the ordinary quantum mechanics, which may be supposed to represent 'observable' quantities in any future theory, also; for it is clear that the purpose of a theory must be to give relations between 'observable' quantities. Now, it is not always quite simple to say what we mean by an atomic variable being 'observable'. What is directly observed in the laboratory is always a macroscopic quantity, for example, the position of the hands of a measuring instrument, points and lines on photographic plates, etc. In order to draw any conclusions about the values of atomic quantities from these direct observations, we need a theory, and if the theory allows unambiguous conclusions to be made about an atomic variable, this variable is said to be an 'observable' quantity. Strictly speaking, the question whether a definite atomic quantity (like the position of an electron) is observable or not can, therefore, only be decided after the theory has been fully developed.

There are, however, a few atomic variables which are so directly connected with the observations which are made in the laboratory, that they must be expected to be 'observables' in any theory.

(1) In the first place, all the variables of free elementary particles, such as the momentum, kinetic energy, mass, electric charge, etc., must be considered observable; for the ordinary quantum mechanics may be supposed to hold for free particles, since all difficulties come in only through the interaction between the particles.

(2) The cross-sections for all kinds of atomic processes are certainly observable, since most experimental data about an atomic system are given in terms of cross-sections.

(3) The energy values of atomic systems in closed stationary states are also so directly connected with simple observations that they must be considered observables in any theory. They may be determined on the lines of a Franck–Hertz experiment, or by observation of the energies of emitted particles. All spectroscopic determinations of atomic energies are of the last-mentioned type and, in the case of radioactive nuclei, the fine structure of emitted α-particles allows immediate conclusions about the energy levels of the rest nuclei.

(4) In the last-mentioned cases, the mean life-time or the decay constants of the radioactive nuclei must be considered observable.

If we can develop a theory which contains only relations between the variables (1)–(4), and enables us to calculate these variables in special cases, this theory must be considered wholly satisfactory from a physical point of view, since it allows us to give definite answers to all such questions in which the experimental physicist may be interested.

However, in ordinary quantum mechanics other quantities in addition to the quantities (1)–(4) are

considered observable. According to this theory, one may, for example, also ask for the value of the probability that two colliding particles have a given small mutual distance, r, and this probability is given by the absolute square of the value of the wave function corresponding to this small value of r. Such a question can, however, never be of direct interest to the experimental physicist, since his experiments only give cross-sections, that is, the probabilities for large distances r. We may therefore expect that only the asymptotic values of the wave functions for large values of r will enter directly into the future theory, and not the wave function for all values of r.

Now, Heisenberg noted that the asymptotic expression for the wave function in ordinary quantum mechanics for any kind of system is determined by a certain matrix S which he called the 'characteristic matrix'. In quantum mechanics the matrix S can be calculated when the Hamiltonian of the system is given. When S is given, the asymptotic behaviour of the wave functions and all kinds of cross-sections are determined, but not the probabilities for the particle being separated by small distances. Heisenberg, therefore, made the assumption that the characteristic matrix S in a future theory will take over the part played by the Hamiltonian and the wave functions in ordinary quantum mechanics, and that the atomic systems in the new theory will be defined by S and not by H or ψ.

It may now be shown that all the quantities (2)–(4) may, in fact, be calculated if we only know S; but such questions as to the probabilities of the particles being separated by definite small distances r cannot be answered unambiguously when we know the matrix S only. Thus, the new theory in which S, but not H, in general is given, means a new step forward away from the classical theory, which tried to give a detailed picture of the physical process.

In order to develop a theory on these lines, we shall in the first place try to find the general conditions which the characteristic matrix satisfies quite independently of the structure of the atomic system considered. To find these general conditions, we make the assumption that all general conditions which the characteristic matrix satisfies in quantum mechanics, independently of the form of the Hamiltonian, will hold also in the cases where no Hamiltonian of the system exists. In this way, it is easily shown[2,3] that the characteristic matrix is always a unitary matrix, namely,

$$S^\dagger S = S S^\dagger = 1$$

where $S^\dagger$ is the Hermitian conjugate of S.

Further, using the connexion between the matrix elements of S and the cross-sections, it is easily proved[3] that S is an *invariant* matrix; that is, if $\bar{S}$ and S are the characteristic matrices of the same atomic system in two arbitrary Lorentz frames of reference, we have simply

$$\bar{S} = S.$$

This means that S has a meaning quite independently of the Lorentz frame which we use in our description. This simple transformation property of the characteristic matrix brings about a considerable simplification in the description of atomic phenomena as compared with the quantum mechanical description, in which the fundamental matrix, the Hamiltonian, has rather complicated transformation properties under Lorentz transformations.

If the characteristic matrix is given, one of the main problems is to find a representation in which S is in the diagonal form. The analogous problem in quantum mechanics, to bring H into the diagonal form, is solved if we know a complete set of commuting constants of the motion (J), that is, a sufficiently large number of commuting variables J which commute with H also. In the same way, our problem is to find a complete set of commuting variables (α) satisfying the equations

$$\alpha S - S \alpha = 0.$$

In a representation where the α's are in the diagonal form, S will also be in diagonal form, and the eigenvalues S^0 of S will be functions of the eigenvalues (α^0) of the α's, that is,

$$S^0 = S(\alpha^0).$$

Now, the total kinetic energy always commutes with S and, if the α's also commute with W, we may take W as a member of the complete set of variables commuting with S. In this case, the α's may be called constants of collision, since they may be shown to have the same values (or mean values) before and after the collision. However, they need not have constant values during the collision and, for a system which has no Hamiltonian, it is meaningless to speak of the mean value of an α during the collision. The total kinetic energy W, for example, is a constant of the motion, since W has the same value before and after the collision; but W is, of course, not a constant of the motion. The constants of collision thus play a similar part in the new theory to the constants of motion in quantum mechanics.

In quantum mechanics the form invariance of H under rotations in three-dimensional space gives us a set of three constants of the motion, that is, the components of the total angular momentum. In the same way, the invariance of S under the larger group of Lorentz transformations may be used to find at once a set of six constants of collision

$$(\alpha) = (K_x, K_y, K_z, W, L, m) = (W, \beta)$$

where K and W are the total linear momentum and kinetic energy respectively, while L and m are two variables which, in the system of reference where K is zero, are identical with the magnitude of the total angular momentum and the component of the angular momentum in a definite direction, respectively[3].

If the characteristic matrix S is given, all cross-sections can be determined immediately from S, but if, as claimed by Heisenberg, the matrix S is to give a complete description of all 'observable' quantities for any atomic system, the quantities (3) and (4) must be derivable from S also. (In his papers quoted above, Heisenberg only considered the quantities (2) and (3).) The clue to the solution of these problems was given by Kramers[2], who remarked that the Schrödinger wave function ψ_{W^0} belonging to a continuous energy value W^0 in all physically important cases in ordinary quantum mechanics is an analytical function of the variable W^0. By the process of analytical continuation, ψ_{W^0} may then be given an unambiguous meaning for complex values of the variable W^0, as well as for real values W^0 smaller than the minimum value W_m^0 of the energy in a continuous state. In any event, ψ_{W^0} will be a solution of the Schrödinger equation, but it is not possible to give a physical interpretation of this solution for all values of W^0. Consider, for example, the case of a real $W^0 < W_m^0$: then the asymptotic expression of ψ_{W^0} for large values of the relative distance between the particles consists of two terms, the first of which

vanishes for large distances, while the second term increases exponentially with increasing distances. The last term contains an eigenvalue S^0 of the characteristic matrix as factor. Thus, ψ_{W^0} will be an eigenfunction corresponding to a closed stationary state only for those real values of $W^0 < W^0_m$ which make S^0 equal to zero.

In this way, the energy values in the closed stationary states are determined as the zero points of the eigenvalues S^0 of S on the real axis in the W^0-plane. In the same way, it may be shown[4] that the singular points of S^0 in the lower half W^0-plane determine the energies and decay constants of the system in radioactive states, where the system can emit one of its particles. In fact, these quantities are determined by the real and imaginary parts of those values of W^0 (in the lower half-plane) where S^0 has a pole.

It thus seems that all experimental results may be described by means of Heisenberg's characteristic matrix without making use of the wave functions of ordinary quantum mechanics, and it seems possible on these lines to get a relativistic treatment of atomic phenomena, which does not contain the difficulties inherent in all relativistic quantum field theories of the Hamiltonian form.

[1] Heisenberg, W., Report to the Solvay Congress which was planned to take place in 1939.

[2] Heisenberg, W., "Die 'beobachtbaren' Grössen in der Theorie der Elementarteilchen", (i) *Z. Phys.*, **120**, 513 (1943); (ii) *ibid.*, **120**, 673 (1943); (iii) and (iv) *ibid.* (1944–45).

[3] Møller, C., "General Properties of the Characteristic Matrix in the Theory of Elementary Particles, I", *D. Kgl. Danske Vidensk. Selsk. Mat.-fys. Medd.*, No. 1 (1945).

[4] Møller, C., "General Properties of the Characteristic Matrix in the Theory of Elementary Particles, II", *D. Kgl. Danske Vidensk. Selsk. Mat.-fys. Medd.*, No. 19 (1946).

HETEROGENESIS AND THE ORIGIN OF VIRUSES

THE name heterogenesis has been used to describe the derivation of a living thing from something unlike itself. In discussions of this subject many years ago—whether eels could be born of mud, or maggots and bacteria from putrefying matter—it was something non-living from which organisms were thought to have sprung. Later the argument took a different turn and there was speculation as to whether things as small as viruses might not be derived from some constituent of the complex cell-structure of higher animals or plants. This new aspect of the heterogenesis controversy formed the subject of a discussion at the British Association in 1931, opened by Sir Henry Dale, and the matter has now been debated again by the Society for General Microbiology, meeting at Leeds on July 23.

There are two main conceptions of the origins of viruses. Most workers on animal viruses have maintained that they resemble degraded bacteria which have lost their structural and biochemical complexity in the process of becoming adapted to a specialized parasitism. In the end, in Laidlaw's words, "they live a borrowed life", depending on the host cell for the enzymatic activity necessary for their multiplication.

Alternatively, it is argued, some self-replicating cytoplasmic constituent of a complex cell, such as a plasmagene, may become capable of multiplying when transferred to a new environment such as another cell and acquire an individuality of its own. Such an agent, being complex, would presumably tend to vary; and being variable and self-replicating, would become subject to the laws of natural selection and acquire the status of an independent organism.

All speakers at the discussion agreed that the degraded parasite hypothesis was almost certainly true as regards the animal viruses, at least the larger ones. As Dr. F. M. Burnet of Melbourne pointed out, the student of infectious disease has to assume that view from a pragmatic angle; to the epidemiologist many viruses behave so very much like organisms in general. Dr. G. M. Findlay further noted that occurrences of apparently spontaneous origin of animal viruses were almost unheard of. Quarantine was of undeniable efficiency in keeping out such viruses as rabies, foot-and-mouth disease and rinderpest; these gave no evidence of arising *de novo* in fresh hosts.

A difficulty arises in regard to the bacteriophages —or as they are coming to be called, bacterial viruses —though Dr. A. Felix adduced reasons for refusing to consider them as being viruses at all. The trouble is to imagine, if the degradation hypothesis is applicable, from what the phages could have been degraded. Here Dr. Burnet produced a new and fascinating theory: that they were the direct descendants of precellular stages in the evolution of living forms; after the first bacteria were evolved, such primitive precellular creatures were at a great disadvantage and only those which adopted a parasitic habit within the dominant bacteria were able to survive.

The tailed tadpole-like form which the electron microscope reveals for many bacterial viruses certainly seems to set these apart from other viruses. Indeed, there was a general feeling throughout the discussion that a decision as to the origins of viruses should be taken on their merits for each group, animal, plant and bacterial viruses, and that a tendency for generalization to be too inclusive should be resisted.

The animal pathologists were mainly agreed that the viruses in their field were degraded organisms, but some of them made reservations as regards tumour viruses. Dr. Peyton Rous, whose presence was much welcomed, referred to induction of neoplasms of all sorts in mouse embryo tissue exposed to methylcholanthrene. Could we believe, as seemed to be forced on us by these findings, that a virus was present in all the cells and handed down by heredity? The tumours produced involved all sorts of tissues and were of most varied histological types. Could each type be due to activation of a different virus? In the case of fowl tumours, the filterable agents were highly specific, each producing a tumour of one precise histological type. The original tumours from which the infective filtrates were derived had no obvious epidemiological connexion with another similar type of tumour. Both Dr. Rous and Dr. A. Haddow leaned to the heterogenetic explanation of the origin of some tumour viruses. But the latter pointed out important distinctions to be drawn among the tumour viruses. That causing rabbit papillomata—from which cancers may derive—behaved like a degraded organism. The Bittner mouse cancer agent also acted like an extrinsic agent but rather less characteristically than did the papilloma virus. The story of the fowl tumour viruses, however, rather suggested the doings of agents of intrinsic origin.

Dr. C. H. Andrewes was reluctant to draw a distinction between tumour viruses and others. He

TEA RESEARCH INSTITUTE OF CEYLON

Applications are invited for the post of Scientific Officer at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon. Applicants should possess an honours degree, or an equivalent qualification, in agriculture or a related pure science. Evidence of ability to carry out independent research will also be required. The officer's duties will include advisory work and research on soil management in relation to the cultivation of tea. Preference will be given to a man with experience in soil physics and field experimental methods including the statistical examination of experimental data. The officer selected may be required to work either at St. Coombs or at an out-station in Ceylon.

Salary in the scale £600–40–1,200 (payable in Ceylon at Rs. 15s. to the £) with free quarters and heavy furniture or house allowance in lieu. A higher initial salary may be given to a man with special experience. A temporary Dearness Allowance (at present Rs. 200s. a month for a married officer or Rs. 125s. for a bachelor) will also be granted. The officer appointed will be required to contribute to the Ceylon Planters' Provident Society at the rate of 10 per cent of salary to which the Board will contribute a similar amount. The appointment is non-pensionable. Home leave will normally be granted at the rate of eight months leave for each four years and four months service in Ceylon. Travelling expenses in Ceylon will be payable at the rates allowed to officers of similar status in Ceylon Government Service. The appointment will be subject to confirmation after three years service in Ceylon.

Applications giving full details of previous training and experience and accompanied by copies of any published papers and the names of three persons to whom reference may be made, should be sent before November 30 to the Secretary, Ceylon Association in London, King William Street House, Arthur St., London, E.C.4, from whom further particulars concerning the appointment may be obtained.

ROLAND V. NORRIS,
Tea Research Institute of Ceylon. Director.

THE AUSTRALIAN ALUMINIUM PRODUCTION COMMISSION

Wanted, Engineer, with sound training and experience in Mechanical Engineering, a thorough knowledge of Chemical and Metallurgical fundamentals, particular knowledge of the chemistry and metallurgy of alumina and aluminium, and wide experience in the design and operation of plants for the production of alumina and its reduction to metal.

The Engineer will be required to co-operate with the designers and subsequently to assist in the erection and early operation of a plant to be built in Australia.

The engagement will be for a limited period, probably until six months after the plant is in successful operation, but not less than two years from date of appointment. The appointment will not be made before January 1, 1947.

Liberal salary and travelling expenses will be paid to the successful applicant. Under present Australian law, remuneration earned by a non-Australian appointee, if taxable in the country of his domicile, will be exempt from Australian income tax.

Applications, which will be treated as confidential, should be addressed in the first instance to: The Deputy High Commissioner for Australia, Room 115, Australia House, London, and should state age, training, degrees held, experience, war service, and salary required. Copies only of references should be forwarded. Only applicants with an intimate knowledge of alumina and aluminium production will be considered.

Applications will close on October 31, 1946.

NUFFIELD FOUNDATION

FELLOWSHIPS AND SCHOLARSHIPS
FOR THE ADVANCEMENT OF EXTRACTION METALLURGY

With the object of advancing research and training in extraction metallurgy, the Nuffield Foundation is offering a limited number of Fellowships and Scholarships, for which citizens of Great Britain, the Commonwealth and Empire are eligible to apply.

Travelling Fellowships are offered to men who are members of the teaching staff of universities and approved schools of mines and metallurgy.

Travelling Postgraduate Scholarships are offered to junior members of the profession who are graduates of universities and approved schools of mines and metallurgy.

Vacation Scholarships are offered to mining and metallurgical students at universities and approved schools of mines and metallurgy.

Full particulars and application forms may be obtained from the Secretary, Nuffield Foundation, 12/13 Mecklenburgh Square, London, W.C.1.

NEWFOUNDLAND GOVERNMENT LABORATORY

Applications are invited for the following fisheries research posts in the Newfoundland Government Laboratory:

(1) Senior Chemist—Candidates should possess Doctor's degree in Chemistry and have had experience in research on fisheries products. Salary $5,000 rising by annual increments of $200 to $6,000, or $4,000 rising by annual increments of $100 to $5,000, according to experience and ability.

(2) Chemist—Candidates should possess good qualifications in Chemistry with post-graduate experience. Salary $3,000 rising by annual increments of $100 to $4,000.

(3) Marine Biologist—The post involves research on one or more of the ground fishes and also some hydrography. Candidates should be able when necessary to carry out biological and hydrographical work at sea. Salary $3,000 rising by annual increments of $100 to $4,000.

All posts are non-contributory pensionable posts in the Newfoundland Civil Service. Further particulars can be obtained on request. Applications, stating age, qualifications, experience and the names of two or three references, should be sent to the Director, Newfoundland Government Laboratory, St. John's, Newfoundland.

SCIENTIFIC CIVIL SERVICE

Applications are invited for the post of Director of Research in a New Mechanical Engineering Research Organisation to be established by the Department of Scientific and Industrial Research. The object of the new organisation will be to supplement the mechanical engineering research already carried out in this country by research on basic and generic problems of wide importance in mechanical engineering development.

Candidates should have high academic or professional qualifications; together with extensive experience of research and the organisation of research, preferably in mechanical engineering science.

The headquarters of the Director are expected in the first instance to be in London, but may eventually be removed out of London. The salary for London will be £2,000 per annum, subject to a deduction of £50 or £100 on transfer of the headquarters, according to its location. Superannuation provision will be made under the Federated Superannuation System for Universities.

Further particulars and application forms may be obtained from the Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1631, and completed applications should be returned to that address not later than November 8, 1946.

SCIENTIFIC CIVIL SERVICE

Applications are invited for appointment to the post of Director of Research in a new Hydraulics Research Organisation which is to be established by the Department of Scientific and Industrial Research. The scope of the new organisation will embrace problems of 'loose boundary' hydraulics, and associated civil engineering problems, affecting docks and harbours, canals and rivers, coast protection, and land-drainage and reclamation.

Candidates should have had extensive experience of research, and the organisation of research, in physical or civil engineering science.

The headquarters of the Director are expected in the first instance to be in London, but may eventually be removed out of London. The salary scale for London is £1,600–£1,800 by increments of £50 per annum. This scale would be subject to a reduction of £50 or £100 on transfer of the headquarters, according to its location. Superannuation provision will be made under the Federated Superannuation System for Universities.

Further particulars and application forms may be obtained from The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1632, and completed applications should be returned to that address not later than November 8, 1946.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as Head of the Department of Electrical Engineering in the College.

The scale of salary attached to this appointment will be £900 to £1,000 per annum.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College within two weeks from the date of publication of this advertisement.

THOS. BOYCE,
Director of Education.

SHORT SERVICE COMMISSIONS IN THE EDUCATION BRANCH OF THE ROYAL NAVY

Applications are invited from University graduates and qualified teachers under 36 years of age for short service commissions of 3, 4 or 5 years in the Education Branch of the R.N. Opportunities will be afforded for officers to be selected for permanent commissions.

Entry will be in 2 grades. Selected candidates with 1st and 2nd Class Honours Degrees receive approximately £328 in their 1st year's service, £347 in 2nd year, £438 in 3rd and 4th years, £474 in 5th year. Other candidates receive £237 in 1st year, £310 in 2nd and 3rd years, £347 in 4th and 5th years. Married men, if aged 25 or over, receive marriage allowance of £228 p.a. Accommodation and rations are provided or allowances in lieu. An outfit allowance is paid. Tax-free gratuities of £337 10s., £450 or £562 10s. are payable at the end of 3, 4 or 5 years respectively. Teachers who enter from contributory service under the Teachers' (Superannuation) Acts will continue in contributory service, superannuation contributions being deducted from the above gratuities.

Apply to Director, Education Department, Admiralty, London, for further information and application forms.

THE WEST RIDING OF YORKSHIRE RIVERS BOARD

Applications are invited for posts of Assistant Chemists in the Chief Inspector's Department. Candidates must hold a Degree in Science with Honours Chemistry or Chemistry as principal subject or possess equivalent qualifications. The appointments are open to men and women. Salary £320, rising by annual increments of £15 to £405 per annum, plus war bonus (at present £59 16s. and £48 2s. per annum respectively for males and females).

The appointment will be subject to the provisions of the Local Government Superannuation Acts, 1937 and 1939, and will be terminable by one month's notice on either side. The selected candidates will be required to pass a medical examination.

Applications, stating age, qualifications and experience, accompanied by copies of three recent testimonials (which will not be returned), and endorsed "Assistant Chemist", should reach the undersigned not later than October 1, 1946.

Canvassing, either directly or indirectly, will disqualify, and candidates, when making application, must disclose in writing whether to their knowledge they are related to any member of, or to the holder of any senior office under, the Board. Deliberate omission to make such a disclosure will disqualify the candidate, and, if the omission is discovered after appointment, he will be liable to dismissal.

H. F. ATTER,
Clerk & Solicitor.
The West Riding of Yorkshire Rivers Board,
71 Northgate, Wakefield.

CHELSEA POLYTECHNIC, LONDON, S.W.3

DEPARTMENT OF BIOLOGY

Applications are invited from University Graduates for the full-time post of Assistant Lecturer in Botany and Zoology. (A knowledge of Animal Physiology will be an advantage). Salary in accordance with the Burnham Scale for Technical Teachers. Further particulars and form of application may be obtained by sending a stamped addressed foolscap envelope to the Principal, Chelsea Polytechnic, London, S.W.3, to whom applications must be returned within 14 days of the appearance of this advertisement.

THE UNIVERSITY OF MANCHESTER

NUFFIELD DEPARTMENT OF INDUSTRIAL HEALTH

Applications are invited for the post of Lecturer in Industrial Health. Previous experience of Industrial Medicine is not a necessary requirement but applicants should have had research experience in medicine or one of the medical sciences, and must hold a registrable medical qualification. Duties to commence as early as possible. Salary, £1,000 per annum. Applications should be sent, not later than December 1, to the Registrar, The University, Manchester 13, from whom further particulars may be obtained.

UNIVERSITY OF MELBOURNE

Applications are invited for the position of Senior Lecturer in Charge of the Department of Political Science. Salary £800 (Australian) per annum, plus cost of living adjustment (at present £48), subject to Provident Fund contributions. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is October 28, 1946.

KING'S COLLEGE OF HOUSEHOLD & SOCIAL SCIENCE
(UNIVERSITY OF LONDON)
CAMPDEN HILL ROAD, LONDON, W.8

Applications are invited for appointment as Assistant Lecturer and Demonstrator in Physiology, to date from October 1946. Initial salary, £350 per annum. The appointment is open to men and women equally.

Applications, together with copies of three testimonials, should reach the Secretary (from whom further details may be obtained) as soon as possible.

BIRMINGHAM TAME AND REA DISTRICT DRAINAGE BOARD

BIOLOGIST

An assistant is required in the Board's Laboratory at Erdington, Birmingham, to undertake research work on problems concerned with sewage purification. Applicants (age 21-28) must be graduates in zoology or biology. Commencing salary £260–£360 per annum, according to age and experience, plus cost-of-living bonus varying from £48 5s. to £55 18s. per annum. Applications together with copies of testimonials should reach the undersigned not later than fourteen days from this date.

ARNOLD L. GREEY, F.C.I.S.,
Clerk's Office, Clerk to the Board.
117 Colmore Row, Birmingham, 3.

THE UNIVERSITY OF SHEFFIELD

Applications are invited for the post of Research Assistant for Cancer Research in the Department of Pathology. Applicants should have had some experience of biological research methods. A medical qualification is not essential but otherwise some special experience in histology, tissue culture, biochemistry, genetics, viruses or in any branch of cancer research is desirable. Salary: £600–£800 according to qualifications and experience. Applications (4 copies) should be sent to the undersigned, from whom further particulars may be obtained, not later than October 19, 1946.

A. W. CHAPMAN,
Registrar.

SUDAN GOVERNMENT

VACANT POST OF
CHIEF PLANT PHYSIOLOGIST

The Research Division, Department of Agriculture and Forests requires a Chief Plant Physiologist for service in the Sudan, as head of the Agronomy and Plant Physiology Section which undertakes the bulk of the field experiments throughout the country. Only first class candidates having considerable experience need apply. An initial short term contract for five years on special terms is envisaged; secondment from a University or Research Institute can be considered. Further details and forms of application may be obtained from Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF CHEMICAL ENGINEERING

A Research Worker, who should be a physicist or physical chemist, with some research experience, is required in the Coal Treatment Laboratory of the Department of Chemical Engineering for investigations connected with the cleaning of coal (with particular reference to fundamental work connected with suspensions of fine solids in aqueous media). Salary up to £450 per annum, according to qualifications and experience. Duties to begin as soon as possible. Applications should reach the undersigned (from whom further particulars may be obtained) not later than October 15, 1946.

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

DERBY TECHNICAL COLLEGE
NORMANTON ROAD, DERBY

The Governors invite applications for a full-time Lectureship in Mathematics. Applicants should be graduates of a British University. Ability to teach Mathematics up to Final Degree standard in Engineering and Science, or the applications of Mathematics to Engineering, will be an added recommendation.

Salary according to Burnham Scale. Application forms, to be returned by September 30, 1946, and further particulars, may be obtained from the undersigned.

W. ALFRED RICHARDSON,
Principal.

MEDICAL RESEARCH COUNCIL

The National Institute for Medical Research, Hampstead, has a vacancy for a technician in an organic chemical research laboratory. Salary scale £230–£15–£290 plus consolidated addition of £78. Superannuation scheme in force. Apply, stating age and experience, to Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE

Applications invited for full-time appointment as Lecturer in Physics. Burnham Technical Scale salary for assistants—£300 to £525 per annum by annual increments of £15—commencing salary in accordance with experience. Additions to scale for degree (£15 on minimum, £30 on maximum) and for time spent in approved study or training (maximum addition £45 for five or more years).

Further particulars from:

F. LONSDALE MILLS,
Education Offices, Clerk to Governors.
North Street, Wolverhampton.

DERBY TECHNICAL COLLEGE
NORMANTON ROAD, DERBY

Senior Laboratory Steward required to take charge of equipment and stores in Chemistry Department. Ability to maintain and repair laboratory apparatus and experience in arranging lecture experiments are desirable. Salary in accordance with Corporation Scale, at present £6 1s. 6d. per week (for men); the post is superannuated. Applications should be received by the undersigned not later than September 28, 1946.

W. ALFRED RICHARDSON,
Principal.

SHEFFIELD NATIONAL CENTRE FOR RADIOTHERAPY

Applications are invited for the post of Assistant Physicist. The salary will be in the Hospital Physicists Scale of £450, rising by annual increments of £25 to £600, the initial salary being according to qualifications and experience. F.S.S. in force. The work will include teaching and co-operation in the research programme of the Centre. Applications should reach the Secretary not later than Monday, October 21.

"Broom Cross",
Tree Root Walk, Sheffield, 10.

UNIVERSITY OF BRISTOL
RESEARCH STATION, CAMPDEN, GLOS

Applications are invited for the post of Assistant Chemist of research in fruit and vegetable preservation. Salary, £350 to £500 per annum, according to qualifications. Modern house available. Candidates should possess a good Honours Degree, and preferably should have some knowledge of food analysis. Applications should be addressed to the Director, Research Station, Campden, Glos.

THE INSTITUTION OF CHEMICAL ENGINEERS
EXAMINATION, 1947

Application forms (returnable December 2, 1946) and particulars of the Associate-Membership Examination for 1947 may be obtained from the Hon. Registrar, Institution of Chemical Engineers, 56 Victoria Street, Westminster, London, S.W.1.

Belgian Congo. Applications are invited

for the following three appointments in the plantations organisation of a well-known Company.

(1) Technical Director. Responsible for the organization and co-ordination of research and for the general control of plantation methods and technical processes. Research experience in tropical agriculture essential. Salary equivalent of not less than £2,000 per annum according to experience and qualifications.

(2) Agronomist to undertake research on planting methods with particular reference to the oil palm. Remuneration equivalent of not less than £1,200 per annum according to experience and qualifications.

(3) Soil Scientist. To undertake research on soils. With particular reference to crop production and disease incidence in connection with plantations. Salary of not less than £1,200 per annum according to experience and qualifications. In each appointment a knowledge of French would be advantageous. Age not more than 35. Annual leave in Great Britain or other Home Country and provision for retirement. Passages and quarters provided. Write, giving full particulars to Box 1308, c/o Charles Barker & Sons, Ltd., 31 Budge Row, London, E.C.4.

Wye College (University of London),

near Ashford, Kent. The Governing Body invites applications from men and women for the post of Head of the Department of Biological Sciences. Applicants should have an Honours Degree in Botany with preferably some experience in work applied to agriculture and/or horticulture. Salary will be £800 to £900 per annum according to qualifications. The appointment will include superannuation under the F.S.S.U. scheme. Conditions of appointment, form of application, and further particulars to be obtained from the Secretary-Registrar, Wye College, near Ashford, Kent.

Applications are invited for the following

appointments in the Scientific Officer grade. Salary not less than £255 per annum (plus war bonus), according to qualifications. F.S.S.U.

i. Zoologist to undertake work in connection with the study of fish populations.
ii. Botanist to work on phytoplankton in collaboration with other members of a team studying hydrology and lake metabolism.

Candidates should have an honours degree. Previous research experience is not essential. The appointments will be probationary for one year. Further details from, and applications before November 15 to, the Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland.

Technical Assistant required by Works

Manager in complete charge of factory employing about 2,000 people in the neighbourhood of London on the manufacture of chemicals and on packaging operations. Remuneration up to £900 per annum, dependent upon qualifications and experience. Applicants should preferably be between 30–35, have an engineering or chemical engineering qualification and have had sound technical experience in a comparable works. The person appointed must be capable of undertaking full responsibility for assignments given him by the works manager. Applications should give full details and be addressed to Box 694, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Zoologist in 'Scientific Officer' class to

work on ecological problems connected with water pollution. Applicants should have an Honours Degree in Science and preferably some taxonomic knowledge of animals to be found in rivers and streams. Initial salary not less than £255 per annum (plus war bonus), according to qualifications. F.S.S.U. The appointment will be probationary for one year. Applications, with names of two referees, should reach the Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland, from whom further particulars may be obtained, not later than November 30.

The Linen Industry Research Association

has vacancies on the scientific staff of its Research Institute, situated near Belfast, for research and development work on flax bleaching, spinning, and weaving. Candidates must have a good degree in Chemistry or Physics or Mechanical Engineering, and some research experience. Salary will be in the scale according to age, qualifications, and experience. The scales rise to £450 per annum for Junior Scientific Officers, and to £700 per annum for Scientific Officers, plus war bonus in each case.

Application forms are obtainable from the Director of Research, Linen Industry Research Association, The Research Institute, Lambeg, Co. Antrim, Northern Ireland.

Technical Assistant in Bacteriology.

Experienced bacteriological technician required to take charge of media kitchen, etc., for unit working on bacteriology of freshwater. Salary £5 to £6 per week (plus war bonus) according to qualifications. Applications before October 31, giving full details of training and experience and names of two referees, to the Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland.

Research Laboratories in N.W. London

have vacancies for one or two graduates in Heat and Temperature Control Sections; good honours degree in Physics, General Science or Electrical Engineering and several years' research experience required. Good prospects for men with ability and initiative. Opening also in Primary Batteries Section for young graduate with good degree in General Science or Chemistry. Apply in writing, stating age, qualifications and experience to Research Laboratories of the General Electric Co., Ltd., Wembley, Middx.

Indian Tea Association require three

Advisory Officers. Applicants should have taken a good degree in agriculture or an honours degree in science followed by at least one year's study of agriculture at University level. Salary scale, Rs. 600 rising by annual increments of Rs. 50 to Rs. 1,800 per month with free bungalow accommodation. Successful candidates will receive one year's training at the Association's Scientific Department in Assam prior to posting in the tea districts of Assam, Dooars or Darjeeling. Consideration will be given to applicants who have taken an honours degree in science but have no knowledge of agriculture. Such men if selected would be required to undergo one year's training in agriculture (including the applications of the sciences) and would receive a scholarship grant of £226 plus lecture and laboratory fees and £5 book allowance. Salary scale as above on appointment. Applications, giving age and full particulars of education, together with the names of two referees as to character and ability, should be sent to the Secretary, Indian Tea Association (London), 39 Lombard Street, London, E.C.3.

(*Continued on page* iv *of Supplement.*)

(*Continued from page* iii *of Supplement.*)

A vacancy exists with an old-established Company for a first-class Ceramic Chemist in a senior position. Applicants must have had practical experience with ceramic insulating material of exceptionally high alumina content and be capable of supervising control of processes and constituent materials. Apply Box 693, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited by Lever Brothers & Unilever, Ltd., for the following appointments in the Scientific Library of their Research Department at Port Sunlight, Cheshire. (i) Librarian. To be responsible for the library and for the organisation of the Abstracting Service. (ii) Abstractors. Four posts, open to women, who must possess a Degree in Science. A knowledge of French or German will be an advantage.

Salaries will be related to qualifications and experience. Applications should be addressed to : Lever Brothers & Unilever, Ltd., TD/R., Unilever House, Blackfriars, London, E.C.4.

Lever Brothers & Unilever, Ltd., re-quire four Assistant Bacteriologists for work in a variety of fields in their Research Department at Port Sunlight, Cheshire.

Applicants must possess a University Degree or Diploma in Bacteriology, or an Honours Degree in Chemistry with adequate post-graduate training or experience in bacteriology. Salaries will be related to qualifications and experience.

Applications should be addressed to : Lever Brothers & Unilever, Ltd., TD/R., Unilever House, Blackfriars, London, E.C.4.

The National Coal Board have a limited number of vacancies for scientists with honours degrees in one of the following subjects : Mathematics, Physics, Chemistry, Mineralogy, Geology, Biochemistry or Physiology—or with experience of Operational Research. Application forms can be obtained from the Director of Personnel, National Coal Board, Lansdowne House, Berkeley Square, W.1.

Particulars of scientists in the employ of colliery companies have been obtained separately, and will be automatically considered.

Technical Assistant required in De-partment of Plant Physiology. Commencing salary £300 per annum. Some laboratory experience essential. Applications, including names of two referees, should be sent to the Registrar, Queen Mary College (University of London), Mile End Road, E.1.

Laboratory Steward required for the Chemical Laboratory of Royal Holloway College (University of London). Wages according to age and experience. Applications should be made in writing to the Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

Qualified Chemist with research and/or process experience in oils, fats and waxes, or allied industries, required by a London firm. Knowledge of analysis and modern physico-chemical methods desirable. Age about 25–35 years. Well paid, very interesting, and promising position. Detailed applications only will be considered. Apply Box 689, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chief Analyst required by Chemical Manufacturer with factories in Scotland. Applicants should be 30–35 years of age, have good academic qualifications, industrial experience and ability to develop original methods. Salary commencing £750. Apply Box 691, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Young Graduate with experience in Electronics required for research by University Medical Department. Commencing salary, £350–£450. Reply Box 692, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Assistant or young Chem-ical engineer and lab. boy required by London firm. Experience in oils, fats and waxes, or allied industries an advantage. Well paid and promising positions. Detailed applications only will be considered. Apply Box 690, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Consultants required for application of Paints for Hand Tool Production. Write Box 695, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistant Secretary. Book-keeping and clerical experience essential, age 30 or over. Commencing salary £250–£300 according to suitability, rising by £20 p.a. to £360. Apply, stating education, full experience, references, by October 5, 1946, to General Secretary, Society of Dyers & Colourists, 32–34 Piccadilly, Bradford.

University of London—St. Thomas's Hospital Medical School. Applications are invited for the post of Lecturer in the Department of Anatomy. Initial salary £650–£750, according to experience. Successful candidate will be required to contribute to superannuation scheme under the F.S.S.U. Applications (6 copies) should be lodged at the Dean's office by September 30, 1946.

Company situate in North Midlands have vacancy for a Research Chemist. Experience in laboratory management and knowledge of plastics and/or chemical engineering an advantage. Gross salary £450/700 per annum or a higher figure might be offered to a candidate capable of accepting special responsibility. Give full details in writing to Box 696, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Engineering Firm, Glasgow, requires Second-in-Command for Research Dept. High executive and technical ability ; experience in modern flow theory and practice. Reply very fully, stating salary required. Box No. 304, 8 Serle Street, London, W.C.2.

The Research Department of Cam-bridge Instrument Co., Ltd., Cambridge, has vacancies for : (1) An Assistant Physicist (graduate), with a useful pair of hands and preferably with some research experience. (2) A Laboratory Technician to undertake glass-blowing, vacuum work, etc. Apply in writing giving details of education, experience, and salary required.

Scientific Periodicals Wanted : Rev. Modern Phys., J. Appl. Phys., Rev. Sc. Instr., Trans. Am. I.E.E., Phil. Mag. (since about 1930). Box 697, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

felt that latency and activation by an appropriate stimulus were the characteristic features of the behaviour of many, perhaps most, viruses in their natural hosts. He suggested that with some viruses parasitic adaptation to the host might become so perfect that the individuality of the virus was lost in that of the host cell. This might be permanent; but if the change was a reversible one, viruses brought to light would have an apparently heterogenetic origin. There was some evidence, as in insect viruses and Rickettsiæ, of transmission through the egg.

There was less tendency for speculation among the students of plant viruses, exemplified by Dr. F. C. Bawden. He preferred to "wait and see", but clearly had a weakness for heterogenesis. Virus-like proteins might be normal constituents of some plants, but our present methods of detecting them would not be nearly delicate enough—unless the object of our study was self-reproducing in another environment.

Along with speculation on the origins of viruses must go curiosity as to what they look like. The metal-shadowed electron micrographs which Dr. R. W. G. Wyckoff showed (see *Nature* of March 2, p. 263) caused much interest and pleasure. The bean mosaic particles, lining up in orderly array to form a crystal, caused a spontaneous burst of applause; while pictures of influenza virus existing as small spheres or, unless our eyes deceived us, as long filaments, left us in awed wonder.

OBITUARIES

Dr. Arthur W. Rogers, F.R.S.

On June 23 there died at Cape Town, at the age of seventy-four, one to whom South Africa owes much in regard to geological discovery, description and application. A. W. Rogers was born at Bishops Hull, Somerset, and educated at Clifton College and Christ's College, Cambridge—of which he was later elected an honorary fellow—and also studied at the University of Heidelberg. In 1896 he became assistant geologist to the Geological Commission of the Cape of Good Hope, director of the Commission in 1903, and director of the Geological Survey of the Union from 1916 until his retirement in 1932. His thirty-six years of sterling service with the Government were divided equally between the Cape and Transvaal provinces.

Closely associated in the field at first with his colleague, Prof. E. H. L. Schwartz, largely within the picturesque south-western corner of the Cape with its magnificent exposures of folded strata, he was able by 1905 to publish "An Introduction to the Geology of Cape Colony", the first text-book of its kind for southern Africa, and a work of considerable merit. In it were set forth the main tectonic lines, stratigraphy, palæontology and history of this interesting land with its many pre-Cambrian systems, Carboniferous glacials, prolific Permo-Triassic vertebrates and mesozoic dolerites. During the next decade he carried investigation far to the north—to the border of the Kalahari and German territory—describing little-known pre-Cambrian groups or discovering new ones, such as the crocidolite-bearing jaspers, the Numees tillite, Ongeluk tillite, magmatic copper-bearing eruptives and melilite-basalts.

In the Transvaal his main work lay in the mapping of the Heidelberg gold-fields, during which the glacials of the Witwatersrand beds were first recorded. Administrative duties greatly interfered with his output of purely scientific work. Under his able direction, however, a high standard was achieved by the Geological Survey, and numerous maps and memoirs issued, not a few of them of high economic importance.

Attracted, like so many others, by the vast Kalahari and its queer siliceous and calcareous rocks, he was able to cross its heart as well as inspect its borders, and contributed two illuminating addresses on the solid and surface geology of that sand-strewn region.

Always interested in the finer structure of substances, he developed upon retiring to the Cape in 1932 a still keener interest in the microscopical and microchemical examination of the sedimentary rocks, a study which he pursued the more constantly after 1938, when cardiac disturbances had debarred him from further field work. To many of us such minuter researches proved helpful indeed.

His writings were numerous and varied: for the most part accounts of regional geology appearing as departmental reports or in yearbooks, or else as papers based thereon, though none was of monographic size. His most important works are "The Geology of the Country around Heidelberg", his contribution to the "Handbuch der Regionalen Geologie: The Union of South Africa" (1929) and his fascinating history of "The Pioneers in South African Geology and their Work" (1937), in which so much interesting geological as well as biographical information was so meticulously recorded for posterity. His presidential addresses cover a wider field and range in their subjects from past climates to the evolution of river systems and 'pans'. Only just recently did he complete a description of the Diatom floras of the diatomaceous deposits of the Union in collaboration with L. E. Kent, intended for Memoir No. 42 of the Geological Survey, a research on which he had been long engaged.

In all, Dr. Rogers contributed both abundantly and nobly to our geological and geographical knowledge of a wide terrain, which the writer indeed regards as one of the key regions of the earth.

Connected with many learned societies, he was elected a fellow of the Royal Society of London (1918), the Geological Society of London (1896) and Royal Society of South Africa, as well as honorary fellow, member or correspondent of others. Rogers was president of the Geological Society of South Africa (1915), of the South African Association for the Advancement of Science (1922), of the International Geological Congress (1929) and of the Royal Society of South Africa (1934–35).

His awards were numerous: the Bigsby Medal (1907) and Wollaston Medal (1931) of the Geological Society; South Africa Medal (1913) of the South African Association for the Advancement of Science; Scott Medal (1931) of the Biological Society of South Africa, and Draper Memorial Medal (1936) of the Geological Society of South Africa.

Rogers will always be remembered for his geniality, readiness to discuss or guide, scrupulous attitude towards the work or views of others, and honesty of purpose. His outlook was, however, coloured by some conservatism. Throughout, he was the scientific worker pursuing his subject for its own sake, and perhaps for that reason the grander problems of the African continent do not seem to have gripped him. Having been closely associated with Arthur Rogers over many years, the writer feels that a noteworthy geologist has been lost to the world.

Alex. L. de Toit

Dr. Louis Martin

By the death of Dr. Louis Martin on June 13, one of the last remaining links with Pasteur has been severed. Martin was born on September 20, 1864. In 1892, when he was a young doctor at the hospital for children's diseases in Paris, he became associated with Roux in a remarkable series of investigations which showed the immense possibilities of the newly discovered antitoxin for the control and treatment of diphtheria. The results of their work were communicated at an International Medical Congress at Budapest in 1894 by Roux, Chaillou and Martin in a paper the importance and high quality of which has been recognized for half a century. This was Martin's introduction to diphtheria, a subject in which his interest remained unabated to the end of his life. He was appointed to the staff of the Pasteur Institute in 1892, where he remained for the rest of his working life, occupying positions of increasing importance and finally becoming director in 1934. He made notable contributions to the bacteriology of the diphtheria bacillus and closely related organisms, devised a culture medium for the production of diphtheria toxin which is widely used to-day, extended his researches on the prophylaxis and treatment of diphtheria, and studied the problems presented by the 'carrier'. For many years he was responsible for the production of the antitoxins and antisera required in France, and later he found solutions to the technical and administrative problems created by the enormously increased demand for these materials during the First World War.

Martin was also interested, and experienced, in public health problems and in the construction and organisation of infectious diseases hospitals. His advice was constantly sought by the State Department and by municipalities concerning the control of epidemics; and the Pasteur Hospital, which Martin served since its establishment in 1900, gave him the opportunity for studying, under what were then novel conditions, the medical care and nursing of cases of infectious disease. With Brouardel he wrote a treatise on hospital organisation and the prophylaxis of infectious diseases, which is a standard work on this subject in France.

In 1914, Martin became vice-president of the Society of Biology and, in later years, president of many learned societies. In 1919 he became a member of the Academy of Medicine and in 1937 he was elected to the Academy of Sciences. Martin's somewhat forbidding appearance and brusque manner hid a warm, kind and generous nature. He gave a lifetime of high endeavour to the service of science, to France, and to the Institute he loved so well.

Percival Hartley

Mr. G. H. J. Adlam, O.B.E.

Mr. G. H. J. Adlam, editor of the *School Science Review*, died suddenly on July 30. With his passing a great landmark has gone, for he alone of the officers of the Science Masters' Association was re-elected year after year, so that members came to look upon him as a permanent pillar of the Association. His was the thought that first suggested the *School Science Review* and his the guiding hand that led it to success. As time went on, zeal for the welfare of the *Review* grew upon him and gripped him more and more until it became his ruling passion. When at the age of sixty-seven he retired from his school duties, having with indifferent health courageously carried on during the War, he looked forward to his leisure to make the *Review* even better. Already in his hands the 1919 booklet of thirty-two pages had in a few years become the largest and most influential journal of school science in Great Britain, if not in the world. Undoubtedly Adlam did more for the betterment of school science than any man of his generation: the value of his work is incalculable. Such an achievement could not pass unnoticed and in 1934 Adlam was awarded the O.B.E. Later, in 1941, he became president of the Science Masters' Association.

Adlam was educated at Wells Cathedral School and Wadham College, Oxford. He graduated with first-class honours in chemistry, and later obtained his B.Sc. for research work on the water component of systems of hydrated salts. He was the editor of the Science Masters' Association publications and the author of some widely used text-books of chemistry. After a varied teaching experience, he settled down at the City of London School, where for many years he was in charge of the science.

"Joe" Adlam, shy and kindly, was in school and on committee an admirable colleague, sage in counsel and sound in judgment. At this critical time in educational affairs his advice and lead will be sorely missed. Qualified as a man of science, he was also an accomplished English scholar, with a rich humour and a rare aptitude for finding the appropriate word. To many a diffident young author he was extraordinarily kind, suggesting better arrangements of his subject-matter and not infrequently re-writing an entire article. In all his activities, his standards were high. He had a dread of losing grip and rusting away; but he died as he wished, in the midst of useful work—he had just completed the third volume of Physics in the Science Masters' Book.

All who knew Adlam will lament his death and extend their sympathies to his widow, formerly Florence Lavinia Chun. A charming hostess and capable housekeeper, she shared his enthusiasm for his favourite recreation—the cultivation of his rock plants—and did much to cheer the evening of his life.

G. Fowles

Dr. L. B. C. Cunningham

Dr. Leslie Bennet Craigie Cunningham died at Harrow on August 31 at the age of fifty-one. Although seriously ill for a lengthy period prior to his death he continued, until the last few weeks, to evince the keenest interest in the research problems of air armaments to which his life's work was devoted.

Born of Scots parentage, Cunningham was educated at Edinburgh Academy and Sedbergh School. His career at the University of Edinburgh was interrupted by the First World War, in which he was commissioned in the King's Own Scottish Borderers and later transferred to the Royal Engineers (Signals Service). On the completion of his studies at Edinburgh he was appointed as an education officer in the R.A.F. and served at No. 1 Air Armament School at Eastchurch and later Manby. In this post his work ranged over the whole theory of air armament both in instruction and research. In 1931 the two-year advanced armament course of university standard was inaugurated under his technical direction, and all senior present-day R.A.F. armament officers were at one time Cunningham's pupils, many

consulting him regularly throughout the Second World War. During this period he was awarded the Ph.D. of the University of Edinburgh for his work on bomb ballistics.

At the outbreak of the Second World War, Cunningham was appointed by the Director of Scientific Research, Air Ministry, to lead a small body of research workers in the development and application of a mathematical theory of air combat which he had earlier produced. The scope of the work of this group, called the Air Warfare Analysis Section, and its strength, expanded rapidly during the War until it eventually covered a very wide field, ranging from the geodetic work associated with the blind-bombing tactics of the R.A.F. to the statistical theory of aim-wander in aerial gunnery.

In 1945 Cunningham was elected a fellow of the Royal Society of Edinburgh. Security restrictions unfortunately prevented the publication of much of his work, but a joint paper with W. R. B. Hynd on the application of the theory of random processes to air-warfare, read recently before the Royal Statistical Society, indicates the trend of much of his recent work.

Cunningham was prevented by his death from taking up a high appointment at the Royal Aircraft Establishment, Farnborough, and his loss will be keenly felt throughout the sphere of air armaments. He will be remembered with affection by all who worked with him. E. C. CORNFORD

WE regret to announce the following deaths :

Sir Carruthers Beattie, during 1918–37 vice-chancellor and principal of the University of Cape Town, on September 10, aged seventy-nine.

Sir James Jeans, O.M., F.R.S., on September 16, aged sixty-nine.

Nikolai Morozov, honorary member of the Academy of Sciences of the U.S.S.R., known for his general writings on scientific topics, on July 13, aged ninety-two.

NEWS and VIEWS

Engineering at Edinburgh : Prof. R. N. Arnold

PROF. R. N. ARNOLD has been appointed to the regius chair of engineering in the University of Edinburgh. Prof. Arnold completed a brilliant studentship record by graduating at the University of Glasgow in 1932 with first-class honours, and followed this directly with a period on research, which qualified him for the associateship of the Royal Technical College and won the principal College research award. Appointment to a Senior Caird Scholarship then followed, and with this, he went to Sheffield to continue his work on engineering materials in Prof. Lea's laboratory. This phase of his research career was notable for work on embrittlement, the theme of several important papers and the subject of his thesis for the Ph.D. degree. In 1934 he accepted appointment to a Commonwealth Fund Fellowship and spent the two succeeding years at the University of Illinois. His work there was marked by a significant change from the more static type of materials investigation to the dynamical questions of impact and vibration ; and his later publications have demonstrated his interest and power in this field.

On his return from Illinois in 1936, Dr. Arnold was appointed to a lectureship in the Department of Civil and Mechanical Engineering in the Royal Technical College, Glasgow, where in addition to a wide range of teaching, he took a prominent part in the special investigations conducted by the department. His work on the topical engineering problem of the 'singing propeller' was particularly valuable, and the papers published by him and his colleagues on this subject aroused considerable attention and gained the Gold Medal of the Institute of Engineers and Shipbuilders in Scotland and the Thomas Lowe Gray Prize of the Institution of Mechanical Engineers. In 1941, Dr. Arnold joined the senior staff of the Metropolitan-Vickers Electrical Co., and while there was engaged on many important investigations. Later papers on some of these have made him widely known as a main authority on such diverse lines as machine tool dynamometry and gyroscopic stabilization problems. The latter was the subject of his thesis for the Glasgow D.Sc., which gave a fine demonstration of analytical and experimental powers, adequately and successfully combined with inventive faculty and design capacity. He was appointed professor of engineering at University College, Swansea, in 1944, and leaves this position to succeed the late Sir Thomas Hudson-Beare at Edinburgh. Scottish engineering will welcome his return. He brings a fine teaching experience and real gifts of exposition to the instruction of its students, and a proved and polished research power to aid its development.

Geology at University College, London : Prof. S. E. Hollingworth

DR. S. E. HOLLINGWORTH has been appointed to the Yates–Goldsmid chair of geology in University College, London. On leaving Cambridge, Dr. Hollingworth joined the Geological Survey in 1921 and went to the Cumbrian unit then based on Whitehaven. He took part in the survey of the Whitehaven, Gosforth, Cockermouth and Brampton sheets. In Whitehaven and Gosforth he was concerned mainly with Borrowdale rocks and with the Ennerdale Granophyre, but had some Carboniferous rocks with hæmatite. In the Cockermouth Sheet he was allotted the area including the Carrock Fell Complex, made classic by Harker, the greisen mass (with tungsten deposits) of the Skiddaw Granite and the metamorphic aureole of Skiddaw Slates, the Eycott and the northern area of Borrowdales with the Caldbeck mining field, mainly derelict but including the barytes deposit of Potts Ghyll. Much of this work is as yet unpublished, but marks an advance on that of previous workers. In the Brampton area he was concerned mainly with Lower Carboniferous strata and Triassic rocks with gypsum. Here he became particularly interested in drift deposits which led to his paper on glaciation in Western Edenside (*Quart. J. Geol. Soc.*, p. 281, 1931), which was accepted for D.Sc. London. On the dispersal of the Cumbrian unit, Dr. Hollingworth was sent to the Droitwich area, mainly on Trias, and later to that around Cambridge, with its widespread Drift and Recent deposits. At the outbreak of war it was essential that assistance from the Survey should be forthcoming on home ore deposits,

and Dr. Hollingworth was chosen as one of the team selected for the Jurassic iron ores, when again he did excellent work. It will be seen that in his Survey career Dr. Hollingworth has gained considerable experience on a variety of rocks and minerals in various fields. Moreover, he has been ever ready to follow up aspects arising from Survey work which could not be included in the official programme. All this should prove invaluable at University College.

Morbid Anatomy in the University of London : Prof. Dorothy Russell

Dr. Dorothy S. Russell, recently elected professor of morbid anatomy in the University of London and director of the Bernhard Baron Institute of Pathology at the London Hospital, was born at Sydney, Australia. Coming to England as a child, she went from the Perse High School for Girls to Girton College, Cambridge, and passed Part I of the Natural Sciences Tripos (Class 1). A Gilchrist Studentship gave her another year at Cambridge. She entered the London Hospital in 1919, took the Conjoint Diploma in January 1922, and later became M.D. Lond. (University Medal), M.A. Oxford (by decree), Sc.D. Camb. (for published work) and M.R.C.P. London (by by-law 123). She was the first woman awarded the John Hunter Medal of the Royal College of Surgeons (1934). After a year as pathology assistant in the Institute (1922–23) she became a Junior Beit Fellow. Her research, "A Classification of Bright's Disease", was made a Special Report by the Medical Research Council. Then as Rockefeller Medical Research Fellow she divided a year in the United States between Prof. F. B. Mallory and Dr. Wilder Penfield. She then worked in the Bernhard Baron Institute with Sir Hugh Cairns with grants from the Medical Research Council, to the scientific staff of which she was appointed in 1933. She worked at Oxford during the War, returning to the Institute in October 1944.

Of Prof. Russell's numerous publications the most striking perhaps are the study of gliomas by tissue culture with the late Dr. J. O. W. Bland, and the cinematograph demonstration of the living cells with Dr. Bland and the late Dr. R. G. Canti. By culture she also determined the true nature of previously doubtful gliomata. Her work on the pituitary gland is most important. Her experimental work at Oxford proved of great practical value to the troops. Her publications include papers upon general morbid anatomy, in which she has always taken an active interest.

Imperial College of Tropical Agriculture : Mr. H. J. Page, M.B.E.

Mr. Harold James Page has been appointed principal of the Imperial College of Tropical Agriculture in succession to Mr. O. T. Faulkner, who retired on August 31. Mr. Page, who will take up his new duties early in 1947, was educated at Southend High School and at the University of London, where he held three scholarships and was prizeman in organic chemistry and gold medallist in physiology ; in Berlin under Prof. Willstätter and in Paris at the Institut Pasteur. During 1920–27 he was chief chemist and head of the Chemical Department at Rothamsted Experimental Station. On leaving Rothamsted he became head of the Research Laboratories at the Imperial Chemical Industries Agricultural Research Station at Jealott's Hill and eventually controller of agricultural research there. In 1936 Mr. Page was appointed director of the Rubber Research Institute of Malaya, and during the Second World War was interned in Sumatra for three and a half years.

The Library Association

The University and Research Section of the Library Association held its tenth week-end conference at Winchester College during September 6–9. At the general meeting of the Section, Mr. G. Woledge, librarian of the British Library of Political and Economic Science, London School of Economics, outlined the proposals for a survey of the specialist bibliographical resources of the country. Libraries which already possessed the nuclei of specialist collections would be encouraged to develop those collections so far as their means allowed ; and the survey would cover Government, university, research and the larger municipal libraries alike. The status of librarians in Government departments was the subject of a discussion to which two librarians from Government libraries made valuable contributions. It was urged that trained librarians should be employed in all departmental libraries, and that, in order to attract individuals with professional qualifications, a new librarian grade should be introduced in the Civil Service, analogous to those already established for other professional appointments. In this way a library post would not merely be a stepping-stone to a higher appointment in a different branch of the department, but would offer adequate prospects of promotion within its own field, and so result in an increased efficiency in Government departmental libraries.

Mr. A. E. Cummins, librarian of the Chemical Society, opening a discussion on the procurement of foreign publications for British libraries, outlined the conditions at present obtaining in Germany and contrasted sharply the far-sighted policy adopted by the Americans and Russians with the meagre results obtained by ourselves. Mr. K. Garside, deputy librarian of University College, London, viewed with concern the opportunities already lost and emphasized particularly the urgency of procuring important works published in Germany since the end of the War ; the Library of Congress Mission has been empowered to cover the post-war field on behalf of the libraries of the United States. Mr. J. S. G. Simmons, deputy librarian of the University of Birmingham, pointed to the need for ensuring a regular flow to Great Britain of Russian publications, and especially of bibliographical reference material. The Section discussed the priorities to be allotted to the various categories of libraries in the distribution of war-time publications that were in short supply, and expressed the view that, where only a single copy of a work was available, that copy should be placed in a library where it would be readily accessible to all who had cause to consult it.

Industrial Relations and the Trade Unions

A broadsheet "Inside the Unions" (No. 249) recently issued by Political and Economic Planning is of some interest to scientific workers as a factual study of a movement towards which some professional associations of scientific workers are attracted. It is also of value in its bearing on the question of industrial relations and the causes of the rift between rank and file and the branch secretaries and national leaders indicated by a number of unofficial strikes.

The broadsheet analyses trade union activity at three levels, and directs attention to the clearly marked gradation of attitude running through the union structure : the rank and file, suspicious of employers and of those who put their point of view, deceptively quiescent for long periods, ill-versed in the difficulties of negotiation ; the more experienced and consistently active group in a branch, conscious of difficulties, anxious not to imperil the claim of the branch to meet employers as a responsible body, yet militant and conscious of pressure from below, often critical of apparent inertia at the national level ; and finally, the national officials concerned with the main issues of policy, weighing the balance of forces and expediency, trying to form and execute a broad strategy for the advance of the union, embarrassed by manifestations of irresponsibility by the branches or rank and file which may prejudice much greater issues. An important feature of the broadsheet is its analysis of attendance and voting in trade union branches and the attempt to correlate both with the size of the branch. The division between 20 per cent of regular active attention to union business and the 80 per cent of apparent apathy but episodic action goes back for nearly a hundred years in the union structure. This attempt to bring a controversial subject within the ambit of scientific analysis is noteworthy, not only for the reasons already given, but also as illustrating an approach which should be much more widely applied in the study of democratic institutions.

Observations at the Ebro Observatory

Series A of the *Boletin Mensual del Observatorio del Ebro*, 31, Nos. 1–9 (1943), deals with heliophysics, meteorology and seismology. Under the first are included the observations of sunspots, which are classified under five different types, definitions of which are supplied. Thus, type 1 includes a group of one or more scattered spots ; type 2 a formation of two spots ; type 3 a string of spots ; type 4 isolated spots ; and type 5 an irregular group with large spots. A table gives a comparison of solar activity in the sectors north-east, south-east, south-west and north-west. 'Meteorology' contains tables showing the atmospheric pressure, temperature, relative humidity, rainfall, hours of sunshine, etc. The third portion consists of short tables in which, among other items, are included the period, amplitude, time of occurrence and observations of earthquakes, and information, where such is available, regarding the epicentre. Series B deals with terrestrial magnetism and electricity and with atmospheric electricity for the months October, November and December 1936. This series consists almost entirely of tabular matter dealing with the general characteristics of each month, the maximum amplitude of oscillation of the compass, and the mean values for each month, and also the atmospheric potential gradient.

Bristol City Musuem and Art Gallery

The annual report for 1945 of the Committee of the Bristol City Museum and Art Gallery notes the separation (proposed in 1944) of museum and art gallery services, the former under the direction of Dr. F. S. Wallis, and the latter under the direction of Mr. H. W. Maxwell. This appears to be a progressive movement on the part of the Committee, and the policy will be highly favourable for the future activities of both institutions. Although for the present the City Museum and the City Art Gallery will remain in the Art Gallery buildings (those of the Museum having been badly damaged during the War), the Committee has under consideration a long-term policy which includes the future provision of new sites for both art gallery and museum purposes. As in the case of other 'bombed-out' museums, the museum in Bristol has been faced with many difficulties, but numerous temporary exhibitions of topical and educational interest, together with 'museum competitions' held in collaboration with the Bristol Holidays-at-Home Committee, have helped to bridge the gap left by lost exhibition galleries. These, besides attracting large numbers of visitors, have been, without doubt, of considerable public value. The re-opening of the Georgian House and the resumed use of the Red Lodge for the annual exhibition of paintings and other functions are also reported.

Locating High-frequency Cable Faults

In a paper on new methods of fault location, read by F. F. Roberts in London before the Institution of Electrical Engineers, it is pointed out that normal fault-locating procedures become impractical in certain conditions, either for purely technical reasons or on account of the loss of service-time involved. The author first summarizes a theoretical investigation of the possibilities of applying pulse and frequency-modulation methods to this problem on wide-band coaxial telephone cables, and then describes a practical fault-locator employing D.C. pulses. The problem is contrasted with that of radar, and the factors controlling the choice of the transmitted wave-form and those limiting the accuracy of location obtainable are then discussed. The fundamental requirements of a frequency-modulation system are examined in some detail, and it is concluded that, although a frequency-modulation instrument would be attractive in certain circumstances, the practical advantage lies with the pulse type of fault-locator owing to the clarity and reliability of its indications when more than one fault is present. The D.C. pulse instrument described has been in use for some time, and faults on coaxial cables have been located within 1 per cent of their true distances at ranges up to ten miles.

1851 Exhibition Research Scholarships

Overseas Science Research Scholarships for 1946 have been awarded by the Royal Commission for the Exhibition of 1851 to the following : *Canada :* on the recommendation of McGill University, Montreal, to Dr. J. T. Edward for research in organic chemistry at the University of Oxford ; on the recommendation of Queen's University, Kingston, to G. R. G. Lindsey for research in physics at the University of Cambridge ; on the recommendation of the University of Toronto to C. A. Barnes for research in physics at the University of Cambridge. *Australia :* on the recommendation of the University of Melbourne to A. M. Clark for research in zoology at the University of Cambridge ; on the recommendation of the University of Sydney to E. E. Salpeter for research in theoretical physics at the University of Birmingham. *New Zealand :* on the recommendation of the University of New Zealand to H. A. Whale for research in physics at the University of Cambridge ; and A. V. Jones for research in physical chemistry at the University of Cambridge. *South Africa :* on the recommendation of the University of the Witwatersrand to P. R. Levy for

research in organic chemistry at the University of Oxford. *Eire:* on the recommendation of the National University of Ireland to M. J. Cranley for research in chemical physics at the Royal Institution, London. *India:* on the recommendation of the Indian Institute of Science, Bangalore, to G. N. I. Ramachandran for research in physics at the University of Cambridge; and K. R. Surange for research in plant morphology and palæobotany at the University of Cambridge or the University of Reading.

Rockefeller Travelling Fellowships in Medicine

THE Medical Research Council announces that it has awarded Rockefeller Medical Fellowships to the following, for the academic year 1946–47: Dr. Sheila T. E. Callender, graduate assistant, Nuffield Department of Clinical Medicine, Oxford; Dr. C. E. Dent, research assistant, Medical Unit, University College Hospital, London; Mr. A. M. Jones, Leverhulme Research Scholar (Royal College of Physicians), University and Royal Infirmary, Manchester; Dr. A. M. Macdonald, Department of Pathology, University of Edinburgh; Dr. J. E. Morison, lecturer in morbid anatomy, Queen's University, Belfast; Dr. F. T. C. Prunty, lecturer in chemical pathology, St. Thomas's Hospital Medical School, London; Dr. F. F. Rundle, surgical specialist, R.A.M.C., lately chief assistant and registrar, Westminster Hospital, London; Dr. J. Swinney, assistant surgeon, Department of Urological Surgery, Newcastle-on-Tyne General Hospital.

The Council has also awarded a Dorothy Temple Cross Research Fellowship in Tuberculosis to Dr. T. F. Jarman, assistant tuberculosis physician, Welsh National Memorial Association.

Poultry Mission to North America

THE Minister of Agriculture and Fisheries, in conjunction with the Secretary of State for Scotland, has arranged to send a mission to North America for the purpose of investigating, on behalf of the agricultural departments and their poultry advisory committees, the progress in the development of the poultry industry that has been made in the United States of America and Canada during recent years, and in particular to examine the stock improvement schemes in both countries. It is contemplated that the mission will start early in October and will spend a month in the United States, followed by a fortnight in Canada. It is proposed that the mission will consist of the following: Dr. R. Coles, superintending poultry advisory officer of the Ministry of Agriculture and Fisheries; Dr. A. W. Greenwood, acting director, Institute of Animal Genetics, University of Edinburgh; Mr. R. F. Gordon, senior research officer, Ministry of Agriculture and Fisheries, Veterinary Laboratory, Weybridge; Mr. C. Hedderwick, Somerset Poultry Farm, Bathpool, Taunton, Somerset; Mr. J. Sutton, The Clifton Pedigree Poultry Farm, Clifton, near Preston; Mr. G. Sykes, Queen Manor Farm, Laverstock, Salisbury.

International Hematology and *Rh* Conference

AN International Hematology and *Rh* Conference will be held in Dallas, Texas, on November 15. This conference will be held in affiliation with the Second Mexican Blood Transfusion Congress which meets in Mexico City during November 17–25. The guest speakers will include Dr. Philip Levine (New Jersey), Dr. R. R. Race (Lister Institute), Dr. William Dameshek (Massachusetts), Dr. Ernest Witebsky (New York), Dr. I. Davidsohn (Chicago), Dr. Louis K. Diamond (Massachusetts), Dr. Ludwig Hirszfeld (Wroclaw, Poland), Dr. I. G. Guzman (Mexico City), Dr. E. Uribe Guerola (Mexico City), and Dr. J. M. Hill (Texas). The secretary of the meeting is Dr. Sol Haberman, William Buchanan Blood, Plasma and Serum Center, Baylor University Hospital, Dallas, Texas.

Announcements

THE Eleventh International Congress of Pure and Applied Chemistry will meet in London, under the presidency of Lord Leverhulme, during July 16–24, 1947, concurrently with the celebration of the centenary of the foundation of the Chemical Society. Further information about the Congress can be obtained from the honorary organiser, Eleventh International Congress of Pure and Applied Chemistry, 56 Victoria Street, London, S.W.1.

THE British Mycological Society will hold its fiftieth anniversary meeting at the Royal Institution, London, during October 23–25. The programme is so organised as to correlate mycology with other subjects —mycorrhiza, soil fungi, seed-borne diseases, medical mycology, antibiotics, growth substances. It is hoped that overseas mycologists will be able to attend the meeting. Further information can be obtained from the Secretary, British Mycological Society, British Museum (Natural History), Cromwell Road, London, S.W.7.

A CONFERENCE of the Nutrition Society is being held on September 21, beginning at 10.30 a.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1. This precedes a general business meeting of the Society, which is to be held there on the same afternoon at 2.30 p.m. The programme and time-table are as follows: "The Work and Aims of the Food and Agriculture Organisation" (papers are to be read by Sir John Orr, Director-General of the Food and Agricultural Organisation); Mr. D. Lubbock ("Nutritional Aspects of the World Food Picture"); Dr. P. Lamartine Yates ("The Development of Food Supplies"); Dr. W. R. Aykroyd ("The Nutritional Programme of F.A.O."); Miss E. Fautz ("World Needs for Processed Milk"). Further details can be obtained from the hon. secretary, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

UNIVERSITY COLLEGE, Nottingham, has announced two new appointments in the Faculty of Agriculture and Horticulture. Mr. R. T. Pearl, head of the Department of Biological Sciences at Wye College (University of London) and editor of *Scientific Horticulture*, the journal of the Horticultural Education Association, has been appointed to the newly created post of director of horticultural studies and reader in horticulture. Mr. Pearl will be responsible for the development of teaching and research in horticulture and will take up his duties on January 1, 1947, at the Midland Agricultural College. Mr. R. F. Martyr has been appointed lecturer in fruit and vegetable culture at the Midland Agricultural College and will shortly take up his duties. Mr. Martyr has held senior posts in the Horticultural Advisory and Educational Service in the North Midland counties and is at present horticultural advisory officer to the County of Lindsey.

LETTERS TO THE EDITORS

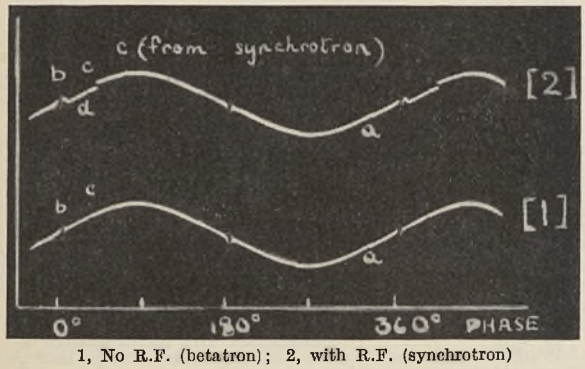
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Experimental 8 MeV. Synchrotron for Electron Acceleration

THE synchrotron principle has been suggested by Veksler[1] and McMillan[2] as a possible means of accelerating electrons to high energies. This letter describes modifications which have been made to a 4 MeV. betatron to convert it to an 8 MeV. synchrotron. The experiments prove that the synchrotron principle is a valid one for electron acceleration.

The betatron chosen for modification[3] was one of Kerst's early models, similar to that described by him[4]. It accelerates electrons to 4 MeV. when unmodified, and X-rays are produced by allowing the orbit to collapse so that the electron beam strikes a tungsten target. The equilibrium orbit is at 7·5 cm. radius and the target is at 4·6 cm. radius, so that there is a considerable delay between the time when the central core saturates and the emission of the X-rays. In operation as an unmodified betatron we have the following conditions: peak field at equilibrium orbit, 2,000 gauss; 50 cycle R.M.S. current in field coils, 35 amp.; central core saturates at a phase of 24° relative to the minimum field; electrons strike the target at a phase of 90°, that is, when the field is maximum. The current in the exciting coils was now stepped up to 70 amp., the maximum permissible without breakdown. This did not increase the energy of the electrons, since saturation of the core now occurred earlier and consequently the electrons struck the target well before the exciting field reached its maximum. The following conditions now pertained: peak field at orbit, 4,000 gauss; central core saturated at phase of 12°; electrons struck target at phase of 30°. To demonstrate synchrotron action it was only necessary to show that, with the betatron thus over-run, the electrons could be made to strike the target at a phase of 90° by suitable application of radio-frequency acceleration. Then it would follow that the energy had been doubled (to 8 MeV.).

To indicate this experimentally the following wave-forms were superposed on an oscilloscope: (*a*) the current in the field coils (which is proportional to the magnetic field), (*b*) the voltage applied to the injector gun, which was a very heavily damped oscillation produced by a peaking transformer, (*c*) the response from a Geiger-Muller counter placed in the X-ray beam, (*d*) the rectified envelope of the R.F. voltage across the resonator. The traces obtained with and without the R.F. voltage are shown in the photographs 1 and 2. The letters correspond to the wave forms listed above.



1, No R.F. (betatron); 2, with R.F. (synchrotron)

It will be seen that with the R.F. off there was only a single counter response at a phase of 30°. With the R.F. on, the expected counter response due to the synchrotron was obtained at 80° (showing 8 MeV.) as well as a response persisting at 30° showing that all the electrons were not caught. The synchrotron response could be moved about in phase by alteration of the R.F. pulse width, keeping its starting point constant.

The fact that a considerable proportion of the electrons were being accelerated to high energies was confirmed by placing an ionization chamber in the X-ray beam. The ionization produced was increased by a factor of 4 times on switching on the R.F. voltage. This is in agreement with an expected increase in conversion efficiency at the target for higher energies. If all the electrons could be accelerated to 8 MeV. the increase factor would probably be about six times[5].

The R.F. apparatus used was chosen for availability and ease of construction, and no attempt was made to remove many obvious deficiencies. The accelerating voltage was produced by a quarter-wave long resonator of the coaxial line type[6] excited at 640 Mc./s. by a small loop. The electrons passed up the hollow inner conductor of the resonator and were accelerated at the gap. The resonator could not be solid, or eddy currents would have disturbed the electron orbits. It was therefore constructed from 26 S.W.G. wires, 1/16 in. apart, mounted on distrene spacers. The wires were shorted together at the current antinode only. The whole was bent into a quadrant round the circumference of the 'doughnut' and was completely external to it. The R.F. field produced was markedly inhomogeneous, since only those wires which were of resonant length were strongly excited. In addition the field was reduced by the presence of the porcelain doughnut and its 'Aquadag' coating, and by the proximity of the magnet. These disadvantages were outweighed by the ease of construction of the resonator. The R.F. power was produced by a small C.W. oscillator, feeding a buffer amplifier which was modulated to give an R.F. pulse of variable length and phase, reaching its full value in 10 microsec. The mean power supplied was about one watt and the peak accelerating voltage across the resonator was appreciably less than 100 volts. It appeared that an increase in the power supplied would have increased the X-ray yield, as also would steepening the leading edge of the R.F. pulse.

The results we have so far obtained certainly indicate that the synchrotron is a powerful means of accelerating electrons, and show clearly its advantage over a betatron in giving much greater energy and X-ray yield without increase in magnet size.

This work was carried out as part of the programme of the Telecommunications Research Establishment of the Ministry of Supply. Acknowledgment is made to Mr. A. R. Greatbatch for facilities provided in his Department to use the betatron, and to the assistance given by our various colleagues at Telecommunications Research Establishment and the Armament Research Department. We also thank the Directorate of Atomic Energy for permission to publish these results.

F. K. GOWARD

Telecommunications Research Establishment,
Malvern, Worcs.

D. E. BARNES

Armament Research Department,
Woolwich, London, S.E.18.

Aug. 20.

[1] Veksler, *J. Phys. Acad. Sci. U.S.S.R.*, **9**, 153 (1945).
[2] McMillan, *Phys. Rev.*, **68**, 143 (1945).
[3] Pollock, *Phys. Rev.*, **69**, 125 (1946).
[4] Kerst, *Phys. Rev.*, **60**, 47 (1941).
[5] Kaye and Binks, *Brit. J. Radiol.*, **13**, 193 (1940).
[6] Hansen, *J. Appl. Phys.*, **10**, 39 (1939).

Space-diversity Reception and Fading of Short-wave Signals

IT is well known[1,2] that fading patterns of short-wave signals as received on two or more aerials spaced a few wave-lengths apart are independent of each other; and this fact has been utilized in space-diversity reception, where the outputs from separate receivers connected to such aerials are mixed together in order to obtain a fairly constant signal level. It is generally assumed, however, that the variations of intensity of signal on a single aerial are of random nature caused by scattered waves from diffracting centres in the ionosphere[3,4].

As a preliminary to the investigation of the various modes of diversity reception within a limited space, we have recently made a large number of visual[5] and automatic ink records of fading of short-wave signals received from All India Radio, Delhi, situated at a distance of 678·4 km. It has been observed that there are occasions when the nature of fading of the signals rapidly changes from random variations of peaky type to a smooth and quasi-periodic nature, often accompanied by slow changes of a few minutes. Observations have been made on 41, 31, 25, 19 and 16-metre bands, with vertically polarized waves, mostly during the day-time. The slow variations associated with the quasi-periodic nature of the fading suggest that purely random variation, agreeing with Rayleigh intensity distribution, may occur so long as the wave suffers single-spot reflexion in the ionosphere; but, as soon as the signal undergoes two or more reflexions, either from one

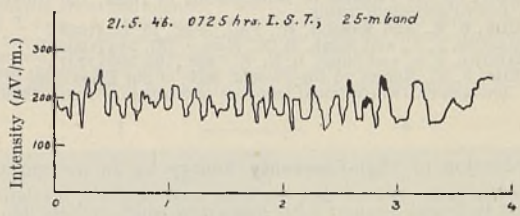


Fig. 1

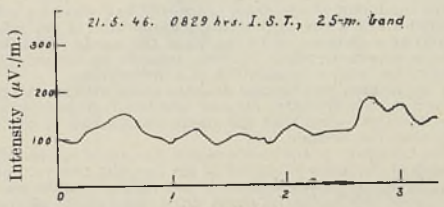


Fig. 2

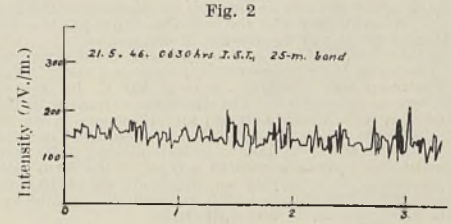


Fig. 3

ionospheric layer or from two different layers simultaneously, the fading pattern changes from random type to comparatively smooth and quasi-periodic type, with slow variations, resembling the pattern in the output of diversity receivers[6].

Automatic ink records of the fading pattern have been made with a 7-valve superheterodyne receiver after removing the incorporated automatic volume control system. The rectified signal from the second detector was amplified by a neon-coupled two-stage D.C. amplifier, the output of which was applied to the pen recorder with vertically moving paper, run by a self-governed electric motor. The speed of paper was maintained at 4·5 cm./min. Three typical records of fading of signals are reproduced. Fig. 1 shows the usual peaky and random variations on the 25-metre band in the morning hours due to single hop path necessitated by low ionic density. Towards the end of this diagram it will be seen that the variation tends to be less rapid, as just after that time the fading pattern changes gradually to the type shown in Fig. 2, which exhibits the delineation of the same signal received later, with quasi-periodic nature accompanied by slow variations caused by double reflexion at two different spots in the ionosphere. For the sake of comparison, a typical record of random fading of the B.B.C. (London) station is shown in Fig. 3, and it will be observed that the pattern of fading is similar to that in Fig. 1, as both the signals have presumably undergone single reflexion in the ionosphere. Thus the fading patterns shown in the above records indicate that the type of variation of intensity of signals changes as the number of reflecting spots in the ionosphere is altered.

Calculations made from the average equivalent heights of the *E* and *F* layers[7,8,9], and the required angle of radiation from Delhi station show that electronic concentrations of about $1·5 \times 10^5$ to $6·4 \times 10^5$ electrons per c.c. and $4·7 \times 10^5$ to $1·2 \times 10^6$ electrons per c.c. for single and double reflexions respectively would be necessary for an incoming wave of the 25-metre band. The hours of such concentration in the *E*-layer as observed at Calcutta[10] agree fairly well with the occurrence of the above change in fading pattern, especially during morning hours between 0630 and 0930 hours I.S.T., during which period the rise in ionic density is very rapid. Thus the above observations are useful in explaining the principle and application of diversity reception, and also in throwing light in the direction of further development of such systems.

A detailed account of the above investigations will be published elsewhere. We thank Principal M. Sengupta for his interest during the progress of the work.

S. S. BANERJEE
G. C. MUKERJEE

Section of Communication,
Engineering and Applied Physics,
Engineering College,
Benares Hindu University.
July 18.

[1] Beverage, H. H., and Peterson, H. O., *Proc. Inst. Rad. Eng.*, **19**, 531 (1931).
[2] Peterson, H. O., Beverage, H. H., and Moore, J. B., *Proc. Inst. Rad. Eng.*, **19**, 562 (1931).
[3] Ratcliffe, J. A., and Pawsey, J. L., *Proc. Camb. Phil. Soc.*, **29**, 301 (1933).
[4] Pawsey, J. L., *Proc. Camb. Phil. Soc.*, **31**, 125 (1935).
[5] Banerjee, S. S., and Mukerjee, G. C., *Science and Culture*, **11**, 571 (1946).
[6] Report on the Progress of Broadcasting in India, 120 (Govt. of India Publication, 1940).
[7] Mitra, S. K., and Rakshit, H., *Phil. Mag.*, **15**, 20 (1933).
[8] Banerjee, S. S., and Singh, B. N., *Nature*, **137**, 583 (1936).
[9] Banerjee, S. S., and Singh, B. N., *Z. Phys.*, **105**, 309 (1937).
[10] Mitra, S. K., Report on the Present State of our Knowledge of the Ionosphere, 193 (National Institute of Sciences of India, 1935).

Production of High-Frequency Energy by an Ionized Gas

IT has been observed that the inner conductor of a coaxial line tuned to frequencies near 1,000 megacycles which projects into an arc discharge in mercury vapour can be excited by the discharge if a bar magnet is brought near the tube. Both a thermionic tube and a mercury pool tube showed this behaviour.

The inner conductor of a tunable concentric half-wave transmission line projected about 1 cm. into each discharge tube (4 cm. diameter, 70 cm. long) at a distance of 10 cm. from the anode. The line was coupled to a superheterodyne receiver tunable to frequencies near 1,000 megacycles, with a band-width of 4 megacycles.

When a bar magnet was brought near the tubes with its axis parallel to the tube axis, the discharge divided into two regions separated by a dark space. The region near the anode was pinkish in contrast to the region near the cathode.

When the boundary of the anode region was made to coincide with the extension of the inner conductor of the line, the receiver indicated an output corresponding approximately to 1 millivolt on the end of the line. This amplitude increased about three times as the temperature of the condensed mercury was reduced from 24° C. to 0° C. Noise of lower amplitude could also be detected for positions of the boundary between the line projection and the cathode. No input was observed in the cathode region or in the absence of the magnet.

With the thermionic cathode and a condensed mercury temperature of 11° C., Langmuir probe measurements indicated electron temperatures of approximately 30,000° K. and 26,000° K. for the cathode and anode regions respectively. The discharge current with the magnet present was about 0·35 ampere, and 1 ampere in its absence. When the discharge was in this condition the resistance in series with the tube could be heard 'singing'. A cathode ray tube connected directly across this resistance showed a trace of the form associated with low frequency noise having an amplitude up to 10 volts. In general, the noise levels observed with the cathode ray tube and with the superheterodyne receiver varied similarly.

The tube with an anchored spot cathode contained two anodes, that nearer the cathode drawing currents of the order 3 amperes, the other drawing smaller currents. Under these conditions a noise was observed which corresponded to 0·7 volt between the top anode and the cathode; on bringing a magnet near the tube this amplitude rose to 3 volts. A probe situated between the two anodes indicated electron temperatures of 15,500° K. and 19,000° K. in the cathode and anode regions respectively. The discharge current with the magnet present was about 0·79 ampere, and 0·92 ampere in its absence.

A similar increase in noise at frequencies up to 5 megacycles on the application of a magnetic field has been reported by J. D. Cobine and by C. J. Gallagher in 1944.

P. C. THONEMANN
R. B. KING

School of Physics,
University of Sydney.
Aug. 9.

Momentum Spectrum of Mesons at Sea-Level

A SERIES of cloud-chamber measurements of the momentum spectrum of mesons at sea-level has been made, extending the spectrum to the important low-momentum region which is modified by meson decay. A short reference to this work, which was completed in the summer of 1939, was given by Rossi[1].

Measurements of the meson spectrum at low momenta are complicated by the presence of a considerable electron component, and by instrumental selection arising from the strong curvature of the tracks and from large scattering. In order that mesons might be identified with certainty, the low momentum spectrum, $p < 10^9$ *ev./c.*, was obtained from tracks traversing 2 cm. of gold, and for these measurements the corrections for scattering of the particles in the gold plate were large. A check was made, by a series of photographs taken with a weak magnetic field and with the lower selecting counter in the middle of the chamber, immediately below the metal plate in which the greater part of the scattering took place, that this spectrum was truly normalized to the main high momentum spectrum. These checking measurements were relatively inaccurate, but in them the ratio of the number of low momentum particles to the number of high momentum particles was not subject to large instrumental bias.

The high momentum spectrum to which the lower range was normalized is given in Table 1, together with the more extensive results of Blackett[2] and Jones[3]. In the highest ranges, $p > 10^{10}$ *ev./c.*, the large number of particles reported by Jones is not confirmed. This group may well be over-emphasized in Jones's spectrum as a result of the non-Gaussian form of the distribution of instrumental errors to which he directs attention.

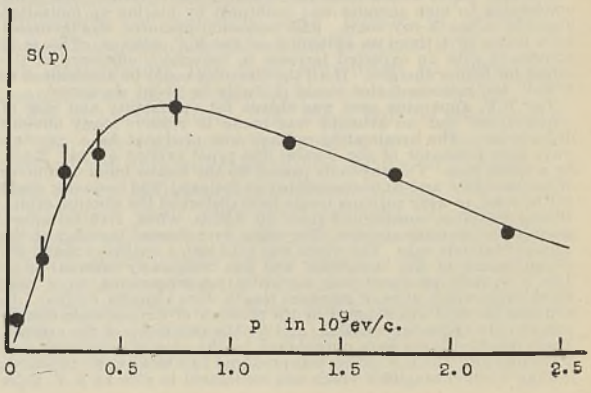
TABLE 1. THE MESON SPECTRUM, $p > 10^9$ *ev./c.*

Total number of particles, $p > 10^9$ *ev./c.*	Blackett 620	Jones 802	Wilson 301
Range of momenta (*ev./c.*)	Number of particles for a total of 1,000 in the range 10^9–10^{10} *ev./c.*		
10^9–$2·10^9$	383	393	367
$2·10^9$–$3·10^9$	219	243	223
$3·10^9$–$6·10^9$	280	258	288
$6·10^9$– 10^{10}	118	106	122
10^{10}–$2·10^{10}$	86	(289)	102
$2·10^{10}$ upwards	80		82

TABLE 2. THE MESON SPECTRUM, $p < 10^9$ *ev./c.*

Range of momenta (*ev./c.*)	Number of particles for a total of 1,000 in the range 10^9–10^{10} *ev./c.*
$5·10^8$– 10^9	238 ± 18
$3·10^8$–$5·10^8$	76 ± 9
$2·10^8$–$3·10^8$	35 ± 6
10^8–$2·10^8$	18 ± 4
$3·10^7$ (Williams)	2 in a band of about $3·10^7$ *ev./c.*

The low momentum spectrum (Table 2) is based on 123 tracks with $p < 10^9$ *ev./c.*, and the values are given in the table in a form directly comparable with those of Table 1. In the diagram, the differential momentum spectrum is given up to a momentum rather greater than $2·10^9$ *ev./c.*, the probable error of points based on the new low momentum spectrum being indicated.



At very low momenta, $p < 10^8$ *ev./c.*, mesons are distinguished from electrons by heavy ionization in the cloud chamber rather than by behaviour traversing a metal plate. The technique of random expansions in a large chamber with a low magnetic field, adopted by Williams[4], is of particular value in this region, and a measurement by Williams is included in the table and in the diagram.

J. G. WILSON

Physical Laboratories,
University of Manchester.
Aug. 16.

[1] Rossi, *Rev. Mod. Phys.*, **11**, 301 (1939).
[2] Blackett, *Proc. Roy. Soc.*, A, **159**, 1 (1937).
[3] Jones, *Rev. Mod. Phys.*, **11**, 235 (1939).
[4] Williams, *Proc. Roy. Soc.*, A, **172**, 194 (1939).

Viscosity of Associated Liquids

EXISTING theories of the viscosity of liquids fail to give a satisfactory account of the temperature variation of the viscosity of certain associated liquids. The X-ray diffraction patterns of liquids show that the inter-atomic distances vary about a mean; the variability increasing with increasing temperature. In addition, for the silicate glasses and for water, it is concluded that the structure is a random three-dimensional network of atomic bonds. This network is continuous throughout the liquid and in this sense glasses and water are associated liquids. In glasses the network is built up of Si—O bonds and in water of O—H bonds, the silicon atoms being surrounded by four oxygen atoms, and in water, the oxygen atoms by four hydrogen atoms.

Owing to the variability of the inter-atomic distances, some of the Si—O—Si or O—H—O links are so long that the position of equilibrium of the central atom ceases to be midway between the two outer atoms. Two positions of equilibrium for the central atom now appear, one to each side of the midpoint, with a potential barrier between them. When a shear force is applied the barriers will be lowered in the direction of the force, and there will be a drift of atoms in that direction. If it be assumed: (1) that thermal motion ensures that, at constant temperature, the number of atoms having such alternative positions available to them remains constant, and (2) that the four co-ordinated atoms have always only one position of minimum potential energy available which moves with the flow; then an expression can be set up for the viscosity of the liquid.

As the variability of the inter-atomic distances increases the number of atoms having alternative positions available to them will increase. To obtain a simple expression for the viscosity as a function of temperature the assumption may now be made that the two-bonded atoms fall into two classes, (*a*) no alternative position available, (*b*) two equilibrium positions available separated by a potential barrier of height E at a distance apart a; E and a are taken to have the same values for all atoms in class (*b*). The expression for the coefficient of viscosity then becomes

$$\eta = \frac{1}{\omega} \; QT \; e^{E/kT}, \quad . \quad . \quad . \quad (1)$$

where η is coefficient of viscosity, T is absolute temperature, ω is fraction of total number of two bonded atoms in class (*b*), Q is a constant and k is Boltzmann's constant.

Having made the assumptions of the previous paragraph it appears that the variation of the number of atoms in class (*b*) with temperature might be found by a process similar to that used in the cases of Frenkel and Schottky defects in ionic lattices. An expression for the variation of ω with temperature found in this way and substituted in (1) gives

$$\eta = T \; (Ae^{E/T} + Ce^{D\,T}), \quad . \quad . \quad (2)$$

where A, B, C, D are constants which in a more accurate expression would be slowly varying functions of temperature (that is, of the order of volume changes with temperature).

This equation has been fitted to the experimental results for a lime-soda-silica glass and for water. Comparison is made between the calculated and experimental values in the table.

Lime soda glass

Equation found

$$\eta = T \; (2{\cdot}86 \times 10^{-19} \, e^{50{,}980/T} + 2{\cdot}11 \times 10^{-9} \, e^{-7{,}600/T})$$

Temperature ° C.	1127	1027	827	627
$\text{Log}_{10}\,\eta$ Exp.	3·06	3·620	5·37	9·05
Calc.	3·154	3·680	5·366	9·048

Water

Equation found

$$\eta = T \; (3{\cdot}1 \times 10^{-11} \, e^{3{,}763/T} + 8{\cdot}78 \times 10^{-8} \, e^{1{,}620/T})$$

Temperature ° C.	100	80	60	40	20	0
η Exp.[1]	0·2838	0·3565	0·4688	0·6560	1·0050	1·7921
Calc.	0·2838	0·3569	0·4692	0·6570	1·0047	1·7460

Equation (2) may also be written

$$\eta = T \, A^1 \, e^{B^1/kT} \, [1 + C^1 \, e^{D^1/kT}]. \quad . \quad (4)$$

Here the expression in the square bracket gives the value of $\frac{1}{\omega}$ and the remaining terms are concerned with the flow.

In the case of water the equation becomes

$$\eta = T.e^{2{\cdot}24 \times 10^{-13}/kT}. \; 8{\cdot}78 \times 10^{-8} \; [1 + 3{\cdot}54 \times 10^{-4} \, e^{2{\cdot}94 \times 10^{-13}/kT}]. \quad (5)$$

Ubbelohde and Woodward[2] estimate the height of the potential barrier separating the two equilibrium positions of a hydrogen atom between two oxygen atoms 2·8 A. apart as $2{\cdot}2 \times 10^{-13}$ erg. and $1{\cdot}33 \times 10^{-13}$ erg. when the oxygen atoms are 2·75 A. apart. This compares favourably with $2{\cdot}24 \times 10^{-13}$ obtained from equation (5).

For the case of Schottky defects in rock-salt Mott and Gurney[3] estimate $C^1 \sim 10^{-3}$–10^{-4} and $D^1 \sim 30 \times 10^{-13}$; the values obtained thus appear to be reasonable.

The constant A^1 corresponds with Q in the equation (1) and the theoretical value agrees with the value from the viscosity data to within a factor of 10. Bearing in mind the nature of the approximations made, the rough numerical agreement of the constants in the equation fitted to the viscosity data with their estimates by other means is at least suggestive that the theory is on correct lines.

A full account of this work is being prepared for publication.

R. W. DOUGLAS

Research Laboratories,
General Electric Co., Ltd.,
Wembley.
Aug. 22.

[1] Bingham, "Fluidity and Plasticity" (McGraw-Hill, 1922), p. 339.
[2] Ubbelohde, A. R., and Woodward, I., *Proc. Roy. Soc.*, A, **185**, 448 (1946).
[3] Mott, N. F., and Gurney, R. W., "Electronic Processes in Ionic Crystals" (Oxford, 1940).

Mechanism of Creep in Metals

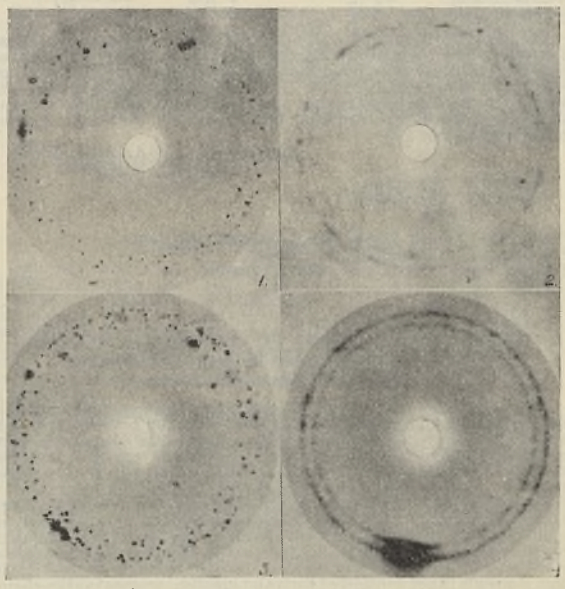
IT is thought that the experimental observation described in the present note leads to new and useful information on the mechanism of creep in metals, a problem which was the subject of a recent conference at the Royal Society[1].

The observation will be better appreciated if reference may first be made to the following relevant results from previous work at the National Physical Laboratory on the structural changes revealed by X-ray diffraction when a metal is plastically deformed.

(*a*) Under normal static loading of a *polycrystalline* metal, the grains break down into crystallites characterized by widely differing orientations, and for a given metal, a particular lower limiting size. This has been termed the random crystallite formation[2].

(*b*) Under similar loading of a *single metal crystal*, a dislocation of the mosaic structure occurs, but the mosaic elements in general remain approximately parallel. This condition has been termed the 'parallel crystallite formation', to distinguish it from the case of the polycrystalline metal, and to emphasize the point, not generally realized, that the behaviour of the isolated single crystal in this respect is quite different from that of the metal crystal in the aggregate[3].

It was considered that a difference in this fundamental process of breakdown of the grains might be a factor distinguishing the normal short-time deformation of a polycrystalline metal in a tensile test with increasing stress from continuous deformation at the much slower rate known as 'creep'. This has proved to be the case. A specimen of aluminium, initially annealed, was stretched at 300° C. in a normal tensile test to an extension of 0·9 per cent, the extension being completed in about two minutes; it was then unloaded, cooled and examined by X-rays. A similar specimen was allowed to creep under a load of $\frac{1}{2}$ ton/sq. in. at the same temperature until the same extension was reached, but the extension took fifty minutes. X-ray examination then showed that the tensile specimen showed the random crystallite formation referred to in (*a*) above, but the creep specimen had the



parallel crystallite formation referred to in (*b*). Thus, in creep, the polycrystalline specimen had deformed like a single crystal.

It should be added that when the tensile specimen after unloading was held at the elevated temperature for the same time as the creep specimen, no appreciable recovery in structure occurred.

The effect is illustrated in Figs. 1, 2, 3 and 4. Fig. 1 is a back-reflexion photograph from the metal in the initial state; the sharp (420) reflexion spots indicate perfect strain-free grains. Fig. 2 is from the tensile specimen after extension; the transition from reflexion spots to an almost continuous ring indicates the extensive nature of the breakdown to the random crystallite formation even after only 0·9 per cent extension. Fig. 3 is from the creep specimen, and shows that the reflexions are still relatively sharp spots, indicating a minimum disturbance of the internal structure of the grains. Fig. 4 is from the extended tensile specimen after it had been heated at 300° for 1 hour, and shows that no appreciable recovery or recrystallization has taken place.

W. A. Wood
H. J. Tapsell

National Physical Laboratory,
Teddington. Aug. 12.

[1] Allen, N. P., *Nature*, **157**, 469 (1946).
[2] Wood, W. A., *Proc. Roy. Soc.*, A, **172**, 231 (1939).
[3] Wood, W. A., *Proc. Phys. Soc.*, **52**, 110 (1940).

Standard Entropy of Adsorption

We have recently shown[1], by a thermodynamical procedure, how the standard free energy of adsorption of a solute on to a solution/air interface (ΔG°) may be obtained from the limiting slope a at low concentrations of the surface tension-concentration curve. This is given by the equation

$$a = \delta RT \exp.(-\Delta G^\circ/RT) \quad . \quad . \quad (1)$$

where a is $-(d\gamma/dc)_{c=0}$ and δ is the thickness of the surface layer, which was identified with the most probable length of the adsorbed molecule. The standard states in bulk and on the surface are hypothetical states in which the solute is at unit activity in each (activity is expressed in molality units), but essentially have all the properties of infinitely dilute solutions.

It is possible to obtain the standard entropy of adsorption (ΔS°) from this. Differentiation of equation (1) with respect to T gives

$$\Delta S^\circ = -\left(\frac{\partial \Delta G^\circ}{\partial T}\right)_P = -\frac{\Delta G^\circ}{T} + \frac{RT}{a}\frac{da}{dT} - R \quad . \quad (2)$$

In the derivation of equation (2), the entirely justifiable assumption is made that δ does not vary appreciably with temperature within any reasonable range of temperature. Unfortunately, little experimental work has been carried out on the variation of a with temperature. The only available data are from measurements by Rehbinder[2] of the surface tensions of solutions of fatty acids of various chain-lengths at different temperatures and concentrations. The accuracy of these determinations is not high, but they allow a systematic series of values of da/dT to be calculated. If these values are used in conjunction with the more accurate values of a at 20° C. recently given by one of us (A. F. H. W.)[3], it is possible to arrive at a numerical estimate of ΔS° for the adsorption of some members of the fatty acid series at an aqueous surface. These values of ΔS° calculated by means of equations (1) and (2) are shown in the accompanying table.

Solute	ΔG° kcal./mole	ΔS° cal./° C. mole	ΔH° kcal./mole
Propionic acid	−1·63	−14·4	−5·9
n-Butyric acid	−2·45	− 6·2	−4·3
n-Valeric acid	−3·18	+ 1·1	−1·8
n-Caproic acid	−3·72	+ 6·6	−1·7
n-Heptoic acid	−4·52	+ 7·2	−2·4

The data for *n*-caproic and *n*-heptoic acids are likely to be less accurate, since with chains of this length the time-dependence of surface tension becomes important and Rehbinder's method[2] was not suitable to take account of this. The apparent falling off in the ΔH° values for these two compounds may be illusory, and more account should be taken of the increasing trend shown by the lower members of the series.

A. F. H. Ward
L. Tordai

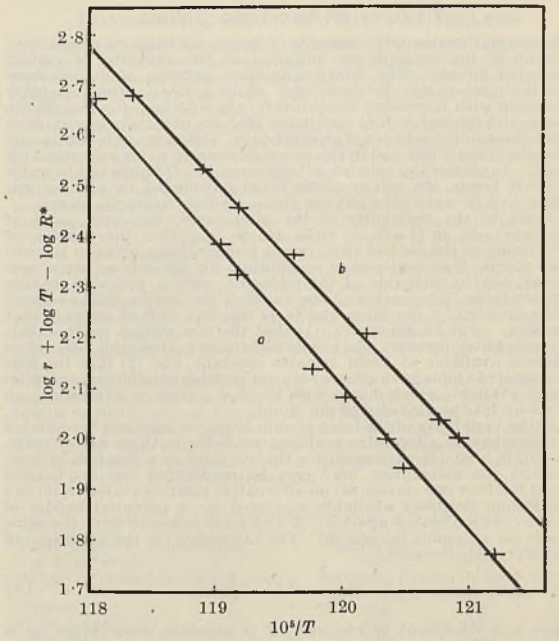
College of Technology,
University, Manchester.
July 28.

[1] Ward and Tordai, *Trans. Farad. Soc.*, **42**, 413 (1946).
[2] Rehbinder, *Z. Phys.*, **52**, 641 (1924).
[3] Ward, *Trans. Farad. Soc.*, **42**, 399 (1946).

Chain-initiating Process in the Reaction between Hydrogen and Oxygen between the Second and Third Explosion Limits

There has been much discussion concerning the reaction responsible for the initiation of chains, in the thermal reaction between hydrogen and oxygen, in the non-explosive region between the second and third explosion limits[1]. In their early work[2], Lewis and von Elbe favoured the thermal dissociation of hydrogen, but in a later paper[3] they reject this view because their value of the overall activation energy is "of the order of only 100 K-cals" which they regard as the sum of the activation energies of the chain-initiating and chain-propagating steps, and hence conclude that the energy of activation of the initiating reaction is less than 100 kcal. This value excludes the dissociation of hydrogen (and, of course, oxygen, but the thermal dissociation of this molecule is not considered for valid kinetical reasons) as the chain-initiating reaction, and to meet these conditions, these authors postulate the dissociation of hydrogen peroxide according to $H_2O_2 \rightarrow H_2O + O$ or $2OH$, without being very precise about the origin of the hydrogen peroxide, other than assuming that the reaction $H_2 + O_2 \rightarrow H_2O_2$ may play a part initially. Recently, Willbourn and Hinshelwood[4] have made a fresh experimental study of the third limit and the slow reaction at lower pressures and, in contrast to Lewis and von Elbe, conclude that the initiation reaction is probably $H_2 + M \rightarrow 2H + M$.

A choice between these two mechanisms is possible if the energy of activation of the initiation process is carefully determined. Accordingly, we have obtained pressure-time records at many temperatures within the range 555°–575° C. at pressures equivalent to: (*a*) 200 mm. $H_2 + 110$ mm. O_2 at 577° C. and (*b*) 300 mm. $H_2 + 150$ mm. O_2 at 577° C., under conditions approximating as closely as possible to those of Willbourn and Hinshelwood. A cylindrical silica vessel coated internally with potassium chloride and held in a thermostatically controlled horizontal electric furnace was used as reaction vessel and a mirror type Foord gauge used as a manometer. The rest of the apparatus was of conventional design. The reproducibility of the results was good.



Under steady state conditions when the chains are terminated linearly, the rate of a chain reaction is the rate of initial production of centres divided by the net branching factor and multiplied by the reciprocal of the mean life of the centres[5]. The denominator in the expression can be evaluated in terms of the experimental variables from studies of the adjacent explosion boundary, at all points on which, provided thermal influences are absent in the explosion, the denominator is zero[5]. Using such reasoning, Willbourn and Hinshelwood write r (the rate of pressure change in mm. Hg min.$^{-1}$) $= f_1 R^*/$ (constant) T, where f_1 is the rate of the initiating reaction, the contant is independent of temperature, and R^* is a function of temperature and concentration of reactants which can be calculated from the experimental data on the third limit. The energy of activation of the initiation reaction can then be obtained from the slope of the curve obtained by plotting (log r + log T − log R^*) against T^{-1}. The figure shows the results obtained in our experiments. They are linear in confirmation of the general validity of Willbourn and Hinshelwood's mechanism; and lead to values of the activation energy for the initiation reaction of 134 ± 4 and 123 ± 3 kcal. for (*a*) and (*b*) respectively: thus virtually excluding the initiation reaction proposed by Lewis and von Elbe and affording additional evidence for the thermal dissociation of hydrogen as this process.

Since M in this reaction includes oxygen molecules, a corollary to this conclusion is that a collision between highly energized hydrogen and oxygen molecules can, and often does, result in dissociation of the hydrogen rather than in reactions of the type: $H_2 + O_2 \rightarrow H_2O_2 + 35$ kcal., or $H_2 + O_2 \rightarrow 2HO - 20$ kcal. (the heats given apply to molecules in their ground states)[6]. This result would not have been anticipated and is rather surprising on theoretical grounds.

P. G. Ashmore
F. S. Dainton

Laboratory of Physical Chemistry,
Cambridge. Aug. 16.

[1] The explosion limits are here numbered in order of increasing pressure. See also refs. 3 and 4 where the same convention is used.
[2] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases", 39 (Cambridge, 1938).
[3] Lewis and von Elbe, *J. Chem. Phys.*, **10**, 376 (1942).
[4] Willbourn and Hinshelwood, *Proc. Roy. Soc.*, A, **185**, 353 (1946).
[5] For elaboration of this, see Dainton, *Trans. Farad. Soc.*, **38**, 227 (1942).
[6] Assuming the value of Q_a for H_2O_2 of 255·7 kcal. mole^{-1} given by Skinner, *Trans. Farad. Soc.*, **41**, 645 (1945), and Dwyer and Oldenberg's value of 100 kcal. for the bond energy in the OH radical (*J. Chem. Phys.*, **12**, 351 (1944)).

Production of Metabolic Benzpyrene Derivatives *in vitro*

It has been shown by Weigert and Mottram[1] that, independent of its mode of introduction into an animal, benzpyrene passes through a series of chemical changes prior to its final excretion. The following evidence suggests that the first derivatives—provisionally termed X_1 and X_2—are produced locally in those organs (liver, kidney, lung) where the benzpyrene is concentrated after intravenous or intraperitoneal injection, and also in the blood. The same happens in the subcutaneous tissues and in the skin of mice after the injection or painting of benzpyrene.

A series of mice were decapitated immediately after the intravenous injection of a colloidal suspension of benzpyrene. The shed blood and the carcasses were then stored at 0° C. and examined at intervals of a few hours for metabolic products. The amount of X_1 present in the liver, lung, kidney and the clotted blood increased slowly. Further, human blood was mixed with a benzpyrene suspension and the presence of X_1 was detected after a few hours by a sensitive fluorescence method.

The following technique has been adopted for the study of benzpyrene metabolism *in vitro*. Mice are clipped, killed and the whole of the skin between the fore and hindquarters is removed and placed on filter paper moistened with Ringer-Locke solution. Measured areas are painted with solutions of benzpyrene in acetone and then excised and floated on to Ringer-Locke solution in Petri dishes, the hair surface being uppermost. These are placed in the incubator at 37° C.

After incubation for periods of three hours or more the presence of X_2 can be shown. On the basis of its absorption and fluorescence spectra and its behaviour towards various solvents, the X_2 formed under these conditions would appear to be identical with that formed in the mouse skin after painting the living animal and after intravenous or intraperitoneal injection. Quantitative estimations (full details of the methods used will be published elsewhere) indicate that when a dilute solution of the benzpyrene (0·002 per cent in acetone) is applied, up to 40 per cent is recoverable in the form of X_2.

The use of this *in vitro* technique with the mouse skin shows definitely that the first stage of the metabolic conversion is the same as *in vivo* and takes place at the site of application of the benzpyrene.

Records of detailed studies using this *in vitro* system and the corresponding *in vivo* system are now in course of preparation for publication.

F. Weigert
G. Calcutt
A. K. Powell

Mount Vernon Hospital and the Radium Institute,
Northwood, Middlesex.

[1] Weigert, F., and Mottram, J. C., *Cancer Res.*, **6**, 97 (1946).

Relation of Crystal Size and Shape to Contact Toxicity of D.D.T. Suspensions

It is frequently found that in two-phase disperse insecticidal systems in which the toxic compound constitutes part or whole of the disperse phase, toxicity bears an inverse relation to the particle size of the disperse phase. Recent work here has shown, however, that in the case of aqueous suspensions of pure *p,p'*-D.D.T. [1-trichloro 2,2-bis(*p*-chlorophenyl) ethane], this relationship is reversed.

p,p'-D.D.T. normally crystallizes in needles[1], but in certain circumstances can be made to form plate-like crystals. In the preparation of suspensions the overall size as well as shape of crystal can be varied. This does not involve any changes in the fundamental habit of the crystal, but merely variations in the external form produced by different growth conditions. In this way, suspensions of six distinct types, each of characteristic and fairly uniform crystal size and shape, have been prepared and tested here against *Tribolium castaneum* Hb. (red-rust flour beetle), using, chiefly, a recently developed dipping technique[2]. Within the range of crystal sizes tested, namely, from colloidal D.D.T. to a suspension of needle-shaped aggregates 350 μ long, toxicity is associated primarily with overall length, and increases with length; breadth is of lesser importance, but it seems definite that increasing the breadth of a crystal from a needle to a plate shape subtracts somewhat from its toxicity. Thus, of all the sizes tested, colloidal D.D.T. is least, and 350 μ needles most, toxic. The ratio of the median lethal doses of these extreme sizes is of the order of 12 : 1.

There must, of course, be an upper limit to the toxicity, for it is obvious that an increase in the crystal dimensions beyond certain limits would not be accompanied by a corresponding increase in toxicity. As the choice of 350 μ needles as a standard size was purely one of convenience, it is scarcely likely that such a suspension does represent maximum toxicity.

These results are in line with those of Parkin and Green[3], who showed that the toxicity to houseflies of residual D.D.T. films increases with the age of the film and that this is related to slow crystallization of D.D.T. from a "poorly toxic gum-like residue".

The origin of these differences is not clear, but they are certainly not due to the few small differences in the media of the separate types of suspension. That they do not have their origin in any operation peculiar to the dipping technique is shown by the fact that similar differences are obtained with the Potter spraying apparatus[4]. However, it may be that with smaller particles there is a greater 'run off' of insecticide from the insects' bodies, that is, larger particles are retained more readily by irregularities on the cuticle surface. This would be equivalent, in fact, to a higher dosage; hence the higher kill.

Further work on this subject is in progress here and complete details will be published elsewhere at a later date.

Andrew H. McIntosh

Department of Insecticides and Fungicides,
Rothamsted Experimental Station,
Harpenden, Herts. Aug. 14.

[1] Gooden, E. L., *J. Amer. Chem. Soc.*, **67**, 1616 (1945).
[2] McIntosh, A. H., in the press.
[3] Parkin, E. A., and Green, A. A., *Nature*, **155**, 668 (1945).
[4] Potter, C., *Ann. Appl. Biol.*, **28**, 142 (1941).

An Insect Vector of the Turnip Yellow Mosaic Virus

In a recent communication[1] we described a new virus attacking turnips, which we had isolated in crystalline form. At that time we had found no insect vector for the virus, all the experiments with aphides having proved negative. However, since the virus attacks an annual crop like the turnip it seemed highly probable that some insect vector was involved, so further investigations were undertaken. A small plot of turnips was sown out-of-doors and a few infected plants placed at random in the plot. It was soon evident from the rate and manner of spread of the virus that some insect was transmitting it.

Examination of the insect fauna of the plot showed the only insects present in any number to be aphides and flea-beetles (*Phyllotreta* spp.). Since the aphides had already been tested with negative results attention was directed to the flea-beetles and the following experiment was carried out. Two insect-proof cubicles in the glasshouse were filled with healthy young turnip and Chinese cabbage plants and two infected plants were placed in each cubicle as a source of virus. In one cubicle a large number of flea-beetles, mostly *Phyllotreta cruciferæ* and *P. vittula*, were liberated; the other cubicle which acted as a control was kept free of insects. Ten days after the introduction of the flea-beetles into the cubicle, the first plant became infected; the following day three more plants developed the disease and during the next two days, five more. In the control cubicle there was no spread of the virus.

This seems fairly conclusive that the flea-beetle is, in fact, the vector of the turnip yellow mosaic virus, and if confirmed will be the first instance of virus transmission by a biting insect in Great Britain. Whether the transmission is a purely mechanical process is not yet certain, though it seems probable that this is so.

Kenneth M. Smith
Roy Markham

Plant Virus Research Station
and Molteno Institute,
Cambridge.
Aug. 22.

[1] *Nature*, **157**, 300 (1946).

Carrot Fly Control

The control of carrot fly by the application of insecticides direct to the plant rows has shown interesting anomalies when compared with that of root flies of somewhat similar habits. Calomel, for example, effective against cabbage root fly, does not appear to work against carrot fly.

It is of interest to record in this connexion the results of trials made in 1945 comparing the efficacy of a D.D.T. (Geigy) 5 per cent dust and a benzene hexachloride dust containing 0·25 per cent gamma isomer as crude benzene hexachloride (formulated as *P.P.* flea-beetle dust). It is seen from the accompanying table that the control given by the benzene hexachloride (B.H.C.) is of a quite remarkable order, whereas only moderate control was effected by D.D.T.

Carrot Fly Trials 1945. Summary of Replicates

	Total number of carrots examined	% Clean	% Slight attack	% Moderate attack	% Unsaleable
Control	236	12·7	18·7	11·9	56·7
D.D.T.	419	44·2	21	9·3	25·5
B.H.C.	350	99·7	0·3	—	—

Results obtained this year have, so far, been confirmatory.

The reason for this difference is not yet apparent. The characteristic odour of B.H.C. might suggest that a deterrent effect is involved, but this is scarcely borne out by the way protection so exactly followed the limits of distribution of the dust; in addition, a fumigant effect may not be out of the question. It is hoped to get further evidence on these matters.

One other point regarding phytocidal action may be mentioned. Unnecessarily heavy dressings of B.H.C. do not appear to have a hurtful action on the carrot, whereas with the Brassicæ even moderate dressings may seriously affect the stem at the point where contact is made—possibly a point of interest in regard to the mode of action of benzene hexachloride.

H. C. F. Newton
J. E. Satchell
M. W. Shaw

Harper Adams Agricultural College,
Newport, Shropshire.
Aug. 20.

Powdery Mildew of Potato

Powdery mildew on potato was first recorded in Great Britain in 1932, when the oidial stage was found on the leaves of seedling potatoes in a glasshouse at Cambridge[1]. It was again observed at Cambridge in the late summer of 1945, and a field survey was made to determine its prevalence. The mildew was found not only on seedling plants in the greenhouse, but also on potatoes in trial plots in the open. A search was then made for it in the immediate neighbourhood, and later this was extended to cover an area within a ten-mile radius of Cambridge.

Mildew was prevalent throughout the area inspected. Crops in the vicinity of the trial plots were most heavily infected, but elsewhere infection was greatest in the south-west of Cambridgeshire. Mildewed plants were found twelve miles away, namely, at Burwell, where a mild attack had developed in a garden.

In the field the disease was observed on the following varieties: Majestic, Dunbar Rover, Abundance, Dunbar Standard, Arran Victory and President. A number of hybrids, derived from parental stock of King Edward, were also affected. Majestic was the variety most noticeably attacked, but mildew was not observed on Kerr's Pink, Gladstone and Red Skin, or on any other Solanaceous plant.

Inoculation experiments were made on plants related to the potato, and on species known to be susceptible to *Erysiphe cichoracearum*.

The only plant successively inoculated was *Nicotiana tabacum* var. White Burley.

The mycelium was present on both surfaces of the leaves, but it was usually more abundant on one side than the other. In the greenhouse and trial plots near by, the upper surface was most commonly infected, while in the field the mycelium was more prevalent on the lower surface. Round to oval patches, about 1–3 cm. in diameter, were formed, and on severely infected leaves these coalesced. The affected areas were at first pale green, but afterwards developed a powdery-white appearance. In no case were the petioles or stems attacked, as described by Kunkel[2].

The haustoria, which were formed in the epidermal cells, were subglobose to ovate in shape, measuring approximately 41·5 μ by 27·5 μ. The mean dimensions of the conidia were 29·6 μ by 16·8 μ. No perithecia were observed. Ducomet, in France, observed that perithecia were formed on infected leaves, but the asci did not mature and he was unable to ascertain the species[3].

It is generally accepted that this mildew belongs to *Erysiphe cichoracearum*, though it has not been proved. This species, however, was definitely recorded on potato plants in France in 1927. No other reports of a powdery mildew on potato plants have been recorded in Great Britain other than from Cambridge.

I wish to acknowledge my indebtedness to Dr. W. A. R. Dillon Weston, who brought this disease to my notice, and for much helpful advice and criticism.

D. G. Thomas

School of Agriculture,
Cambridge.

[1] Pethybridge, G. H., *et al.*, Min. Agric. Bull. No. 79, 31 (1934).
[2] Kunkel, L. O., *Phytopath.*, **26**, 4, 392 (1936).
[3] Ducomet, V., *Bull. Soc. Path. Veg.*, France, **8**, 153 (1921); cited in *Rev. Appl. Mycol.*, **1**, 361 (1922).

Transmission of *L. carinii* to Laboratory Animals

Dr. F. Hawking and Miss A. M. Burroughs in a letter to *Nature*[1] state that they have confirmed the reports of the American workers, Williams and Brown[2], and Scott (private communication), regarding the transmission of *L. carinii* to laboratory (piebald) rats, and that in addition they transferred the infection to hamsters and white mice.

The establishment of a strain of filariasis in such a universally available laboratory animal as the white rat would be of great value to workers in tropical medicine, since it would provide them with the means of studying the effects of drugs on a disease heretofore regarded as incurable, and this problem has recently been studied by us at the Liverpool School of Tropical Medicine. The results of our investigations, which will be published in the next number of the *Annals of Tropical Medicine and Parasitology*, although confirming the American workers' statement that *L. carinii* can be transmitted to white rats, do not support the view that a strain of *L. carinii*, suitable for chemotherapeutic investigation, can be successfully maintained in these animals.

Our preliminary observations agreed with those of Dr. Hawking in confirming the American work, but on more intensive study, we observed that although transmission of *L. carinii* from the cotton rat to the white rat could be successfully performed by means of the vector, *L. bacoti*, and although the infective forms reached the adult stage, became sexually mature, and produced microfilariæ, the adult worms in the pleural cavity of the white rat were progressively encapsulated and died within as short a period as 82 days of the first exposure to infection. This premature death of the adult worms has never been observed by us in the natural host, the cotton rat.

In further experiments in which adult *L. carinii* were transferred by surgical means from the pleural cavities of cotton rats to those of white rats, microfilariæ appeared in the peripheral blood of the latter some ten days afterwards, and persisted for a further three weeks, at the end of which period the animals were killed, and it was found that the parent worms were dead and in various stages of encapsulation.

We have not attempted to infect white mice or hamsters, but the results of the experiments reported by Dr. Hawking and Miss Burroughs suggest that these animals may react in a similar manner to white rats, and that caution must be exercised before accepting the view that the presence of microfilariæ in the peripheral blood of these animals necessarily implies that they are suitable hosts in which to establish a permanent strain of filariasis for chemotherapeutic studies.

D. S. Bertram
K. Unsworth
R. M. Gordon

Department of Entomology and Parasitology,
School of Tropical Medicine,
Pembroke Place,
Liverpool 3.

[1] *Nature*, **158**, 98 (1946).
[2] Williams, R. W., and Brown, H. W., *Science*, **102**, 482 (1945); **103**, 224 (1946).

Polyploidy in Sainfoin

Among the herbage crops, cocksfoot (*Dactylis glomerata* L.)[1] and bird's foot trefoil (*Lotus corniculatus* L.)[2] have been shown to be autotetraploids, and lucerne (*Medicago sativa* L.), having also given segregation ratios which can best be interpreted as tetrasomic, may be regarded as an autotetraploid[3]. Sainfoin (*Onobrychis viciæfolia* Scop.) is a tetraploid species with $2n = 28$ chromosomes compared with $2n = 14$ in *O. Caputgalli* Lam.[4]. The question arises whether it is an allo- or an auto-tetraploid. This can best be settled by genetical tests based on the difference between tetrasomic and disomic ratios, but the following observations seem sufficiently indicative to be worth reporting.

By colchicine treatment of seeds or seedlings, sainfoin plants have been obtained with double the normal number of chromosomes. They may be recognized by their pollen grains having nearly double the volume of those of normal plants. Abortion of seeds is characteristic of these plants, but occasional seeds have been obtained after open pollination in the presence of normal plants. These seeds give rise to 'triploid' progeny with 42 chromosomes. Other progeny with about 42 chromosomes have been raised from embryos dissected out of immature seeds and grown on nutrient agar until they form plants large enough to transplant to soil. 'Triploids' have a higher seed fertility than their maternal parent and have a surprisingly regular pollen, with between 0·1 and 5·4 per cent of unfilled grains as judged after acetocarmine staining. The relative volumes of the regularly formed grains of normal, 'triploid' and doubled plants are in the ratio 100 : 133 ; 182.

The first metaphase of meiosis in the pollen mother cells of a plant with 40 chromosomes (obtained by culture of an embryo produced by open pollination of a doubled plant) was studied in a preparation made by a modification of Thomas's method[5]. The following configurations were seen in five cells which could be analysed completely : 1 trivalent, 18 bivalents and 1 univalent (in each of two cells) ; 4 trivalents and 14 bivalents ; 3 trivalents, 15 bivalents and 1 univalent ; 19 bivalents and 2 univalents. These associations show that normal sainfoin is either an autotetraploid or an allotetraploid of the *Primula kewensis* type, derived by chromosome doubling of a hybrid with a high degree of chromosome pairing. It is not an allotetraploid of the *Raphanobrassica* type, derived by chromosome doubling of a hybrid with little or no pairing.

Confirmatory evidence was obtained from an examination of meiosis in normal sainfoin, which was found to have a low chiasma frequency (about 14 per cell), forming mainly bivalents with a single chiasma, occasional bivalents with two chiasmata, chains of four chromosomes and univalents. The low chiasma frequency is probably an adaptive mechanism which assists regular disjunction by reducing the frequency of higher associations than bivalents.

J. L. Fyfe

Cambridge University Plant Breeding Institute.
Aug. 19.

[1] Müntzing, A., *Hereditas*, Lund, **23**, 113 (1937), and Myers, W. M., *J. Amer. Soc. Agron.*, **33**, 893 (1941).
[2] Dawson, C. D. R., *J. Genet.*, **42**, 49 (1941).
[3] Tysdal, H. M., Kiesselbach, T. A., and Westover, H. L., *Res. Bull. Neb. Agric. Exp. Sta.*, **124** (1942).
[4] Senn, H. A., *Bibliogr. Genet.*, **12**, 175 (1938).
[5] Thomas, P. T., *Stain Tech.*, **15**, 167 (1940).

Perilobular Spaces in the Rabbit Pancreas

Kühne and Lea in 1882[1] described (but did not illustrate) two kinds of lobule in the rabbit pancreas : (*a*) a lobule smooth on the surface and in which the cell boundaries of the acinar cells cannot be distinguished ; (*b*) a lobule irregular on the surface like a mulberry and in which the cell boundaries are quite distinct.

They were able to show that on the introduction of an injection mass into the pancreatic duct of the *living* rabbit it penetrated, even at the lowest injection pressures in the case of lobules of the (*b*) type, by way of intercellular canaliculi into a space situated between the bases of the acinar cells and the membrana propria. Here the mass filled a series of clefts or spaces which made a triangular pattern on the surface of the lobule. Immediately the injection pressure was reduced the intercellular canaliculi closed again. In lobules of the (*a*) type the mass never penetrated beyond the lumen of the alveoli.

In the course of a recent re-examination of the blood supply of the rabbit pancreas a number of preparations were injected, immediately after death, and at a pressure never exceeding 120 mm. mercury, with a carmine-gelatine mass, by way of the thoracic aorta. In these animals certain lobules stood out very distinctly by reason of the presence on the surface of the lobule of a network of sinusoidal-like spaces filled with the injection mass (Fig. 1). The arrangement of these spaces appeared to correspond very closely with the description published by Kühne and Lea. The mulberry-like appearance of these lobules is quite distinct in the photographs (Fig. 2).

A re-examination of specimens of uninjected rabbit pancreas showed that no blood-containing spaces of this nature could be observed, but that occasional lobules presented an apparent capsule of delicate

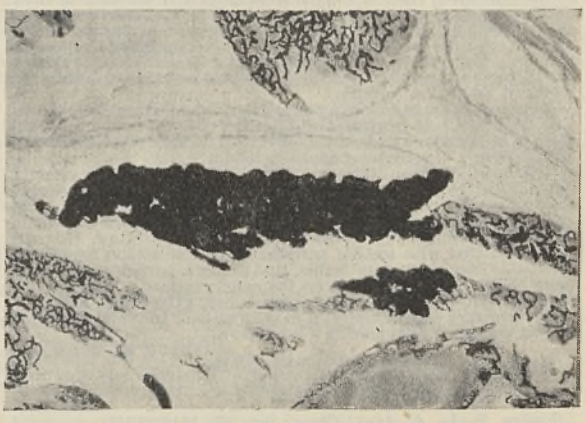


Fig. 1. Sectioned at 30 μ. One atypical lobule surrounded by sinusoidal-like spaces filled with injection mass. Normal lobules above and at each side. (× *c.* 50.)

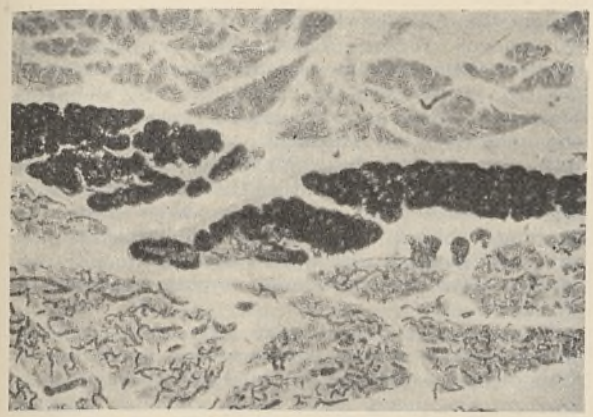


Fig. 2. SECTIONED AT 20 μ. GROUP OF ATYPICAL LOBULES SHOWING THE NET-LIKE ARRANGEMENT OF THE SPACES ON THE SURFACE. ($\times$ *c.* 50.)

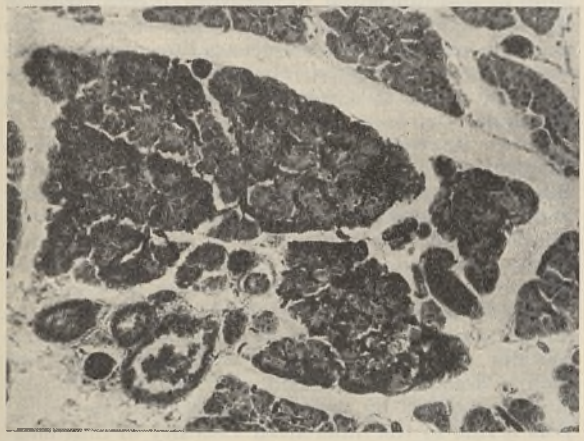


Fig. 3. SECTIONED AT 7 μ. ONE ATYPICAL LOBULE SHOWING EXTENSION OF THE PERILOBULAR SPACES WITH CONTAINED INJECTION MASS BETWEEN THE ACINAR CELLS TOWARDS THE LUMEN. ($\times$ 120.)

connective tissue between which and the bases of the epithelial cells lay a number of large thin-walled capillaries which appeared to be confined to the surface of these lobules alone.

It would seem that these spaces, accessible either from the vascular system or from the acinar lumen, might be :

(*a*) Not preformed spaces, but artefacts produced by the irruption of an injection mass into delicate connective tissue. Their regularity of pattern and their restriction to certain lobules, and the fact that the lobule is completely invested by them, would seem to militate against this suggestion.

(*b*) Lymph spaces, filled from ruptured blood capillaries, or by way of a ruptured basement membrane from the glandular lumen. This would appear, at first sight, to be the most likely explanation. In serial section, however, no extension of the injection mass into lymphatic capillaries presumably draining the space could be detected. Nor is it easy to see why such spaces should be confined to the minority of lobules.

(*c*) Spaces which permit the passage of small quantities of the exocrine secretion of the gland into contact with special thin-walled capillaries which mediate the absorption from this secretion of factors which are presumably of use internally. It would have to be assumed that in the present preparation the spaces have been filled by rupture of the thin-walled capillaries which lie in them. It will be noted that in the photographs the injection mass appears to extend between some of the acinar cells towards the lumen of the acinus (Fig. 3). Kühne and Lea stress the fact that in the living pancreas the injection mass flowed, with the utmost ease and at negligible pressure, from the lumen of the acinus into these spaces. These facts lend support to the view that the connexions between these spaces and the lumen of the acinus are present in the living animal. If such be the case there can be little doubt that the function of these connexions is to convey some of the exocrine secretion into the spaces.

H. HUGHES

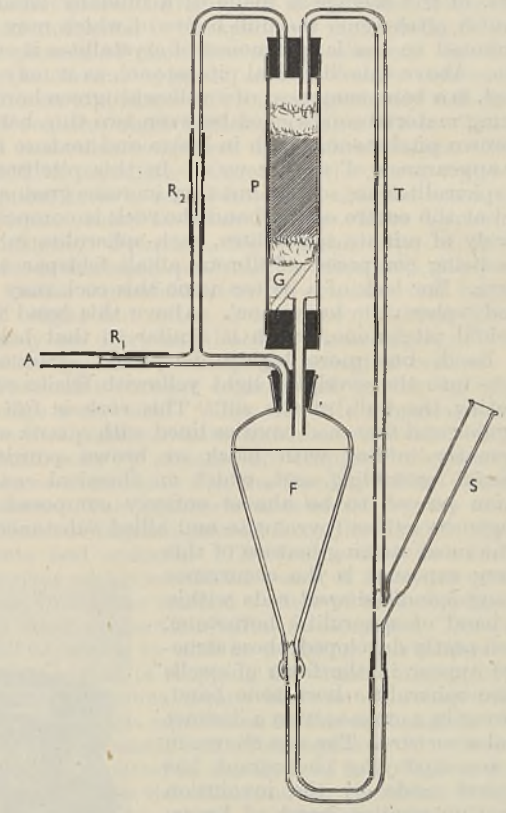
Anatomy Department,
St. Thomas's Hospital Medical School,
London, S.E.1.
Aug. 20.

[1] Kühne, W., and Lea, A. Sh., "Beobachtungen über die Absonderung des Pankreas", Untersuch. physiol. Inst. Univ. Heidelberg, 2, 448 (1882).

A New Soil Perfusion Apparatus

THE soil perfusion apparatus of Quastel and Lees[1] which has now been in use in this Unit for some years requires modification to allow for greater simplicity of construction and greater efficiency and ease of working. The design shown in the accompanying figure, while retaining the essential features of the original apparatus, has been found in practice to offer considerable advantages.

The soil is contained in the glass tube P between glass wool as in the original apparatus. The perfusion solution is in the separating funnel F. A constant small suction is applied at A by a suction pump. This suction is transmitted back through the lengths of thermometer tubing R_1 and R_2 and the soil column in P to the perfusion solution in tube T. This causes air to be drawn in at the base of the side tube S, thereby detaching a column of solution, which is drawn up tube T and discharged on to the top of the soil column. On release of the tension in T by this discharge, solution again rises above the base of S until it reaches the level of the solution in F. More air is now drawn in at the base of S and the whole process repeated. The liquid discharged on the top of the soil column is drawn with the air stream through the soil and drains back into F. The by-pass tube with flow resistance R_2 is not necessary for the working of the apparatus, but is useful in regulating the degree of aeration of the soil, the air flow dividing itself between the soil column and this tube in the inverse ratio of the resistances of these two arms to air flow. Resistance of R_1 should be high in relation to the other resistances in the circuit to ensure steady rates of flow of air and solution. T should be of about 4 mm. internal diameter. Sampling of the perfusion solution for analysis is very simple. Release of suction allows the perfusate to rise in the side-tube S, whence samples can be quickly pipetted off.



The advantages of this apparatus are : (1) Simplicity of construction and reduction in size. (2) Greater ease of sampling of perfusate. (3) More efficient aeration of the soil and the possibility of aeration control. (4) A wide range of perfusion-rates is obtainable by simple adjustment of rate of air flow, which can be made independent of degree of aeration. Experiment has shown that the speed of mixing of perfusate is highly satisfactory. (5) If required, gases of known composition can be used by forcing in at S at the required rate. Analysis of emergent gases can also be undertaken. (6) Freedom from trouble and the need for frequent adjustment. Under test the apparatus has worked continuously for periods of a week or more with no attention whatsoever.

Preliminary experiments carried out with the collaboration of Mr. H. Gleen of this Unit on sulphur metabolism indicate its very high efficiency, although the apparatus has still to stand the test of intensive research conditions.

L. J. AUDUS

Unit of Soil Metabolism,
Agricultural Research Council,
at University College of South Wales
and Monmouthshire,
Cathays Park, Cardiff.
Aug. 22.

[1] *Chem. and Ind.*, No. 26, 238 (1944).

MAGMATIC ROLLS

By Dr. S. I. TOMKEIEFF
King's College, Newcastle-on-Tyne

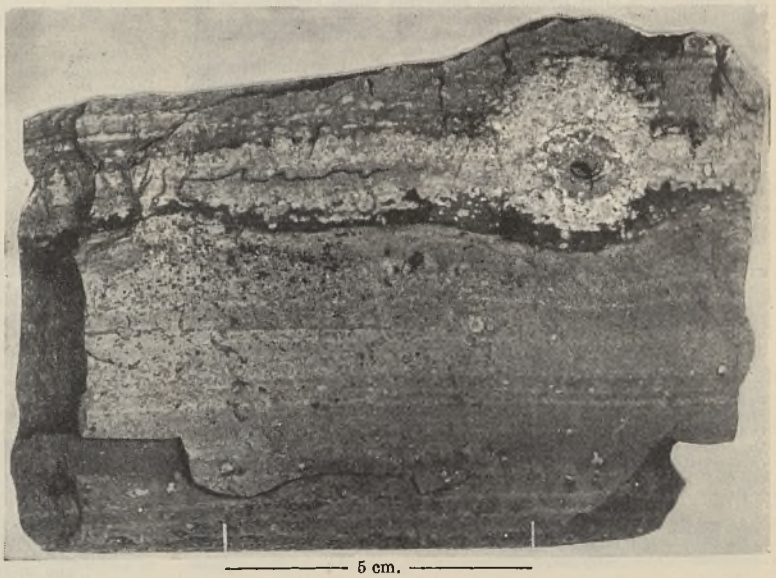
THIS note is written not as a detailed account or discussion of 'the find' described below but as preliminary notice which may be of interest to petrologists and as an invitation to them to express their views.

I recently discovered on the island of Arran a new and somewhat intriguing structural feature of igneous rocks. About one mile south of Brodick pier, along the Brodick–Lamlash road, a sill of felsite about 25 ft. in thickness is well exposed in a roadside quarry. The sill is intruded into the Permian sandstone, but only the lower contact of the sill with the sandstone is exposed in the quarry, where it is represented by a selvage of pitchstone. The bottom 5 cm. of the selvage is made of a fluidally banded greenish pitchstone, the dull lustre of which may be attributed to the large amount of crystallites it contains. Above this 'lithoidal pitchstone', as it may be called, is a band composed of a yellowish-green horny-looking material sandwiched between two thin bands of brown pitchstone, which in lustre and texture has the appearance of sealing wax. In this pitchstone the spherulites are scarce, but they increase gradually until at the centre of the band the rock is composed entirely of minute spherulites, each spherulite in its turn being composed of fibrous alkali feldspar and quartz. For lack of a better name this rock may be called 'spherulitic hornstone'. Above this band the lithoidal pitchstone, which is similar to that below the band, but more highly devitrified, gradually passes into the overlying light yellowish felsite constituting the bulk of the sill. This rock is full of irregular and flattened cavities lined with quartz and frequently infilled with black or brown powdery material resembling soot, which on chemical examination proved to be almost entirely composed of manganese oxides (pyrolusite and allied substances).

The most striking feature of this quarry exposure is the occurrence of long spindle-shaped rods within the band of spherulitic hornstone. When partly developed, these structures appear in the form of swells in the spherulitic hornstone band, showing in a cross-section a distinct spiral structure. The one shown in the accompanying photograph has a spiral made by the involution of a thin median band of brown pitchstone, which on the left side of the specimen appears in the form of a thin crumpled band. The outer convolutions of the spiral are marked by aligned spherulites. In more mature types of this structure the material is completely rolled out with a closely spaced spiral structure, usually almost completely blotted out by the superimposed spherulites, either following the lines of the spiral or in horizontal rows. The evidence presented by their internal structure, indicating their probable mode of origin, suggests the name 'magmatic rolls' for this type of structural feature of igneous rocks. These rolls, on weathering, separate themselves into spindle-shaped rods several feet in length and up to 5 cm. in diameter. Some of them are circular in cross-section, but the majority are elliptical. The weathered-out rolls are covered by minute spherulites aligned roughly parallel to the axes of the rolls, and on their upper surface they often have large blister-like swellings, which in section appear as hollow spherulites with cavities lined with quartz and occasionally containing black shining tabular crystals, probably of pyrolusite.

These long spindle-shaped rolls were probably closely packed within the hornstone band, but in their present weathered-out condition they are lying loose on the quarry floor, which coincides with the plane of the lower selvage of the sill with its dip of 20° to the south. The rolls in their undisturbed position are aligned parallel to a gently curving line more or less tangential to the west to east strike of the sill. This fact, taken in conjunction with the evidence presented by the orientation of the spirals within the rolls, suggests that the movement which gave rise to the rolls was directed from the north to the south.

Three interesting problems arise out of these observations. The first is the origin of the rolls. Why, for example, are they restricted to a particular band in the selvage of the sill? Can it be due to a comparatively lower viscosity of the magma composing this band, which, in its turn, was conditioned by a higher proportion of the volatiles, as evidenced by the formation of hollow spherulites? Then, if the fluidal planar banding of the adjoining pitchstone was due to a lamellar flow of the magma, why was such a lamellar flow transformed into the turbulent flow exemplified by the spiral structure of the rolls? Was it due to the differential viscosity of magmatic layers? And then, assuming that the axes of the rolls represent lineation caused by the plastic flow of the magma, is it possible to compare these structures, as developed in a primary tectonite, with certain



LOWER SELVAGE OF THE FELSITE SILL, COMPOSED OF A BANDED LITHOIDAL PITCHSTONE AND A BAND OF SPHERULITIC HORNSTONE (ABOVE), CONTAINING AN IMMATURE MAGMATIC ROLL SHOWING SPIRAL STRUCTURE IN CROSS-SECTION

structures, such as rodding or pencil structure, as developed in secondary tectonites ?

Secondly, there is the question of the crystallization of the magma. There are two types of crystalline forms in the rocks forming the selvage of the sill : minute crystallites (mostly scopulites) and spherulites. Both of them are usually aligned along flow lines, either horizontal or spiral. There is no indication at what stage of the magmatic history the crystallites were formed, but it is quite obvious that the spherulites were formed at a later stage, as they are often formed astride several flow lines of the glassy material. The alignment of the crystalline elements in these rocks suggests that we are here dealing with a case of 'mimetic crystallization', or crystallization conditioned by the strain set up by flow of a viscous magma.

The third problem concerns the formation of late magmatic minerals. Many previously described hollow spherulites and cavities in acid igneous rocks, besides quartz and feldspar, contain also tridymite, cristobalite and fayalite. The last-mentioned minerals have not, as yet, been detected in the cavities of acid igneous rocks of Arran, but the occurrence of manganese oxides in these cavities is rather striking. Were these minerals deposited from late magmatic fluids ?

In conclusion, I would like to thank Miss Doreen Hickling for her help in the field work and Mr. K. Spink for making the photograph of the specimen.

BIOLOGY OF WATER SUPPLY

SOME years ago the British Museum (Natural History) produced a useful publication on the biology of waterworks, giving an account of the different kinds of animals and plants which live and often cause nuisances in reservoirs, filter beds and pipes. Now the Freshwater Biological Association has produced a work on the subject*, approaching it from quite a different angle. Up-to-date knowledge and theory of limnology—the freshwater equivalent of oceanography—has been combined with practical experience of waterworks as a result of a fortunate association of authors. Prof. W. H. Pearsall has brought to bear the resources of research at Wray Castle, with which he has kept in very close touch since its inception; the late Alan Gardiner and Dr. F. Greenshields have contributed much experience from the laboratories of the Metropolitan Water Board. This pooling of resources has produced a handy work which should be of high value to water engineers and others concerned with the provision of pure water supplies. Though concerned essentially with Great Britain, it should also be read overseas, where the biological problems of water supply are likewise coming into prominence.

One aim of the publication is to explain the fundamental basis of the productivity of water as applying to reservoirs, and in consequence a good deal of chemistry and some physics of the aquatic environment are involved. Thus penetration of light and the annual cycle in the stratification of static water are discussed. On the all-important question of algal growth examples are given, chiefly from Windermere and reservoirs filled with Thames water, which enable the authors "to assume with some certainty that the chemical and physical environment ultimately controls the production of algæ in a given body of water". The control is not always direct, because in some cases, "perhaps particularly in the nutrient-rich waters of the Thames type, a burst of algal growth may sometimes cease before any serious depletion of the mineral nutrient in the water has apparently taken place, implying that other factors are important". In a general discussion of biological relations several principles of practical importance become apparent. For example, the avoidance of rooted vegetation reduces the accumulation of nutrient materials in the mud, and the insurance of ærobic conditions in the lower layers of water reduces to a minimum the quantity of nutrients which reach the water from the mud.

There are four main types of water available for supply in Britain. First, the type from deep wells and boreholes is commonly of good quality provided it is not stored in light, but being 'hard' and rich in plant nutrients, it is capable of high productivity if the process of photosynthesis is allowed. Secondly, the calcareous type of surface water, common in southern and eastern Britain, is generally rich in life and requires rigid bacteriological control. Thirdly, the non-calcareous type of surface waters, chiefly found in mountainous areas of the north and west, requires little or no treatment in the best cases, such as those stored in Loch Katrine, Lake Vyrnwy or Thirlmere. Fourthly, the Pennine type of surface water is extremely peaty and is often acid, due partly to smoke contamination ; it contains few bacteria and algæ, but often a large zooplankton feeding mainly on detritus. Each of these types of water has its separate problems in biological control.

Particular interest is attached to the ageing of storage reservoirs. When the silt, organic matter, lime and nutrient salts which are carried from the upland soils by streams are trapped in a reservoir, there is a tendency for the fertility of its water to increase. This process is accelerated by the annual increase of organic matter from the dead bodies of plants and animals. There are cases in which a reservoir which contained water of first-rate quality when young has reached a stage of undesirable algal and other productivity after 40–50 years. The principle at which to aim in avoiding this undesirable process is that of cropping the organic matter of the reservoir by some means in order to remove each year an amount equivalent to the annual gain. One method suggested, and often applied, is to remove the organic matter in the form of fish. It is perhaps a pity that this debatable matter of fishing in reservoirs, in which those responsible often require biological guidance, is not discussed at greater length.

The biological process involved in slow sand filtration and the effects of algicides are described. There is also a valuable section on forecasting troubles, but this may be a little disconcerting to water engineers in revealing the complex of biological processes : for forecasting an outburst of algæ, for example, no less than eight methods are given, each requiring skilled biological investigation. Specially useful features are accounts of methods used in biological water examination, some of them not yet described elsewhere. For example, there is an improved version of Houston's original method for determining filterability of water. For estimating the amount of plant and animal plankton, the pigment-extraction method, the

* Freshwater Biology and Water Supply in Britain. By W. H. Pearsall, A. C. Gardiner, F. Greenshields. (Freshwater Biological Association Scientific Publication No. 11, 1946.) Pp. 90. Price to non-members, 4s.

Utermöhl sedimentation method and others are described, and so are various useful pieces of apparatus for obtaining samples. More attention might have been given to the preparation of the illustrations, which vary much in quality and appearance. In one of the most significant graphs the horizontal scale is unfortunately omitted.

E. B. WORTHINGTON

ANTI-REFLEXION AND HIGH-REFLEXION FILMS

OPTICAL systems function best when reflexions at the air-glass surfaces are reduced to a minimum. The purple 'bloom' on lenses, a familiar feature in many types of military instruments, is due to the anti-reflexion or non-reflecting thin transparent film deposited on the surface of the lens in order to decrease the amount of reflected light. Interference between the light reflected at the air-film boundary and the film-glass boundary effects a redistribution of the light energy in such a way that the reflected light is reduced and the transmitted light through the glass correspondingly increased. Both the refractive index of the film, which must be less than the refractive index of the glass, and the thickness of the film are controlling factors[1].

Although chemical methods of coating glasses have been used, the better and simpler method is to deposit the film by the high-vacuum evaporation process, similar to that used for making metal-on-glass mirrors. This process allows easy and fine control of the thickness and uniformity of the film. The usual coating materials are magnesium and aluminium fluorides, with a refractive index approximately equal to the square root of the refractive index of glass.

Semi-reflectors made by depositing thin films of silver, aluminium, rhodium, platinum and chromium on glass by the high-vacuum process are in common use, but they suffer from the disadvantage that a considerable amount of light is lost by absorption in the metal films. In anti-reflexion films the interference effects induced by the thin transparent film redistribute the light so that the reflected beam is reduced in intensity, but this is by no means the only arrangement possible. By suitable choice of the refractive index of the film material, this time greater than that of glass, and of the thickness of the film, the reflected beam can be increased in intensity to any desired value for any colour. The film now acts as a high reflector but with the added advantage that the absorption in the interference film is negligible.

The properties of the first interference film semi-reflectors made by the British Scientific Instrument Research Association have been described by K. M. Greenland[2]. The reflectors consist of single-layer and multiple-layer films. The single-layer film is made from material of high refractive index and has an optical thickness of one-quarter of the mean wave-length of the incident light. This gives maximum reflectivity for light incident within 20° of the normal. An even number of alternate layers of low and high refractive indices, starting from one of low refractive index in contact with the glass, make up the multiple-layer film. The reflectivity for the multiple-layer film is higher than the maximum reflectivity for the single-layer film, and the reflected and transmitted beams are more highly coloured. This selectivity, due to the successive filtering action of the several layers, depends on the relative optical thicknesses of the layers, and by suitable selection of the number of layers, their thicknesses and refractive indices, multiple-layer films of different optical characteristics can be built up.

The optical efficiency, that is, the sum of the reflectivity and transmissivity, expressed as a percentage of the incident light intensity, is practically 100 for the interference films, owing to the negligible absorption. Corresponding figures for evaporated rhodium and chromium semi-reflectors lie between 55 and 70.

No mention is made of the actual material used for the films, but it is stated that the choice of suitable material is naturally limited, in that the substance must be both colourless and of high refractive index, and also, since the film is deposited by the high-vacuum process, must evaporate at a convenient temperature without decomposition and adhere well to glass.

S. WEINTROUB

[1] For theoretical details see Greenland, K. M., *Nature*, 152, 290 (1943), and for the use with the new optical glasses see Lee, H. W., *Sci. Prog.*, 34, 533 (1946).

[2] *J. Sci. Inst.*, 23, 48 (March 1946).

HORTICULTURE OF THE ONION

THE American Plant Life Society (formerly the American Amaryllis Society) has devoted Volume 11 of its yearbook "Herbertia 1944" (1946) to the science and practice of onion cultivation. The largest and probably the most outstanding contribution is a translation by H. K. Airy Shaw of A. I. Vvedensky's "The Genus Allium in the U.S.S.R.". This is a critical description of 228 species of the genus. It is reinforced by a paper on the floristic regions of that large area, by William T. Stearn, who also contributes a scholarly evaluation of the distribution, names, literature, classification and garden-worthy species of *Allium* in the Old World. The same author has translated a key to 85 species, published by Victor de Janka in 1886, and, in a more detailed paper, considers the nomenclature and synonymy of *Allium odoratum* and *A. tuberosum*. This symposium of taxonomy deals with about 38 per cent of the estimated total of 600 species belonging to the genus *Allium*.

H. A. Jones discusses problems and progress in onion breeding. This crop is very sensitive to its environment, and selections should be made in the region where the new variety is to be grown. The technique of crossing onion varieties would demand a preposterous amount of time for emasculation, so in practice male-sterile lines have been propagated clonally. They are then interplanted with a suitable pollinating variety, and pollination is effected by the introduction of flies. Two natural amphidiploids have been found in *Allium* crosses. They have considerable vigour, are highly resistant to onion smut, and should provide useful possibilities for the future. The paper also reviews potentialities of resistance to other diseases. Marguerite G. Toole and A. E. Clarke discuss the chromosome behaviour and fertility of colchicine-induced tetraploids in *Allium cepa* and *A. fistulosum*. The autotetraploids are highly self-sterile, but some seeds were obtained after self-pollination. Further tabulation of male-sterility genes in varieties of the onion is given by T. M. Little, H. A. Jones and A. E. Clarke.

It should not be forgotten that various species of *Allium* are ornamental in the garden, and Sgt. B.

Harkness has arranged a short collection of papers by various authors to minister to this aspect. A useful service has been performed by Neil W. Stuart and Dorothy M. Griffin, who describe symptoms of deficiencies of nitrogen, phosphorus, potassium, calcium and boron, using a strain of Yellow Bermuda onion.

Dr. H. A. Jones, to whom the volume is dedicated, also has a bibliography of literature on onion culture. This wider expansion of the American Plant Life Society's activities is very opportune, and there is still a sprinkling of Amaryllid papers to remind members of an earlier, progressive, but perhaps too exclusive specialization.

OUTBREAKS OF THE AUSTRALIAN PLAGUE LOCUST

THE existence of outbreak areas for the Australian plague locust (*Chortoicetes terminifera*) was first established in 1938. Under the title of "The General Ecological Characteristics of the Outbreak Areas and Outbreak Years of the Australian Plague Locust", K. H. L. Key has contributed (Bull. 186, Commonwealth of Australia Council for Scientific and Industrial Research, 1945) an important practical memoir.

The work has special reference to the importance of these factors in the formation of swarms of the insect mentioned. It appears that the outbreak areas lie in a belt of country between the humid and arid regions, in which no one month of a 'normal' season is too moist for the breeding of the locust, and no three successive months too dry, and in which a climatic index of 73 or more prevails. All the outbreak areas are characterized by the presence of self-mulching soil and the absence of dense timber. The locust requires different conditions for its optimum survival and breeding in the egg and later stages. These conditions are provided in distinct habitats termed the 'oviposition habitat' and the 'food-shelter habitat'.

The most important biological attribute of an outbreak centre is to provide conditions for survival and multiplication of locusts at those times when their range of dispersal is at a minimum, and also to provide conditions necessary for an increase in that range of dispersal (by swarm-formation) so that wider areas may be occupied. The opening up of the country has in general favoured the formation of outbreak areas, through the clearing of timber. Bare areas of compact soil are selected for egg-laying by both swarming and non-swarming populations. Adult locusts and the older nymphs are most numerous in the greener parts of tussocky pasture developed on the self-mulching soil.

Those portions of each of these habitats that are most resistant to change under variable seasonal conditions are termed 'oviposition nuclei' and 'food-shelter nuclei'. Where these two types of country are situated adjacent to each other, high populations of the locust are found, presumably because favourable conditions are produced for both the egg and later active stages within the normal dispersal range of the non-swarming population. It is in these areas that swarms arise, and they are consequently termed 'outbreak centres'. Knowledge gained regarding the features of these centres opens up the theoretical possibility of rendering such centres ecologically unsuitable for giving rise to swarms.

FORTHCOMING EVENTS

Tuesday, September 24

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Sir John Myres: "Devastation".

Tuesday, September 24—Thursday, September 26

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND, 39 Elmbank Crescent, Glasgow).—Joint Autumn Meeting.

FARADAY SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1).—General Discussion on "Swelling and Shrinking".

Tuesday, September 24

At 2 p.m.—General Discussion.

Wednesday, September 25

At 10 a.m. and 2 p.m.—General Discussion.

Thursday, September 26

At 10 a.m.—General Discussion.

Wednesday, September 25

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 p.m.—Twenty-first Annual General Meeting.

Thursday, September 26

INSTITUTION OF CIVIL ENGINEERS, Great George Street, London, S.W.1, at 5.30 p.m.—Sir Hugh Chance: "Recent Developments in Optical Glass Manufacture" (Parsons Memorial Lecture). (Members of the Societies participating in the Memorial Scheme are invited.)

Friday, September 27

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The University, Liverpool), at 11 a.m.—Scientific Papers.

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Informal Meeting.

MANCHESTER STATISTICAL SOCIETY (in the College of Technology, Sackville Street, Manchester), at 6.30 p.m.—Mr. Dennis Newman: "Sampling Inspection; Statistical Considerations".

Saturday, September 28

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1), at 2 p.m.—Meeting and Exhibition of Entomological Specimens, Drawings, Photographs, etc.

APPOINTMENTS VACANT

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

HEAD OF THE MATHEMATICS DEPARTMENT at the Municipal Technical College—The Director of Education, Education Offices, Guildhall, Kingston-upon-Hull (September 28).

HEAD OF THE AGRICULTURAL DEPARTMENT AND FARM DIRECTOR at Essex Institute of Agriculture, Writtle, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (September 30).

LECTURER OR ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, University College, Southampton (September 30).

DIRECTOR OF THE PHOTOGRAPHIC DEPARTMENT in the Medical School—The Registrar, King's College, Newcastle-upon-Tyne (September 30).

LECTURER IN BIOLOGY, a LECTURER IN PHYSIOLOGY OR BIOCHEMISTRY, and a LECTURER IN HISTOLOGY AND EMBRYOLOGY—The Secretary, Glasgow Veterinary College, County Buildings, 149 Ingram Street, Glasgow, C.1 (September 30).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary, Appointments Committee of the Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (October 1).

ASSISTANT IN THE DEPARTMENT OF NATURAL HISTORY—The Secretary, The University, Aberdeen (October 1).

EXECUTIVE OFFICER OF THE SEED PRODUCTION COMMITTEE—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge (October 5).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (October 5).

RESEARCH ENGINEER to take charge of and direct research into all processes for the deformation of metals, including rolling, drawing, forging, extrusion, etc.—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (October 7).

HEAD OF THE DEPARTMENT OF BAKERY AND CONFECTIONERY (candidates should possess a degree in Biology or Chemistry, and have had adequate experience, teaching and industrial), and a HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS—The Principal, Borough Polytechnic, Borough Road, London, S.E.1 (October 7).

VETERINARY RESEARCH OFFICER at Regent's Park and Whipsnade Park—The Secretary, Zoological Society of London, Regent's Park, London, N.W.8 (October 7).

RESEARCH OFFICER at the Fuel Research Institute of South Africa—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.761 (October 8).

CHAIR OF BOTANY in the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 18).

RESEARCH OFFICER, DIVISION OF ECONOMIC ENTOMOLOGY, Canberra, to make taxonomic studies of parasitic Diptera or parasitic Hymenoptera—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (October 19).

SENIOR LECTURER IN ANATOMY in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 21).

CHAIR OF VETERINARY SCIENCE, and the HUGHES CHAIR OF VETERINARY PATHOLOGY AND BACTERIOLOGY—The Registrar, The University, Sydney, N.S.W., Australia (December 31).

LABORATORY ASSISTANT (Grade I) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

SENIOR ASSISTANT FOR AERODYNAMICS AND FLUID MOTION, and a SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING, at the Municipal Technical College—The Director of Education, Education Offices, Guildhall, Kingston-upon-Hull.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 13, 1944. Pp. vii + 187. (London: Brompton Hospital, 1946.) 10*s.* [174

Reports of the Council and Auditors of the Zoological Society of London for the Year 1945. Pp. 32. (London: Zoological Society of London, 1946.) [174

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 812, Vol. 239: On the Salinity of the Surface Waters of the Irish Sea. By J. Proudman. Pp. 579–594. (London: Cambridge University Press, 1946.) 2*s.* 6*d.* [174

Society for Freedom in Science. Occasional Pamphlet No. 4: The Planning of Science. By Prof. Michael Polanyi. Pp. 14. (Oxford: Society for Freedom in Science, University Museum, 1946). 1*s.* 6*d.* [174

Annual Report of the Oundle School Natural History Society. Pp. 59. (Oundle: Oundle School, 1946.) [234

Textile Institute. Annual Report, Balance Sheet and Accounts for 1945. Pp. 8. (Manchester: Textile Institute, 1946.) [234

Medical Research Council. Special Report Series, No. 254: An Experimental Study of Rationing. By Dr. R. A. McCance and Dr. E. M. Widdowson. Pp. 62. (London: H.M. Stationery Office, 1946.) 1*s.* net. [234

A Report on the International Control of Atomic Energy. Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants, Washington, D.C. Pp. viii + 44. (London: H.M. Stationery Office; Washington, D.C.: Government Printing Office, 1946.) 1*s.* net. [254

Library Association. University and Research Libraries of Great Britain: their Post-War Development. Pp. 16. (London: Library Association, 1946.) [294

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Thirtieth Annual Report, 1944. Pp. 84. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd., 1945.) [294

A General-Purpose Source Unit for the Spectrographic Analysis of Metals and Alloys. By A. Walsh. (Reprinted from the *Bulletin* of the British Non-Ferrous Metals Research Association, No. 201, March 1946.) Pp. 59–80. (London: British Non-Ferrous Metals Research Association, 1946.) 2*s.* 6*d.* [294

Colonial Office. Nutrition in the British West Indies. Report by Dr. B. S. Platt. (Colonial No. 195.) Pp. iii + 38. (London: H.M. Stationery Office, 1946.) 9*d.* net. [25

The Discovery of the Antiquity of Man: Some of the Evidence. By the Abbé Henri Breuil. (Huxley Memorial Lecture for 1941.) Pp. 11. (London: Royal Anthropological Institute, 1946.) 2*s.* 6*d.* [25

The Ancient Oikoumenê as an Historic Culture Aggregate. By Dr. A. L. Kroeber. (Huxley Memorial Lecture for 1945.) Pp. 12. (London: Royal Anthropological Institute, 1946.) 2*s.* 6*d.* [25

Vitamin Chart. 30 in. × 20 in. (London: Crookes Laboratories, 1946.) Free. [25

University of London. Report of the Principal on the Work of the University during the Year 1945–46. Pp. 8. (London: University of London, 1946.) [65

Other Countries

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 115, Nr. 2: Stratigraphische und Faziesverhältnisse der Oberpermischen Ablagerungen Ostgrönlands (Olim 'Oberkarbon-Unterperm') zwischen Wollaston Forland und dem Kejser Franz Josephs Fjord. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Wolf Maync. Pp. 128+6 plates. 7 kr. Bd. 115, Nr. 3: Zur Petrologie Junger Sande aus Nordostgrönland. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Hans Hübscher. Pp. 108+1 plate. 5 kr. Bd. 115, Nr. 4: Beitrag zur Geologie und Sedimentpetrographie Ostgrönlands. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Karl Kleiber. Pp. 148+6 plates. 8 kr. Bd. 117, Nr. 3: Grønlandsk Medicinsk Statistik og Nosografi, 3: Det Saedvanlige Grønlandske Sygdomsbillede. Af A. Bertelsen. Pp. 234. 11 kr. Bd. 117, Nr. 4: Grønlandsk Medicinsk Statistik og Nosografi, 4: Akutte Infektions-sygdomme i Grønland. Af A. Bertelsen. Pp. 244. 1 kr. Bd. 121, Nr. 4: The Zoology of East Greenland—Freshwater Entomostraca. By Erik M. Poulsen. Pp. 74. 3.50 kr. Bd. 121, Nr. 5: The Zoology of East Greenland—Brachiopoda. By Elise Wesenberg-Lund. Pp. 12. 0.50 kr. Bd. 121, Nr. 6: The Zoology of East Greenland—Decapod Crustaceans. By P. E. Heegaard. Pp. 72. 3.50 kr. Bd. 121, Nr. 7: The Zoology of East Greenland—Gastropoda Opisthobranchiata. By Henning Lemcke. Pp. 50. 2.50 kr. Bd. 121, Nr. 8: The Zoology of East Greenland—Pycnogonida. By K. Stephensen. Pp. 42. 2 kr. Bd. 121, Nr. 9: The Zoology of East Greenland—Marine Ostracoda, Parasitic and Semi-Parasitic Copepoda and Cirripedia. By K. Stephensen. Pp. 24. 1 kr. Bd. 121, Nr. 10: The Zoology of East Greenland—Leptostraca, Mysidacea, Cumacea, Tanaidacea, Isopoda and Euphausiacea. By K. Stephensen. Pp. 82. 4 kr. (København: C. A. Reitzels Forlag, 1940–1944.) [63

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 121, Nr. 11: The Zoology of East Greenland—Hydroida. By P. L. Kramp. Pp. 52. 2.50 kr. Bd. 121, Nr. 12: The Zoology of East Greenland—Medusae, Siphonophora, and Ctenophora. By P. L. Kramp. Pp. 20. 1 kr. Bd. 121, Nr. 14: The Zoology of East Greenland—Amphipoda. By K. Stephensen. Pp. 166. 7.50 kr. Bd. 124, Nr. 1: Report on the Expedition. (The Natural History Expedition to Northwest Greenland, 1936.) By Finn Salomonsen. Pp. 38+1 plate. 2 kr. Bd. 124, Nr. 3: A Study of the Littoral Fauna of Northwest Greenland. (The Natural History Expedition to Northwest Greenland, 1936.) By Holger Madsen. Pp. 24. 1.25 kr. Bd. 124, Nr. 4: Geological Observations from the Thule District in the Summer of 1936. (The Natural History Expedition to Northwest Greenland, 1936.) By Sole Munck. Pp. 38. 1.75 kr. Bd. 124, Nr. 5: The Flora of Melville Bugt. (The Natural History Expedition to Northwest Greenland, 1936.) By Thorvald Sørensen. Pp. 70+1 plate. 3.50 kr. Bd. 125, Nr. 6: Om Grønlands Areal, 2: Arealmaaling af Østgrønland mellem 73° og 76° N.Br., mod vest til Meridianen 32° vest for Greenwich. Af J. M. Danbo. Pp. 24. 1.25 kr. Bd. 125, Nr. 7: Contributions à l'ethnographie des Eskimo d'Angmagssalik. (Expéditions françaises au Groenland, 1934–37.) Par Paul-Émile Victor. Pp. 214. 10 kr. Bd. 125, Nr. 8: i. Spiders (Araneina) from Northeast Greenland between Lats. 70°25′ and 76°50′ N.; ii. On the Possibility of a Reliable Determination of Species of the Females of the Genus Erigone. By Jens Braendegaard. Pp. 32. 1.50 kr. Bd. 125, Nr. 9: Temperature Relations and Phenology of the Northeast Greenland Flowering Plants. By Thorvald Sørensen. Pp. 306+15 plates. 18 kr. (København: C. A. Reitzels Forlag, 1939–1944.) [63

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 126, Nr. 1: Report on the Expedition and on Subsequent Work at the Morkefjord Station. (Dansk Nordøstgrønlands Expedition, 1938–39.) By Eigil Knuth. Pp. 160+1 plate. 8 kr. Bd. 126, Nr. 2: Remarks on the Map and the Geology of Kronprins Christians Land. (Dansk Nordøstgrønlands Expedition, 1938–39.) By Eigil Nielsen. Pp. 36+1 plate. 1.50 kr. Bd. 127, Nr. 2: Radio-Technical Observations in Lat. 76°56′1″ N. and Long. 20°18′2″ W. (Dansk Nordøstgrønlands Expedition. 1938–39.) By Kurt Bæk. Pp. 56. 2.50 kr. Bd. 128, Nr. 1: A Morphologic-Systematic-Ecological Investigation of *Acarina* and other Representatives of the Microfauna of the Soil around Mørkefjord, Northeast Greenland. (Dansk Nordøstgrønlands Expedition, 1938–39.) By Niels Haarløv. Pp. 72+3 plates. 4 kr. Bd. 128, Nr. 2: Saugetiere und Vögel. (Dansk Nordøstgrønlands Expedition, 1938–39.) Von Alarin Pedersen. Pp. 120. 5.50 kr. Bd. 129, Nr. 1: Hans Egede, Grønlands Missionaer og Kolonisator. Af Louis Bobé. Pp. 346+1 plate. 17 kr. Bd. 129, Nr. 2: Brudstykker af en Dagbog holden i Grønland i aarene 1770–1778. Af Hans Egede Saabye. Pp. 130. 6 kr. Bd. 130, Nr. 1: Survey of North Greenland. By Lauge Koch. Pp. 364+21 plates. 22 kr. Bd. 130, Nr. 2: Index to Survey of North Greenland. By Lauge Koch. Pp. 20. n.p. Bd. 131, Nr. 1: Biological Remarks on *Lepidurus arcticus* Pallas, *Daphnia pulex* de Geer and *Chydorus sphaericus* O.F.M. in East Greenland. By Erik M. Paulsen. Pp. 50. 2.25 kr. Bd. 131, Nr. 2: On the Origin of *Saxifraga Nathorsti* (Dusén) v. Hayeck. By Tyge W. Böcher. Pp. 14. 0.75 kr. Bd. 131, Nr. 3: The Skin Musculature of the Greenland Lemming *Dicrostonyx groenlandicus* (Traill.). By Thydsen Meinertz. Pp. 78. 3.75 kr. Bd. 131, Nr. 4: A Study on the Arctic Fox in Greenland. By F. W. Braestrup. Pp. 102+1 plate. 5 kr. (København: C. A. Reitzels Forlag, 1940–1944.) [63

South Australia: Department of Mines. Mining Review for the Half-Year ending 31st December, 1944. (No. 81.) Pp. 111. (Adelaide: Government Printer, 1945.) [73

Smithsonian Miscellaneous Collections. Vol. 104, No. 15: A Bibliography and Short Biographical Sketch of William Healey Dall. By Paul Bartsch, Harald Alfred Rehder and Beulah E. Shields. (Publication 3810.) Pp. ii+96+1 plate. Vol. 104, No. 17: New Westville, Preble County, Ohio, Meteorite. By E. P. Henderson and S. H. Perry. (Publication 3814.) Pp. ii+9+4 plates. (Washington, D.C.: Smithsonian Institution, 1946.) [73

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1945. (Publication 3813.) Pp. ix+116+2 plates. (Washington, D.C.: Government Printing Office, 1945.) 30 cents. [73

Africa Advancing: a Study of Rural Education and Agriculture in West Africa and the Belgian Congo. By Jackson Davis, Thomas M. Campbell and Margaret Wrong. Pp. ix+230+12 plates. (New York: Friendship Press: London: International Committee on Christian Literature for Africa, 1945.) [73

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 131, Nr. 6: The Black-winged Guillemot (*Uria grylle* mut. *Motzfeldi* Benicken.) By Finn Salomonsen. Pp. 22. 0.75 kr. Bd. 131, Nr. 7: Den erhvervsmaessige Udviklung i Julianehaab Distrikt, 1899–1939. Af Paul Ibsen og P.P. Sveistrup. Pp. 64+1 plate. 3 kr. Bd. 131, Nr. 8: Igneous Rocks of the Ivigtut Region, Greenland, Part 1: The Nepheline Syenites of the Grønne Dal—Ika Area. By Karen Callisen. Pp. 74+2 plates. 3.50 kr. Bd. 131, Nr. 9: Det almindelige Handelskompagni, 1747–1774. Af P. P. Sveistrup. Pp. 110. 5 kr. Bd. 131, Nr. 10: Studies on the Cytology of Arctic Plants, 2: Habenaria. By L. Harmsen. Pp. 16. 0.75 kr. Bd. 131, Nr. 11: Remarks on the Breeding Conditions and Moulting of the Collared Lemming (*Dicrostonyx.*) By Magnus Degerbøl and U. Møhl-Hansen. Pp. 40. 2 kr. Bd. 131, Nr. 12: Systematic and Biologic Notes on the Long-tailed Skua *Stercorarius longicaudus* Vieil. By Bernt Løppenthin. Pp. 20. 1.25 kr. Bd. 131, Nr. 13: Arctic Ice Fluctuations in Julianehaab Bay, 1901–1937. By G. J. A. Hansen and P. P. Svelstrup. Pp. 32. 1.50 kr. (København: C. A. Reitzels Forlag, 1941–1945.) [73

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited at St. Martin's Street, London, W.C.2, and The Macmillan Co., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, September 21, 1946.