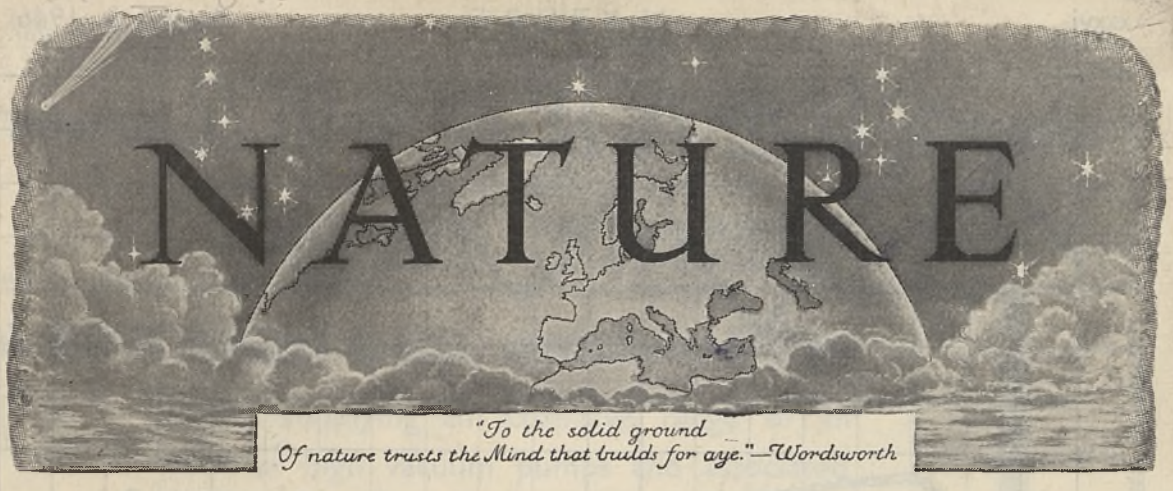

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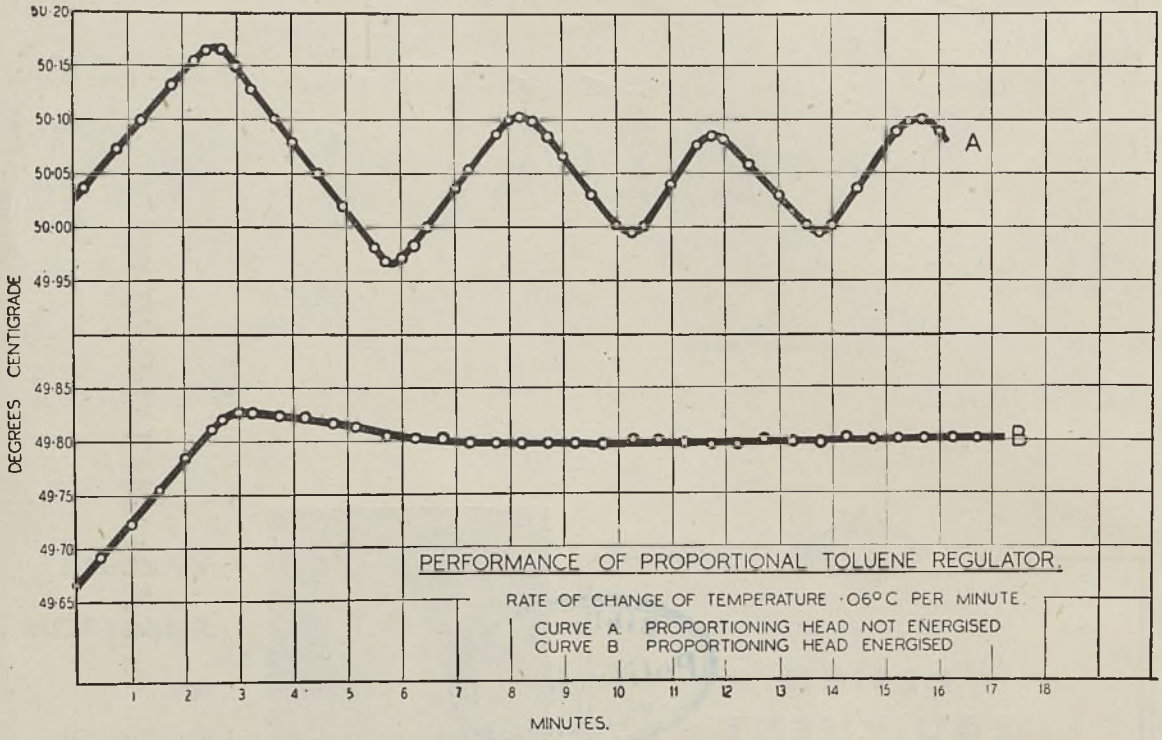

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THE UNIVERSITIES AND ADULT EDUCATION

WHILE the report of the Committee on Scientific Man-Power (see *Nature*, June 15, p. 794) was not concerned with the provision of teachers generally, it has recognized in its assessment of priorities the importance of adequate provision of teachers of science, and that some universities are experiencing an acute shortage of suitable men. The Committee is not satisfied that an adequate supply of science teachers of sufficient calibre would not be forthcoming if appropriate recruiting methods were adopted, although little consideration is given to economic aspects of the situation. Other passages in the report, however, are concerned with the quality of science teaching and with the increased demand for teachers with scientific qualifications which is likely to result from the raising of the school-leaving age, the establishment of county colleges and the implementation of the proposals of the Percy Committee on Higher Technological Education. The Barlow Committee estimates that between 1950 and 1955 an additional 5,000 teachers will be required, and the report leaves a clear impression that the supply of teachers of the requisite calibre is at present one of the major bottle-necks in the expansion of the scientific man-power of Great Britain.

The McNair Committee, reporting two years ago, came to a similar conclusion. Yet the impetus to the closer planning of university development which the Barlow Report has now given has apparently made some of the universities less disposed to accept responsibility for the general supervision of the training of teachers as recommended in one section of the McNair Committee ; though it is to be hoped that the plans for university development will include adequate provision for the establishment of schools of education and for educational research. There would seem to be real danger that nothing effective will be done and a great opportunity be missed. First things must come first, and in his fine chapter on "The University and its Region" in "Redbrick and These Vital Days", Bruce Truscot gives clear warning of the danger attending the failure to maintain standards, just as he indicates the great possibilities in the development of the regional work of the universities.

How important are those extra-mural activities of the universities is well brought out in a memorandum from Nuffield College entitled "The Further Education of Men and Women : a Task of the 1944 Education Act"*. Here again it is noted that the bottle-neck is in the supply of teachers. The memorandum excludes from its purview in general those grant-earning activities of the extra-mural delegacies of universities and of the Workers' Educational Association which have been proceeding on well-defined lines for more than forty years, and to the further expansion or development of which it may well be expected the

* Nuffield College. The Further Education of Men and Women : a Task of the 1944 Education Act. Pp. 12. (London : Oxford University Press, 1946.) 1s. net.

universities will give their first attention, whether or not they may otherwise explore the proposals for regional development outlined by Prof. B. Dobrée or Bruce Truscot. No clear distinction can, however, be drawn between the students covered by adult education in this narrower sense and that much wider field of adult education in general with which this memorandum is primarily concerned. In mental quality and interests, both classes have a great deal in common and, however much may be done to remove financial difficulties, which have been the main obstacle in the past to adult education in the narrow sense, until we achieve the long-term programme of university expansion and its results have accrued through a generation, adult education in the widest sense will remain a problem fraught with the greatest importance not merely to industrial efficiency but also to social welfare generally. As the memorandum points out, the purpose of education for adults is to enable men and women to live full and interesting lives : it must therefore be as wide as human interests, and not subsidiary to an ulterior purpose, whether citizenship or industry or anything else.

On that ground alone, the universities' tradition of service to adult education in its limited sense makes it impossible for them to disregard the wider field with which the Nuffield College memorandum is concerned, although the responsibility for the provision of further education has been placed by the Education Act upon the local education authorities. All that such authorities are at present bound to do, however, is to prepare and submit schemes of further education for their area, having regard to any facilities for further education provided in their area by universities, educational associations and other bodies, and consulting any such bodies and the local education authorities for adjacent areas. The extent of such schemes has not been defined, and there is danger that, unless the Minister's direction is early and specific, the local education authorities may confine their attention to the provision of county colleges simply because of their precise obligation. Moreover, as the Nuffield College memorandum recognizes, the chief difficulty with education for adults lies in the fact that to be vital it must remain voluntary, and that to meet the needs of a great variety of adults a great variety of service is essential. The memorandum leans to the view that the period between the ages of eighteen and twenty-five is the one most neglected by those concerned with adult education ; it is found easier to provide for the settled worker than for those on the threshold of working life. This transition period, however, is of the greatest importance, and often sets the tone for the whole of life.

The memorandum gives a concise and admirable summary of the work of those agencies which are at present attempting to provide education for adults, including that of the Arts Council of Great Britain, the Carnegie United Kingdom Trust, the Women's Institutes, some of which have themselves stimulated the demand for further provision. It should be noted that in the debate on the Army Estimates on June 27, the Secretary of State for War dealt at some length with his plans for education, and indicated his intention to identify army education as closely as possible with civil education. Again, the new provision for the education of children will fail of much of its effect if the parents are uneducated and take no interest in their children's education, particularly in the education of those who have begun to work and are attending county colleges. The increase of leisure is a further reason making the problem more urgent. All who are to take part in tackling the problems of reconstruction, both national and international, should be competent in mind and spirit to help in their solution.

The recommendations to which the Nuffield College memorandum leads fall under four main heads : accommodation, organisation, services at present provided by private enterprise, and teachers. The report is on firm ground in urging the need for more residential colleges, and for giving every encouragement to the movement for residential educational facilities which we have witnessed in the war years. Its proposals in this field contemplate that colleges serving a limited area will provide short courses of varying kinds, while those with a regional or national basis should provide longer courses. The wardens should be hosts and sometimes directors of studies rather than purely administrative officials. Investigation of the possibility of obtaining and adapting large houses and munition hostels which may come on to the market before it is possible to erect buildings specially planned for, or suited to, adult education is also recommended ; as well as a careful study of the comparative costs of erecting, equipping and maintaining new colleges for adult education in Great Britain and in Scandinavian countries. It is suggested that colleges should be situated in different types of area, usually in the country, but there should be some in or near towns which offer educational facilities and activities generally out of the reach of those who live in the country. For non-residential adult education widespread provision is recommended of rooms set aside for educational purposes, including discussion groups, provided with study facilities, and close to community centres and village halls. Centres for adult education serving a considerable area are also suggested ; they should have specialist equipment which cannot be provided in a small room, and also lecture rooms, theatres, etc.

Organisation constitutes a further need. Here the place of the university appears to lie primarily at the centres of the higher levels of adult study, such as tutorial class work, the further development of university extension courses and the arrangement of vacation courses and refresher courses for tutors. The signatories of the memorandum do not believe that the university is the appropriate body to undertake the organisation of pioneering educational work directed to repairing the failures of the national system of elementary education ; but they hope that the personnel of the universities, which often includes those with a special gift for popularizing their subject, should be as ready as in the past to assist local

education authorities and the various voluntary agencies. The memorandum looks to the joint regional authorities to survey the needs of their areas, while the local education authorities should utilize in the management of the proposed halls and rooms the most educationally alive body or bodies in the district; and they should see that the local committee of management, on which the local education authority should be strongly represented, itself represents many different types of interest.

In regard to services affecting education for adults at present provided by private enterprise, the memorandum includes the proposal that careful investigation should be made of the difficulties confronting those who wish to buy books, and that steps should be taken to secure a good book-selling service throughout the country. It is suggested that it would be of an enormous advantage if the public libraries had a first-class national system of issuing both standard annotated book lists in the main subjects, and occasional guides to matters of current public interest. In issuing the American *Quarterly Book List*, sponsored by the Library of Congress, the United States Government last year set an admirable example of what is possible in this field. As regards libraries, the memorandum generally welcomes the proposals of the Library Association for expansion and development of existing library services. It considers that there are enough agencies in existence to do what is required, given adequate financial backing. Similarly, the Arts Council or some like body should be made responsible for the provision of good repertory theatres and opera houses as well as concerts, in all large centres of population; and cinemas on repertory lines should be established, if not by private enterprise then by Government action.

It is in regard to the provision of teachers that the universities can make their most important contribution to adult education, although the difficulty of supply of teachers is less acute than in other fields. The need for teachers is, however, a primary need, and if teachers of the right quality can be obtained, they will be capable of dealing with the varied samples of the community whom they will find in their classes. The War has probably helped the supply, because in the Services so many men and women have been engaged in adult education work of one type or another. Efforts should be made to discover such men and women who have done good work in education in the Forces and induce them to continued similar work in civil life. A general attempt should also be made to attract to this work senior members of the universities and professional men and women all over the country who have some free time to devote to teaching. Both full- and part-time teachers are required, and the universities could also provide many more courses than at present exist for training teachers for such work, not only for the recognized adult education tutor, but also for the amateur.

It is in stressing the qualifications of teachers in adult education that the Nuffield College memorandum comes closest to the ideals outlined by Truscot and Dobrée, and indicates the strongest claims of such further education on the interest and support of the universities. Teaching in adult classes should not, in the view of its signatories, be restricted to those who make it their profession. The qualifications they have in mind are rather the scholar's approach to his subject, and the scholar's conscientiousness in presenting it to students. Enthusiasm is an invaluable quality, but it is not a substitute for accurate knowledge. Of such standards of quality, the universities are the chief custodians, and it is this that gives them their special relation to a system of education for adults. While they can themselves provide facilities for only a small minority of students or even of teachers, they can influence the education of all by extending the service they perform in the education and training of students, by instilling the principles of thoroughness in study and integrity in presentation and by extending the provision they make *intra muros* for research and teaching in the subjects of most importance for adult studies outside. It may well be hoped that the other calls upon the universities in their plans for re-organisation and expansion will not prevent them making this contribution to the whole quality of national life. It is, as Dobrée suggests, part of the obligation of universities to their region to fit their students to help shape the tremendous impulses of life, which, uncoordinated, reduce society to chaos. They must undertake the education of their students in values, and seek to produce men and women eager to develop the culture relevant to our emerging society.

That is true for their part in adult education no less than in their intra-mural teaching, and unless the universities are prepared to help in this way and on a much larger scale than in the past, there is little prospect of achieving that social integration and that understanding of values upon which the continuance of democracy depends. This is one overwhelming reason for the establishment of university schools of education, and for the universities accepting responsibility for the general supervision of the training of teachers and bringing training colleges into some closer relation with themselves. Some universities may well be reluctant to accept even indirect responsibility in this way for the training of some twelve thousand new teachers, and it seems likely at present that university schools of education and joint regional boards on which both the universities and training colleges are represented may develop side by side. This diversity may be no bad thing in itself, and experience should show which method is more satisfactory. But for efficient regional organisation, a spirit of drive and energy must emanate from the Ministry of Education itself, and there must be the vision displayed so conspicuously in the Nuffield College memorandum and by Prof. Dobrée. It is for such vision that the country has a right to look to the universities, and no excellencies in other directions will compensate for its absence in whatever plans for development the universities of Great Britain may in due course lay before the Lord President of the Council, the University Grants Committee or the Ministry of Education.

CULTURING ALGÆ AND FLAGELLATES

Pure Cultures of Algæ

Their Preparation and Maintenance. By E. G. Pringsheim. Pp. xii + 119. (Cambridge : At the University Press, 1946.) 7*s*. 6*d*. net.

THIS little volume comprises a letterpress of only a hundred pages, yet brings together results of more than thirty years of experience of cultural work of freshwater Algæ and Flagellata, much of which was carried out in Germany and is made for the first time easily accessible to the English reader. The portrait of Beijerinck as frontispiece reminds us of the work of one whose name is not always associated in Britain with algology. Eight other illustrations in the text illustrate effectively simple practical devices found to be useful in preparing, handling or maintaining cultures.

Most of the book is concerned with the principles underlying the methods most likely to be successful in culturing Algæ and flagellate unicellular organisms. These differ in several respects from those already well known for Fungi and Bacteria. In the majority of algal cultures, for example, the medium must be near neutrality, mineral salts must be given in considerable dilution and organic nutrients avoided owing to the danger of undue development of bacteria or other unwanted organisms. Wittepeptone, so often used for Fungi, seems to be contra-indicated for almost all Algæ. The important distinction is made between uni-algal (not necessarily bacteria-free) and 'pure' cultures, which contain only the one organism selected. The former are sufficient for many purposes and are much more easily obtained in most cases.

More specific directions with regard to culturing on agar and sub-culturing in soil-water liquid media are given for certain groups in Chapter 8, but even here the information is rather generalized in character.

Dr. Pringsheim has himself made a great advance in establishing pure cultures of many green Algæ, thus making possible a much more systematic study of the living forms. These cultures are available to anyone at moderate price, and will doubtless be in demand as they become more known. The reviewer had occasion to send for some of them. They grew well for a time, but no indication was given as to the nutrients used in the agar slopes, as is usual (and helpful) in standard fungal cultures. Indeed, in view of the frequent reference in the text to the variety of media available and the scattered nature of the literature in which these are recorded, it would seem worth while to have included for easy reference an appendix with a few specific formulæ of proved merit, giving the particular organisms with which they were successfully used. It is true that we are warned (p. 32) that "the precision advocated in many recipes is apt to be misleading" and that changes brought about in the medium by the organisms themselves may be of the first importance, but a formula gives at least a definite starting point, and it is only by a comparison of definite records of the formulæ, the manner of their utilization and the results obtained that the essentials may be discerned.

The author hopes to establish "a small research station" devoted to the study of Algæ. Perhaps, for a time, something of the kind might be attached to some existing or future botanical institute, but there is certainly a wide field for investigation.

The foreword by Prof. Fritsch is a most appropriate introduction to this pioneer work. Author and publisher are to be congratulated on the format and typography, which combine to make this a very pleasant little book of reference. E. M. DELF

ELECTRIC DISCHARGE LAMPS

Electric Discharge Lamps

By Prof. H. Cotton. (Monographs on Electrical Engineering, Vol. 12.) Pp. xvi + 435. (London : Chapman and Hall, Ltd., 1946.) 36*s*. net.

DURING the last fifteen years electric discharge lamps have been developed to an extent which makes them now a commercial product of the first importance. Uyterhoeven published an excellent survey of the subject (Julius Springer, Berlin, 1938), but there is no English translation and his book is already partly out of date. Prof. Cotton's book, the first in the English language, is therefore to be welcomed. It has been written mainly with the requirements of the electrical and the illuminating engineer in mind.

About two thirds of the volume are taken up with fundamentals necessary to an understanding of discharge lamps. Thus radiation and thermionic emission receive brief treatments ; the structure of the atom and atomic spectra occupy some ninety pages ; discharge phenomena and the motion of particles in the discharge are dealt with in two chapters totalling some sixty pages. There are also chapters on fluorescence and on colour and its assessment. The discussion of discharge lamps themselves and the problems involved in their operation occupy two chapters totalling 175 pages, or considerably less than half the total book.

That so much space is concerned with material preparatory to dealing with the lamps themselves raises an interesting question. In many books, a large part of the space is occupied with elementary discussions of fundamentals easily to be found in other places. This is not necessarily a fault, for it is useful to have the subject more or less complete between one pair of covers. Proper balance should, however, be maintained, and there would seem to be two criteria as to whether the practice is justifiable : the material should be restricted to that which clearly relates to the main subject, and its treatment should be concise and should bring out strongly the principles which are actually required. Prof. Cotton could have been more successful in this respect than he has been : more could be said in less space if the important aspects of the fundamental treatment were stressed and unnecessarily lengthy discussion curtailed. As an example : an elementary understanding of spectra in electric discharges does not need the long discussion in Chapter 8 on elliptic orbits ; and after this long discussion, the reader will still probably be puzzled to know how the separation of the s, p and d levels is to be accounted for. There is moreover, throughout the book, a fair number of mistakes and some confusion, although fortunately not of the kind which will seriously worry or mislead the type of reader for whom the book is intended.

However, after these criticisms, there is still much to be praised. Prof. Cotton has conscientiously collected and presented most of the available informa-

tion relating to the important types of commercial discharge lamps, and a pleasing feature of the presentation is the large number of photographs and figures (216 in all) with which the book is provided. The engineer interested in discharge lamps will find the reading both interesting and informative. If he wishes to go more deeply into the subject, sufficient references are given to allow him to extend his reading without difficulty. V. J. Francis

EPIDEMIOLOGY FOR PLANT PATHOLOGISTS

Pflanzliche Infektionslehre

Lehrbuch der allgemeinen Pflanzenpathologie für Biologen, Landwirte, Förster und Pflanzenzüchter. Von Prof. Ernst Gäumann. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 3.) Pp. 611. (Basel: Verlag Birkhäuser, 1946.) 48.50 Schw. francs.

BEFORE welcoming Prof. Ernst Gäumann's comprehensive "Pflanzliche Infektionslehre", a brief obituary notice of the passing of the older type of plant pathology text-book would be a graceful acknowledgment of its period of usefulness, now drawing to a close. The days of the encyclopædia of individual plant diseases are numbered, even for the undergraduate student of plant pathology. Such an encyclopædia is now of little use to the professional plant pathologist, who has at his disposal a rapidly increasing number of monographs about special groups of plant diseases, and even about single individual diseases, written with an authority that no compiler of an encyclopædia can possibly command.

"Pflanzliche Infektionslehre" is essentially a book written by a plant pathologist for plant pathologists. In his preface, Prof. Gäumann tells us that his book is the outcome of twenty years of lecturing to students at the Eidgenössischen Technischen Hochschule in Zurich; he might have added that it is also the result of a wide research experience in plant pathology. The book is divided into six chapters, which deal in turn with infection, epidemiology, parasitic specialization of pathogen, susceptibility of host, ontogenetic development of disease and control methods. Chapter 1 (100 pp.) is concerned with the mechanism of plant infection by fungi, bacteria, viruses and phanerogamic parasites, and with the effect upon it of environmental conditions and concentration of the parasite. A consideration of the various types of infection court follows, and the remainder of the chapter is devoted to the further invasion and spread of the parasite within the host (for example, localized and systemic infection, etc.). This chapter constitutes perhaps the best, and certainly the fullest, account of the physiology of parasitism to be found anywhere. Chapter 2 (110 pp.) follows logically with an account of epidemiology, dealing in turn with sources of infection (infected host plants, saprophytic phases and dormant survival organs of the parasite), and with transmission of inoculum by seed or vegetative propagation of the host, by mycelial growth through the soil, and by wind, water, animals and human agency. After a disquisition on annual and secular periodicity of epidemics, nine conditions for development of an epidemic, and three for its subsequent decline, are discussed. Chapter 3 (80 pp.) deals with parasitic specialization of the pathogen, and with its alteration through the various mechanisms of nuclear segregation, heterokaryosis, cross-breeding, mutation, etc. The chapter concludes with a discussion of the various hypotheses put forward to account for development of parasitic specialization.

Chapter 4 (222 pp.) is the longest in the book, and the slight trepidation with which the reader may embark upon it is not diminished by the formidable array of main headings (five), section headings (seventeen) and sub-section headings (thirty-four). The chapter is divided into two main parts, the first dealing with inherent susceptibility, and the second with the influence of the environment upon susceptibility. In the first part, passive defence mechanisms are discussed under the headings of disease escape, resistance to penetration, and resistance to spread within the invaded host. Active defence mechanisms are next considered under the headings of plasmatic reaction (controlling infection by nodule bacteria of legumes and by mycorrhizal fungi), necrogenous or hypersensitive reaction (for example, varieties of wheat immune to rust), and quasi-immunity reactions induced by previous inoculation (for example, for certain plant viruses). A further distinction is drawn between active defence reactions to the parasite, and those to its toxic growth products; under the second category are discussed histogenous demarcation of infected tissue (for example, abscission in shot-hole disease of peach and demarcation by cork layer in black root rot of tobacco), and gummosis demarcation (for example, silver leaf disease of plum). In the second part of Chapter 4, predisposition of the host plant to disease is discussed under the headings of ontogenetic drift in susceptibility, and the influence of nutritional and other environmental factors, including injuries and pre-existing infections, upon susceptibility.

Chapter 5 (48 pp.) treats of the ontogeny of the individual plant disease, which is discussed under the headings of teratology, pathological anatomy and histology, and pathological physiology. Chapter 6 (5 pp.) on control measures is so brief as to come as a slightly comical anticlimax to the rest of the book; its arrangement seems perfunctory by contrast with the logical development of the five preceding chapters, to the completeness of which it adds little or nothing.

Plant pathologists will find much to argue about, as well as to admire, in "Pflanzliche Infektionslehre"; but this is inevitable, and indeed highly desirable, in a work of this kind. The interpretation of host resistance phenomena, in particular, is highly controversial, and barriers of cork and gum may not be always what they seem. Again, some plant virus workers will dislike Prof. Gäumann's analogy between the barberry as alternate host for wheat stem rust, and aphis vectors as alternate hosts for certain plant-infecting viruses; multiplication of the virus in the insect vector has been freely implied, but not yet proved. Disagreements of this kind, however, can in no way detract from Prof. Gäumann's great achievement in producing a timely and extremely stimulating book. The clear and orderly arrangement of the text will facilitate use of the book for reference, and its value is much enhanced by the inclusion of 90 tables, and 311 graphs, line drawings and half-tone illustrations (some of which have suffered in reproduction). There is a good bibliography and a general index. By omitting to provide an author index, Prof. Gäumann has disdained the customary sop to the vanity of contemporary research workers, but this may assist them to a more deliberate judgment of his book. S. D. Garrett

CIVILIZATION AND THE PURSUIT OF KNOWLEDGE*

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

Science and Invention

SCIENCE as the spirit of questioning is neither moral nor immoral; and its justification is in the accumulation and co-ordination of knowledge. A scientific discovery is an addition to knowledge; and an invention is an additional use of knowledge. On the principle that "Necessity is the mother of invention", the atom bomb was manufactured as a devastating weapon of war; but it should not be assumed that scientists, any more than other groups of people, desire to be associated with the prostitution of knowledge in any form.

When man began to accumulate experience of the properties of natural things and to apply it for his own purposes he rose above all other living creatures and began to weave the fabric of civilization. By his discoveries, he became possessed of knowledge which he is as free to use now as he always has been to distinguish between what is good for his existence and what are poisonous products of the world around him. From birth to death he has to defend himself against the many natural enemies which surround him wherever he is, or submit to be destroyed by them. He entered the world as a child beset with dangers, and under primitive conditions of life is still a victim of their aggressions.

Civilized man has, however, become a giant in his powers of meeting these attacks of natural things and forces, and has learnt how to subdue and overcome some of them, though they still demand the sacrifice of millions of human lives annually. With this knowledge has come the creation of artificial devices of destruction as antagonistic to the development of the human race as the natural processes over which a certain measure of control has been acquired. While man has been learning how to control Nature, he is still in the position of a child in his attitude and outlook towards the dangers which now encompass him, and has not realized that his duty is to overcome them, as he has always had to do to survive the perils of the natural world in which he is placed.

This world has agents of destruction far more ingenious and effective than any contrivances devised by human inventors. Man has, however, not been content to submit to suffer disease and death from these natural enemies but has battled with them, and scientific knowledge has given him the power of conquest over many of them. The same spirit is required to meet and avert the dangers to civilization created artificially, instead of pleading pathetically that they ought not to be put within his reach because he is still a child in wisdom.

At every stage of civilization there have been conflicts between communities for one reason or another, and all available resources of men and material have been used by the adversaries for their armed forces. This is as true of the weapons and machines used in warfare by primitive peoples as it is of those which have been placed at the disposal of the modern world by applications of scientific knowledge to invention.

War has always been an incentive to the use of devices to subjugate opposed armed forces; and the weapons employed have reflected the position of the industrial arts. These have advanced with knowledge of the natural properties of things, from the time when prehistoric man found that he could make cutting and piercing implements from flints, and thus started a new industry, through the bow and arrow period to gunpowder and modern high explosives to the atom bomb. It is for leaders of nations to determine among themselves whether their hearts are strong enough to make the splitting of the hearts of atoms a means of improving conditions of life on the earth and the beginning of a new era, or utterly to destroy what faiths and works have achieved in the history of civilization.

Though the machine age is regarded as having begun in the eighteenth century, the foundations of it were laid ten centuries earlier through the general use of the Latin language and the institution of monasteries in which labour was combined with devotion to high ideals in the shaping of what has become modern European or Western civilization. The distinctive feature of the present epoch is the harnessing of natural sources of energy to do work instead of using the physical powers of human beings and domestic animals to accomplish it. The inventions of the eighteenth and early nineteenth centuries came from the workshop rather than from the scientific laboratory, though revolutionary social and economic developments were brought about by them. Discoveries of science were used in those prosperous times with as much indifference to science as to humanity. There was then no moral indignation, such as is now often expressed, against mechanisms as degrading elements in civilization and destructive of spiritual goodness.

It is natural to long for a more peaceful and less-exacting condition of life than that which prevails in most modern cities and towns in this age of speed, hustle and noise; but there is no historical evidence to prove that before the machine age labouring people in large communities were any happier than they are to-day. The primary needs of human life are food, clothing and shelter, and in the search of them man follows instinctively his animal instincts. He may be contented when these wants are supplied from natural or national resources without undue effort, but his condition is that of the beast in the field or a cave-dweller of prehistoric times. Civilization begins when intelligence is used to increase these resources and to construct a cultural pattern, however primitive this may be.

Whenever natural sources of energy are made available for mechanical work by the use of wind or water power, or combustion of coal or oil, slave labourers of giant strength and untiring capacity enter the service of man and enable higher standards of living to be attained. It is not suggested for a moment that developments of this kind necessarily increase happiness or represent more than a single factor capable of contributing to progressive human welfare. As, however, man has a mind and the unique power of making useful or decorative things from the materials and forces in the world on which he is placed, it must be his duty to bring these gifts and talents into operation.

Languages of Expression

When humanity emerged from its sub-human ancestry, its inherited instincts began to have their impulses determined by a reasoning faculty and it became possible to acquire and accumulate knowledge to be handed down from one generation to another.

* Continued from page 118.

In this respect, therefore, the human race can be said to mark a distinct stage in the evolution of life, and its advances in any direction to represent progress.

All such advances originate in new concepts or ideas which may or may not take material shape. Every new idea is, however, a stimulus to further intellectual expansion or practical endeavour, and civilization is the record of their development. Measured by the means of increasing the material welfare of mankind, science and invention may claim always to have led the way. The laws and principles they discover and apply are additions to knowledge by which conditions of life can be improved in this world during the short period of occupation by the human race. What is our destiny here we do not know, but while we are alive it is our obvious duty to do everything in our power to raise standards of living and find out at the same time the relation of our small planet to the many millions of other bodies in the universe.

The moral law is apprehended by a different set of experiences from that of natural science. Recognition of its influence as well as of the utility of knowledge determine together the progress of civilization. In each case the aim must be the attainment of the highest good on this earth whatever the ultimate destiny of the human race may be. Goodness, truth and beauty are abstract ideas appealing in diverse ways and tones according to attitudes of mind, but appreciation of their qualities is not excluded from the field of natural science any more than it is from other factors which constitute human progress.

Intellectual expansion and the forms in which it is expressed are distinctive attributes of human nature and elements of progressive development. When the Sumerians became urbanized nearly five thousand years ago, they found it necessary to introduce seals and clay sealings as guarantees of authenticity of commercial contracts and legal obligations. With these seals they developed a system of pictographic writing on clay tablets, which evolved into the cuneiform script. As the temple was the centre of the Sumerian civic organisation it was also, through the development of writing, the cultural centre where knowledge was accumulated and used. The inscribed seal had a most important effect on the development of art, while the necessity for a dignified and fitting home for the god led to advance in style in building worthy of the name of architecture, to which the use of mud-brick could have contributed in no other way.

Drawings provide a universal means of representing objects, and their characters also convey individual or composite emotions and meanings. Many early forms of writing are conventional characters developed from pictographs of this kind; and out of these conventionalized marks alphabets were constructed or characters were combined to represent syllables. All human beings express certain emotions, such as anger and fear, by much the same sounds, signs and gestures, and all can interpret simple picture writing, as all can understand the meanings of actions reproduced in modern moving pictures, silent or sound. There are, however, many conventionalized forms of characters to represent these sounds and thoughts by written or printed words, and these combinations make up the many languages of the world.

Pictographs or ideographs thus evolve into symbols representing gestures and sounds and then to alphabets, the letters of which are combined in words to convey ideas from one place or time on the earth to another, however far or long they may be separated. Sounds were combined to express emotional feelings in the earliest civilized times; but the history of the art of music cannot be traced like that of literature because no musical compositions from those times have had their forms or contents preserved.

While, therefore, the contribution of a people or a period to the expansion of the human mind can be found in its literary records, and comparisons made between them on a scale of refinement, there is no clear relationship between early and modern practices of the musical art. The melodies of primitive peoples to-day do, however, afford an indication of rudimentary combinations of sounds; and this folk-music has its own standards of excellence. Progress in music as an art, like that of literature, is in the exalted combination of the notes of a chromatic scale into a composition which arouses in its readers or listeners the emotional feelings which their writer wishes to convey. Fertility of creative ideas and the forms to which these give shape are the measures by which progress in all these arts of expression may be judged.

Increase of opportunities to read and hear what is thought or said in words or music is of even greater importance in the history of civilization than the works themselves. This began with the production of books in which raised letters or other characters were impressed upon the pages with ink or other pigment. Much of the early printing was done with page-blocks of this kind; and the same plan is adopted in printing from stereotyped plates of pages to-day. The use of movable type was first introduced by a Chinese alchemist and inventor, Pi Shêng, in the eleventh century. He used type made of baked clay and experimented also with wooden type. A later improvement made in China was to use tin for the movable type. Early in the fourteenth century movable types were made in Europe of wood, tin and lead, but the modern art of typography may be said to have begun when in 1454 Johann Gutenberg issued from his printing press at Mainz, books printed from types cast in a mould.

From a cultural point of view the value of the invention was in the extension of opportunities of acquiring knowledge through book-learning. There were literary works and libraries in Assyria, Babylonia, Egypt and China in very early times, but each had to be separately written by hand. A book is a collection of scripts joined together to form an organic whole so as to be portable. The first books may thus be said to be those written on papyrus in ancient Egypt. Several rolls of this kind, with columns of hieratic writing done about 2500 B.C., have been found in tombs and are preserved in national museums. They are samples of many early Egyptian writings of a didactic and moral character, apart from religious spells and praises of the divine. Most of this secular and sacred literature preserved on rolls of papyri were made for school use by young scholar-scribes. There were wonder-tales, romances, humorous and gruesome stories, moral admonitions, types of worldly wisdom and rules of devotional conduct towards divine influences, in the East five thousand years ago, as characteristic of human life and its spirit as is the literature of classical and modern times.

The invention of mechanical printing, and the use of paper instead of papyrus, made it possible to produce the many millions of books now in libraries and for the knowledge and wisdom of all peoples to be

distributed throughout the civilized world. It is in the extension of this intellectual influence and the continuous development of processes of reproduction that the art of printing has reached the high position as a cultural force which it occupies to-day.

In so far as art, literature and music are expressions of the human spirit as well as reactions to conditions of life, any agency which multiplies their points of contact may justly be said to aid the progress of the race by expanding the outlook. This is what was done when printing presses converted the small corps of transcribers into a great mechanized force in the front line of civilization. The advance was in apparatus for manifolding literary compositions and thus giving wider range to the light of the torch of learning.

World Services

The value of devices for reproducing words and sounds, written or spoken, lies, therefore, in the increased contacts between human minds, and the measure of truth attained in the reproduction. This has reached a high degree of perfection through the combination of mathematical theory and physical experiment ; with the result that broadcasting truly brought about a condition when "Their sounds went out into all the earth, and their words unto the ends of the world". These developments began with the invention of means of producing and detecting electromagnetic waves other than those in beams of light and transmitted with the same velocity of 186,000 miles a second. What has since been achieved so impressively is due to the use of increased power to create such waves, and increased sensitiveness of instruments to detect and reproduce their qualities. This has been made possible through the increase of knowledge of the atomic structure of matter in relation to the energy of electric waves. The electrons contained in the atoms of all forms of matter were found to be identically the same, and when these are torn off by thermal or electrical influence they constitute a stream of invisible particles which travel with the speed of about one tenth of the velocity of light.

The basis of all systems of radio transmission of sounds or scenes is the production of electrons and the detection of their effects. In a radiolocation equipment, the particles create pulses of waves which are reflected by objects in their path, as sound-waves are reflected in echoes. Though the interval of time between the dispatch of the waves and their reception is extremely short, it is clearly shown on the time-scale of the apparatus used and becomes a scale of distance. As radio-waves are reflected by obstacles of any kind, they can be used in darkness as well as daylight, in thick fog or other obscuring atmospheric conditions, as light to show whether the way is open or not. Radiolocation, or 'radar' as it is now termed, has thus given civilized peoples new powers of electric vision which are already being used to ensure safety of movement on the sea as in the air, in addition to the detection of small or distant enemy aeroplanes and submarines, for which purposes the instruments used were designed and applied with conspicuous success.

All mechanical aids of this kind, whether phonographic or photographic, are often referred to contemptuously as scientific gadgets which are, on the whole, detrimental to progressive spiritual development. It is suggested that because they are created by man's own efforts, without appeal to supernatural influences for guidance or reference to religious faith, pride in them is to be deplored rather than encouraged. By the same token, the natural machine power of modern times is regarded as a failure, and a return to supernaturalism is urged as the only means of shaping a new and better world.

To assume such an attitude towards civilization is irrational and puts two different standards of value in conflict instead of regarding them as complementary to one another. It surely must be the duty of man to learn as much as he can of the material universe, and of the earth upon which he has to live : and it cannot be wrong for him to discover and apply knowledge of natural properties and forces, whether these are understood as having been created for his service or not. To condemn such knowledge as having a numbing effect upon aspirations of the human soul, and the machine age as a degrading period in the upward growth of mankind, cannot be justified either historically or rationally. What is wanted to-day more than at any other epoch of civilization, because of the powers which have been placed at the disposal of civilized peoples, is the strengthening of the human heart everywhere to act upon the principle of brotherly kindness, contained in the maxim common to all religions and ethical systems : do not unto others what you would not they should do unto you.

Civilization and Ethics

Civilization is essentially distinguished from barbarism, and man from other living creatures, by the effects of high spiritual ideals upon human conduct. Many of these ideals are common to all peoples, and the values attached to them determine both individual and social endeavour. The standard of attainment reached by a human society towards all elements of 'goodness' is a measure of the place of the society in a civilizing process. The pursuit of natural knowledge may claim to be one of these ennobling elements, as it leads not only to means of improving conditions of life but also to a broadening of man's intellectual and social horizons. Devotion to these objects, courage of enterprise, faithfulness to truth and humility of understanding represent the spirit of science as truly as they are combined in other fields of thought and action. The relation to moral goodness of the results achieved depends mainly upon the attitude taken towards natural knowledge and supernatural revelation.

As ethics is the science of morals in their widest sense, it is concerned with the influence of each of these attributes upon the character of the individual and the structure of society. What man is in himself, and what are standards of moral righteousness, have varied greatly with cultural conditions in the history of civilization. A system of ethics, or rules of conduct, by observance of which conduct in life is brought into harmony with cosmic principles, is a part of all religions and is associated with many conceptions of deities and conventional forms of worship. In all ethical systems, as in all high religions, certain elements of human goodness or virtue are esteemed, and attachment to them is a measure of righteousness of life.

Socrates taught that in itself right "knowledge is virtue" ; but it was Aristotle, the greatest of the Greek naturalists, who held that happiness or goodness, which in the individual means 'well-being' and to the community 'well-doing', should be the aim of an ethical system. His knowledge of natural history was copious and comprehensive, and he used it to

co-ordinate what was thought or known about living things into a science, while at the same time he showed that appreciation of truth and beauty in Nature does not impair promotion of the quality of goodness of a way of life. The ethics of human conduct taught by Confucius two centuries earlier constituted a similar code of practical morality in a civilization which takes a high place in the history of man and his works.

The highest type of social organisation is that in which both material good and ethical goodness are rightly balanced. As material progress must in its nature be more striking, more patent to observation, than progress in man's ethical and social development, there must always be a lag in time between the operations of the two forces. The idea that the scientific and inventive mind is necessarily antagonistic to the merciful heart is as degrading to knowledge as it is untrue of the virtue of goodness. The gap between application of the two qualities is due to the selfish sides of human nature, and not to the increased power and supplies which knowledge provides for the primary needs of life.

It is permissible to indicate how this knowledge could be used in the construction of a new world, whether for better or worse, but no one believes that improvements of material conditions can be made a measure of ethical goodness. This, however, is what is asserted to be the position occupied by science in visions of the development of the human race in the past, present or future. It is the basis of a charge that advances in natural knowledge are inimical to the growth of the noblest attributes of the spirit of man. We have had, therefore, literary pictures of machinery being developed to such a dangerous stage that it had to be abolished, and on the biological side to conceptions of a world of planned types of inhabitants, each, like social communities of insects, with intellectually deadening functions to perform.

Literary works of this kind are parodies or satires of potentialities of applications of knowledge, and in no way represent a scientific view of the factors which have enabled man to survive and reach his present position. It is true that, by the release of atomic energy, modern civilization has been provided with the means of destroying itself, but the same power is available for making the earth a celestial dwelling place, just according to the service to which it is put. There is now, as always, freedom of choice between good and evil fruits of knowledge; and the ways in which these are cultivated or controlled will be the reply to the menace now facing civilized peoples. All who have goodness in their hearts and goodwill towards their fellows should unite in meeting this challenge to movement onward and upward.

Progressive Humanism

Faith in this spirit, in whatever way it is promoted or manifested in the works of man, is often regarded as presumptuous pride in his creative and constructive capacities and therefore irreligious in the sacred meaning of the word. The spirit is, however, associated with all aspects of intellectual and material progress which have influenced the course of civilization. Devotion to it is the religion of secular or scientific humanism, because its principles do not include knowledge of the supernatural and relate only to the practical application to life of the favourite Christian maxim of the British monk, Pelagius, "If I ought, I can".

Humanism in this sense is the integration of all influences which promote the development of the human race, whether associated with the teaching of a particular religion or not. Principles or practices which raise man out of his animal ancestry and add to his status among living creatures can rightly be termed humanistic. Their spirit is displayed in works of science as well as in art and literature; and the measure of their value is that of the opportunities these afford for improving human welfare on the highest standards that the mind can conceive and the heart will sanction.

Whatever convictions are held about the meaning and purpose of man's existence, he finds himself on a globe from which he has to obtain the needs of life, and also with a mind which can appreciate such abstract qualities as beauty and love, goodness, justice and mercy, whether seen on the earth or projected on the heavens. Modern humanism takes account of all these factors of cultural development, secular or sacred. It understands very clearly that the earth is but a temporary home, not only for the short span of individual life, but also for the whole human race. As tenants or trustees our duty is to make the best use of the resources of our heritage by the exercise of all our talents, and with the belief and hope that by so doing we are contributing to make men god-like if not godly in the sense of religious faith. So may the earth be made a part of the heavens of the universe in spirit, as it is in truth.

DEFENCE AGAINST THE ATOMIC BOMB

THE news of any further increases in the effectiveness of the atomic bomb would at the present time be received with universal disgust or indifference. The discovery of a successful defence against it would occasion equally universal satisfaction and relief. It may be doubted whether the distribution of the world's expenditure on research between the two aspects of the subject—offensive and defensive—takes account of this world-wide prejudice in favour of survival. The publication of the recent report of the British Mission to Japan*, with its unequivocal emphasis on the defensive point of view, is therefore doubly welcome, first as indicating that the British Government does not necessarily subscribe to the view that no defence is possible, and secondly as providing a starting-point for any defensive investigation.

The plain fact, plainly stated in the report, is that an atomic bomb of power equal to those dropped in Japan, if used without warning on a large city of European construction having an average population density equal to that of London, would kill about 50,000 people, and would start fires numerous enough to be uncontrollable over an area of several square miles. The consequences of such an 'incident' can be traced in some detail, but detailed knowledge is not required to grasp the magnitude of the catastrophe.

It must apparently be assumed that a defence by counter-attack on the weapon itself—for example, by a device causing detonation before the target is

* The Effects of the Atomic Bombs at Hiroshima and Nagasaki. Report of the British Mission to Japan. (Published for the Home Office and the Air Ministry.) Pp. vi+22+24 plates. (London: H.M. Stationery Office, 1946.) 1s. net.

approached—is not feasible, and on this ground various statements have appeared that no defence is possible. No device of this kind exists for exploding ordinary bombs, but even the most convinced advocate of strategic bombing would not assert on that account that some defensive measures are not both possible and necessary.

Defence against every weapon must be based on its limitations. The extraordinary power of the atomic bomb may suggest that its potentialities are unlimited ; but such is not the case. At present, its limitations appear to be three-fold : (i) it has a minimum size, and this size is, compared with other bombs, enormous ; no small atomic bomb is possible ; (ii) it is extremely expensive ; only a nation of great industrial power can hope to produce atomic bombs in substantial numbers, even in the absence of international control of the necessary materials ; (iii) if the bomb is detonated at the height required to effect maximum structural damage (as was done at Hiroshima and Nagasaki) quite elementary shelters like the 'Anderson' can be made to provide adequate protection against blast. While no direct evidence exists, it is possible that underground shelters generally would only be demolished within a comparatively limited area, even if the bomb were detonated at ground-level or below. These limitations are not removed if the bomb is made still more powerful, unless at the same time it becomes either easier to manufacture or capable of being detonated in smaller quantities.

Against some societies, then, the atomic bomb is almost useless. Consider, for example, an army, widely dispersed in trenches and dugouts, and provided with an adequate warning system. An attack by atomic bombs would, no doubt, cause some casualties by 'flashburn', although even ordinary clothing appears to offer substantial protection against it, and some would die of 'radiation sickness'. The latter, however, would not become ill for a week or so after the event, by which time the battle might be over. (This comparatively long time-lag suggests to the layman that further research may lead to a decrease in the proportion of deaths among those exposed to gamma radiation.) There would be few blast casualties if the troops were not housed in buildings liable to collapse and bury them. Possibly there might be some psychological reaction, but the experience of the last six years suggests that the survivors of a terrifying, but ineffective and short-lived, attack experience not depression but rather the reverse. The commander of an attacking force would scarcely expend his precious bombs on so unrewarding a target, and the slogan which circulated in Britain during the blitz period, "Safety first—join the Army", would, in an atomic war, become almost the literal truth. Similarly rural areas, villages, and small towns are uneconomic targets, and can be regarded as practically safe.

It is on these lines that a defensive strategy must go forward. The total 'war potential' which goes into the manufacture of an atomic bomb, conveniently measured in terms of electric power, has not been made public, but is certainly large. (The Smyth Report states that to make 1 kgm. of plutonium in one day takes a power supply of the order of one million kilowatts—half the ultimate capacity of the Grand Coulee power plant—and that a bomb requires several kilogrammes of plutonium.) An accurate estimate of the total expenditure involved, taking into account both the supply of raw material and the industrial effort in manufacture, must now be available to the authorities. They can also estimate the proportion of 'potential' bombs which never reach the target, as a result of interference, either with the processes of manufacture or during the final stage of delivery. They are thus in a position to specify the 'minimum economic target', let us say the least important town against which atomic attack is just worth while. To do so they are forced to set a value on human life in terms of the industrial effort of the enemy ; but this disagreeable necessity arises often in war, and they have not a few precedents to guide them.

It is always argued, by the protagonists of any offensive weapon, that to balance the effort expended by the attacker against the damage inflicted on the defender is incorrect. There is, according to them, a large but imponderable 'morale' effect which should be taken into account. No doubt the element of surprise does give a psychological value to a new weapon the first few times it is used, but there is not the smallest evidence that any such effect persists for a longer period. The Ruhr continued to function until it was materially destroyed. The economic effects of bombing in Great Britain were no greater, indeed in many cases they were less, than would have been expected on a basis of purely material calculations.

Given a definition of the 'minimum economic target', the government of a country threatened by atomic warfare could proceed to plan accordingly. A few industries in which concentration is essential, and of importance so great that they form valuable targets in themselves, might go underground, where they would be difficult both to find and to attack. Evacuation of large cities would be carried to an extent never before considered. The city-dweller would have to be accommodated, not in the houses of the countryman, but in temporary or camp towns of the kind which sprang up with miraculous rapidity at the time when the forces for the invasion of Europe were massing in Great Britain, and which would be not simply dormitories, but centres of a still more diffuse and decentralized industry. Obviously the problems presented vary widely with the structure of the nation attacked. They are most difficult for the highly industrial and densely populated countries of Europe ; but simple to the point of being non-existent for scattered rural and agricultural communities.

The aim of the defender must be to allow, or even to encourage, his enemy to expend all his efforts in accumulating an ever-increasing stock of atomic bombs, without ever offering a suitable opportunity for using one. Whether this ideal could be achieved depends on the size of the 'minimum economic target' and, writing without official information, only the wildest guesses as to this quantity can be made. To the writer it seems that a town of 20,000 inhabitants provided with small shelters of the Anderson type or better, and equipped with an adequate warning system, would be a poor target for an atomic bomb. (The rate of progress in radar suggests that a few minutes warning of the approach of even the fastest rocket projectile may not be too much to ask.) Further, the increased use in the future of the framed multi-story construction, to be advocated both on architectural grounds and for blast resistance, might do much to solve the problem of rehousing, which even in a town of population 20,000 would be very serious.

The view is often expressed that atomic war would be the end of civilization. No doubt it would be the end of the colossal sprawling cities which at present deface the horizon of the industrial nations. The inherent badness of such cities is being increasingly recognized, and their doom is sealed even if the threat of war becomes so remote as to be inconsiderable. But there is no reason to suppose that our civilization depends for its life on the existence of the big city. Room could be found for the present population of Great Britain within the present area, in towns none of which exceeded the 20,000 limit, and none of which was closer than five miles from its neighbours. Two hundred years ago there was not a town in Great Britain, with the exception of London and perhaps one or two others, large enough to be considered as an atomic bomb target. But it is at least arguable that in some respects the civilization of that period was not inferior to our own.

D. G. CHRISTOPHERSON

LIFE AND THE SECOND LAW OF THERMODYNAMICS

By DR. J. A. V. BUTLER

Courtauld Institute of Biochemistry, London

WHETHER life processes obey the second law of thermodynamics or if life finds a way of evading the otherwise universal dissipation of energy has been something of a puzzle for a century. Kelvin left the matter open in his formulation of the Second Law, by expressly excluding the operations of 'animate agencies'. Since then, opinions on both sides have been expressed, although a majority would probably be found in favour of the view that any local increase of 'free' energy is compensated by a greater amount of dissipation elsewhere, or as Schrödinger has recently put it[1] in picturesque if somewhat inaccurate language, the organism feeds on 'negative entropy'. On the other hand, G. N. Lewis[2] referred to living organisms as "cheats in the game of entropy", which "alone seem able to breast the great stream of apparently irreversible processes. These processes tear down, living things build up. While the rest of the world seems to move towards a dead level of uniformity, the living organism is evolving new substances and more and more intricate forms."

The matter has been dangerously simplified by many writers by an over-emphasis of the entropy factor[3]. Clausius's statement that the entropy of the universe tends to a maximum, combined with the rather loose identification of entropy with disorder, has led to the formulation of the second law as a universal tendency towards disorder. The fact is that a decrease in disorder can be compensated by a decrease in energy, as when a liquid freezes. The most convenient formulation of such tendencies in limited systems is that the Gibbs free energy decreases in all spontaneous changes at constant temperature. This quantity is expressed by

$$F = H - TS,$$

where H is the energy or, more strictly, the heat content and S the entropy.

My attention was somewhat forcibly drawn to these matters by observing the growth of fungi such as *Penicillium notatum* in flasks. There is no question here of the absorption of energy from light as in plants. A few spores of the fungus placed in a closed vessel in the dark in a suitable nutrient medium, such as the Capek–Dox solution, containing merely sugar, nitrate, phosphate and small quantities of a few metallic salts, become in the course of a week or two a highly complex mass of living tissue. For example, Steinberg showed[4] that the dry weight of the tissue formed with *Aspergillus niger* was frequently equivalent to 52 per cent of the total amount of sugar supplied.

Apparently a considerable increase in the complexity of the contents of the flask has taken place. The question I wish to ask is whether the 'spontaneous' change which has taken place under the influence of the spores is in accordance with the Second Law or not. To put it concretely, if the flask is kept at constant temperature and nothing enters or escapes, is the free energy at the end greater or less than the free energy at the beginning ? An exact answer to this question obviously involves a complete knowledge of the final contents of the flask. If a detailed analysis were available we might conceivably draw up a free-energy balance sheet. Since that is clearly impossible, we can only make simpler and incomplete tests. The essential substances which have to be elaborated in growth processes are proteins, so the most appropriate question to ask is, What is the free-energy change in the elaboration of a protein ?

Soluble proteins have been isolated having a great variety of molecular weights, from 18,000 for ribonuclease to 8,000,000 in hæmocyanins. The crystallization of native proteins, their X-ray patterns, their high specificity and the ease with which they are denatured (that is, disorganised) show them to be structures with a high degree of order. The nature of this organisation is not definitely known; for example, whether the amino-acid residues are arranged in linear arrays or in flat or closed surfaces. However, the exact nature of the organisation is immaterial for the present purpose; we need only suppose that the protein molecule is a definite and unique arrangement of the constituent amino-acids.

Experimentally, the determination of the free energy of a protein would involve establishing an equilibrium between it and its constituents. No such equilibrium has ever been observed, and all the facts indicate that the concentration of protein in equilibrium with amino-acids is vanishingly small. Furthermore, although one or two cases of reversible denaturation of enzymes have been reported[5], these almost certainly involve only limited changes in the molecule and not complete disorganisation. It would appear that equilibrium in the process

Native protein $\rightleftarrows$ completely denatured (disorganised) protein

is overwhelmingly on the side of the latter.

One important factor in the entropy of the protein molecule will be that involved in assembling the residues into one particular pattern, out of the many millions of possible arrangements. This quantity, which we may call the configurational entropy, is easily calculated. Suppose that the protein molecule contains altogether N amino-acid residues, made up of N_1 of type 1, N_2 of type 2, etc. The number of different ways in which these can be arranged in a *linear* array is

$$P = N!/N_1!N_2!, \text{ etc.}$$

which, for reasonably large values of N, can be evaluated as

$$\log P = N\log N - \Sigma N_i \log N_i.$$

This expression is for an assemblage having a co-ordination number two, but the values of P for other types of co-ordination are probably not significantly different. (For this information I am indebted to the late Dr. W. J. C. Orr.)

The configurational entropy of the protein, arising from the fact that the protein is one out of numerous possible arrangements, is $S = -R \log P$, so that we have for the configurational entropy per amino-acid residue :

$$\frac{S}{N} = -R \log_e N - R \Sigma \frac{N_i}{N} \log_e N_i.$$

In the case of pepsin, for example, N is approximately 300, so that the first term in this expression amounts to about — 11 entropy units (cal./deg.) per residue. This would be the configurational entropy of a protein made up of 300 *different* residues. In pepsin the largest quantity of a single amino-acid is tyrosine, present to the extent of 10 per cent, for which the second term amounts to about 0·7 entropy units. If there were ten amino-acids each present to the extent of 10 per cent, the second term would amount to — 7 entropy units, and the configurational entropy would be about — 4 units per residue. The following table shows the configurational entropies calculated in this way for molecular weights between 35,000 and 3,500,000 and on the assumptions of (1) ten different amino-acids each present to 10 per cent, (2) twenty different amino-acids, 5 per cent of each in the molecule.

M	N	$-R \log_e N$	$-R\Sigma \frac{N_i}{N} \log N_i$		$-\Delta S$	
			(1)	(2)	(1)	(2)
35,000	300	11·3	6·8	5·5	4·5	5·8
350,000	3,000	16·1	11·3	10·0	4·8	6·1
3,500,000	30,000	20·5	16·1	14·5	4·3	6·0

We conclude that the configurational entropy of most proteins may be expected to be between — 4 and — 8 entropy units per amino-acid residue.

This, of course, is not the only factor which has to be considered in an estimate of the free energy of formation of a protein. The process of synthesizing the protein may be supposed to consist of two parts : (1) the formation of peptide bonds ; (2) the ordering and aggregation of peptide chains. An estimate of the free-energy change in the formation of the peptide bond has been made by Borsook and Huffman[6]. They found that in the synthesis of *dl*-leucylglycine from *dl*-leucine and glycine there was a free energy *increase* of 7,520 cal., a fairly considerable quantity. Supposing that the denaturation of the protein is a disordering or disaggregation of the peptide chains, we may use the heat of denaturation, taken with the opposite sign, as a measure of the heat-content change in formation of the orderly structure of the protein from a disordered peptide chain. This has been measured in the cases of pepsin and methæmoglobin and amounts to $\Delta H = -300$ cal. per amino-acid residue[7]. Combining this with the configurational entropy associated with the formation of one particular arrangement of amino-acids ($T\Delta S =$ *c.* — 1,500 cal.), we find the free-energy change associated with (2) to be

$$\Delta F = -300 + 1{,}500 = 1{,}200 \text{ cal. per residue.}$$

These calculations are admittedly rough and based on inadequate data ; but if they are not totally incorrect they indicate that the configurational entropy is not a dominant factor in the free energy of a protein. If an organism can synthesize peptide bonds, it appears that it will have no great difficulty in putting together protein molecules of any degree of complication. The free energy must come from the metabolic processes going on in the organism. The complete oxidation of a glucose molecule to carbon dioxide and liquid water yields approximately 700,000 cal. of free energy per mol. This is of the order of magnitude sufficient for the building up into proteins of about a hundred amino-acid residues. There is thus no outstanding difficulty in accounting for the synthesis of living structures with a fairly modest expenditure of food.

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MANGANESE METABOLISM IN SOILS

By Dr. P. J. G. MANN and Dr. J. H. QUASTEL, F.R.S.

Agricultural Research Council, Unit of Soil Metabolism

THE variety of changes undergone by manganese in soils has been the subject of study by many workers, particularly by those interested in 'manganese deficiency'. This is a condition of the soil in which manganese may occur abundantly and yet is not available to the plant in the form or in the amount required for healthy growth.

Our interest in this problem was aroused in the first instance by the discovery that phosphate extracts of soils often give a colour reaction with benzidine which is identical with that obtained when this reagent is added to suspensions, or colloidal solutions, of manganese dioxide. It was thought at first that the substance in the extract reacting with benzidine might be an organic complex in which a higher oxide of manganese was incorporated ; but subsequent investigations (not yet published) by H. G. Dion and P. J. G. Mann in this Unit have proved that the responsible substance in the phosphate extract reacting with benzidine is the trivalent manganic ion. Moreover, these workers have also shown that it is pyrophosphate, present as an impurity in many phosphate preparations, which is responsible for combining with and extracting trivalent manganese in a soluble form from soils.

During the last three or four years we have carried out experiments designed to throw light on the mechanism by which manganese undergoes transformation in soil.

Biological Oxidation of Divalent Manganese in Soils

When manganese sulphate is continuously perfused through neutral or slightly alkaline soils (for example, at *p*H 7·9) at 70° F. using the apparatus of Lees and Quastel (*Chem. and Ind.*, 26, 238; 1944) and daily analyses are made of the manganese present in the soil perfusate, it is found that following the relatively rapid achievement of cationic equilibrium between perfusate and soil, manganese usually disappears from the perfusate at first slowly and then at an increasingly rapid rate until almost the whole of the manganese has disappeared. The initial lag period is variable. Its duration and the velocity of the subsequent rapid rate of removal of manganese from the soil perfusate appear to depend greatly on the nature of the soil under investigation*. A typical curve is shown in Fig. 1, A.

The manganese which disappears from the soil perfusate is found in the soil itself in an oxidized form. It has been estimated manometrically by making use of the reaction

$$MnO_2 + 2NH_2OH = Mn^{++} + N_2O + 3H_2O,$$

which we have found to apply quantitatively to manganese dioxide either alone or when added to soil at *p*H 2. Special precautions must be taken, however, in applying this reaction to soil; for example, phosphates must be added to mask the iron present, as ferric ion reacts with hydroxylamine with gas production. Details of the application of this reaction to the estimation of MnO_2 in soils will be published in due course. Trivalent manganic ion also reacts with hydroxylamine with gas production, so that the gas evolved on addition of hydroxylamine to soil (after due precautions have been taken to mask the iron) is due to the mixture of manganic ion and manganese dioxide present. The increase in gas evolution, on addition of hydroxylamine to soils, at various times after perfusion of manganese sulphate has commenced, may be taken as a measure of the amount of higher oxides of manganese present. This may be calculated for convenience, and for the time being, as 'MnO_2' according to the equation given above. A typical curve showing the rate of formation of 'MnO_2' during a perfusion of manganese sulphate is given in Fig. 1, *B*. The curve shows, as might be expected, the same characteristics as Fig. 1, *A*—a lengthy initial lag period followed by a relatively rapid rate of formation of higher oxides of manganese.

The kinetics of manganese oxidation by neutral soils are those to be expected if the oxidation of manganese in soils under the given experimental conditions is wholly or almost wholly accomplished by proliferating micro-organisms. This conclusion is supported by the fact that the velocity of formation in soil of higher oxides of manganese is optimal at a relatively low concentration of manganese sulphate in the perfusing fluid. This concentration in one series of experiments was 0·02 *M*., above which an increase in the divalent manganese concentrations in the perfusing fluid led to a rapid fall in the rate of formation of higher oxides of manganese.

Effects of Biological Poisons on Manganese Oxidation in Soils

Such diverse cell poisons as chloretone, sodium iodoacetate and sodium azide when added to a soil perfusate containing manganese sulphate bring about a marked inhibition of the rate of formation of higher oxides of manganese in soil. The inhibition with sodium azide may be more than 95 per cent. Typical results are shown in Table 1. These results lead to the conclusion that, under the given experimental conditions, the oxidation of manganese in soils which we have investigated is almost entirely accomplished by biological means.

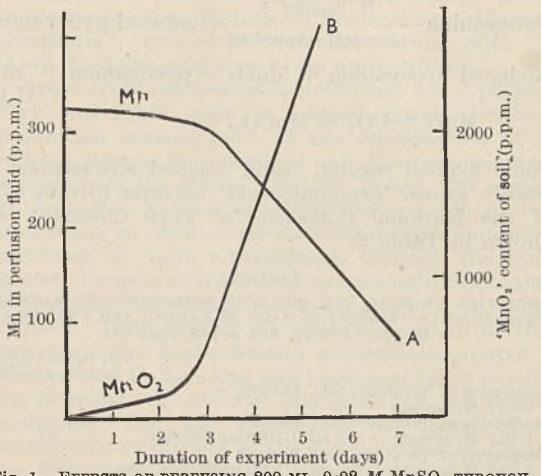

Fig. 1. Effects of perfusing 200 ml. 0·02 *M* $MnSO_4$ through Rothamsted soil at 70° F.

Table 1.

Effects of cell poisons on oxidation of manganese at 70° F. by a Rothamsted soil (50 gm.).

Perfusion fluid	Increase in 'MnO_2' in parts per million of soil			
200 ml. 0·02*M*. $MnSO_4$	3400	3800	3860	3520
200 ml. 0·02*M*. $MnSO_4$ + 0·001 *M* sodium azide	60			
200 ml. 0·02*M*. $MnSO_4$ + 0·001 *M* sodium iodoacetate		260		
200 ml. 0·02*M*. $MnSO_4$ + 0·4% chloretone			1030	0

Manganese Dioxide as a Biological Hydrogen Acceptor

Manganese dioxide is reduced with great ease to form divalent manganese ion by sulphydryl compounds, for example, thioglycollic acid, cysteine or by polyhydric phenols such as quinol, catechol, gallic acid, etc. The kinetics of these reductions may be followed manometrically in the Warburg apparatus by carrying out the reactions in an atmosphere of carbon dioxide. The following reactions take place

$$2\,RH + MnO_2 = 2R + MnO + H_2O;$$
$$MnO + CO_2 = MnCO_3.$$

The velocity of uptake of carbon dioxide is a measure of the rate of reduction of the MnO_2 by the reducing body *R*H.

It is easy to show that suspensions of bacteria in presence of suitable hydrogen donators and traces of such carriers as pyocyanine or methylene blue will bring about a reduction of manganese dioxide. The reactions may be allowed to take place in an atmosphere of carbon dioxide, the velocity of absorption of which is a measure of the speed of reduction of the MnO_2 by the bacteria. The following reactions occur:

* Mn" in the perfusate was estimated by oxidation with periodic acid to permanganate (H. H. Willard and L. H. Greathouse, *J. Amer. Chem. Soc.*, 39, 2366; 1917).

$$\text{Pyocyanine} \xrightarrow[\text{(bacterial suspension)}]{\text{H. donator} +} \text{Reduced pyocyanine};$$

$$\text{Reduced pyocyanine} + MnO_2 = \text{pyocyanine} + MnO + H_2O;$$

$$MnO + CO_2 = MnCO_3.$$

Some typical results, using washed suspensions of freshly grown 'propionic acid' bacteria (Strain 4759 of the National Collection of Type Cultures), are shown in Table 2.

TABLE 2.

REDUCTION OF MnO_2 (0·2 ml. *M*/10 SUSPENSION) BY BACTERIAL SUSPENSIONS IN PRESENCE OF 0·027 *M* $NaHCO_3$ AND A MIXTURE OF 95 PER CENT N_2 AND 5 PER CENT CO_2

	CO_2 uptake (cmm.) in 1 hr. at 37°C.
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate	0
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 pyocyanine	60
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 methylene blue	112
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 β naphthoquinone sulphonate	88

Dr. D. M. Webley, in unpublished work carried out in this Unit, has found that washed suspensions of bacteria isolated from the soil bring about a rapid reduction of manganese dioxide so long as a suitable carrier (such as pyocyanine) and excess of hydrogen donator (in the form of nutrient) are present.

These facts show that the reduction of manganese dioxide can be accomplished either by bacterial masses in presence of their hydrogen donators and carriers, or by compounds, such as thiols or polyphenols, elaborated in the process of bacterial or plant metabolism or in the breakdown of soil organic matter. It follows that the reduction of manganese dioxide in soils is a process which may be accomplished entirely by biological means. Many species of bacteria may be involved in the reduction of the oxide of manganese, the determining factors being the supply, and nature, of the organic matter present.

Effects of Perfusing Glucose Through a Manganese-containing Soil

It follows from what has been stated that if there is present in soil an excess of a nutrient, which will serve as a hydrogen donator to the bacteria the growth of which it stimulates, or which breaks down to form compounds which will directly reduce manganese dioxide, the conditions will be favourable for the reduction of oxides of manganese in soil and hence for the appearance of divalent manganese. If the conditions are aerobic a dynamic equilibrium will be set up in which the rate of formation of divalent manganese by the biological reducing systems will be balanced by the rate of oxidation of this cation by the manganese oxidizing organisms present.

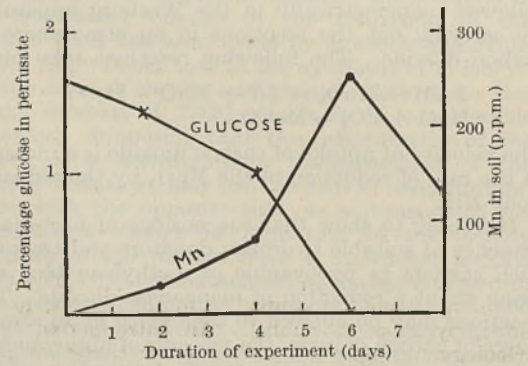

Fig. 2. EFFECTS OF PERFUSING GLUCOSE AT 70° F. ON EXCHANGEABLE (DIVALENT) MANGANESE OF ROTHAMSTED SOIL

The effect of perfusing glucose through a soil containing oxides of manganese is shown in the results given in Fig. 2*. It will be noted that the quantity of divalent manganese gradually increases so long as glucose is present in the system; when the glucose is entirely removed by bacterial activity the concentration of divalent manganese falls.

The effect of the addition of glucose to a soil on its divalent manganese content is seen more dramatically if sodium azide is also added to the soil. The azide retards the rate of oxidation of divalent manganese in soil much more than it retards the rate of reduction of oxides of manganese by soil bacteria in presence of glucose. The result is that glucose in presence of azide greatly enhances the concentration of divalent manganese in soil. A typical result is shown in Table 3.

TABLE 3.

EFFECTS OF GLUCOSE AND SODIUM AZIDE ADDITIONS ON DIVALENT MANGANESE FORMATION IN A ROTHAMSTED SOIL (20 GM.). DURATION OF EXPERIMENT = 44 HOURS AT 70° F.

Additions to air-dried soil	Divalent Mn formed (parts per million)
8 ml. water	5
8 ml. *M*/9 glucose solution	8
8 ml. 0·001 *M* NaN_3	13
8 ml. mixture of *M*/9 glucose solution + 0·001 *M* NaN_3	122

Manganese Cycle in Soils

It is clear from these results that manganese undergoes a metabolic cycle in soils, the kinetics of which is determined by the nature of the micro-organisms and the organic matter present. It appears from unpublished observations of Dion and Mann, in this Unit, that the first product of the biological oxidation of divalent manganese in soil is manganic oxide (Mn_2O_3) which, as was first shown by Meyer and Nehrlich, undergoes spontaneously a dismutation to divalent manganese and manganese dioxide, in accordance with the equation $Mn_2O_3 = MnO + MnO_2$. The velocity of this dismutation decreases rapidly with increase in *p*H, ceasing almost completely at *p*H 8·0.

The metabolic cycle undergone by manganese in neutral soils is summarized in Fig. 3.

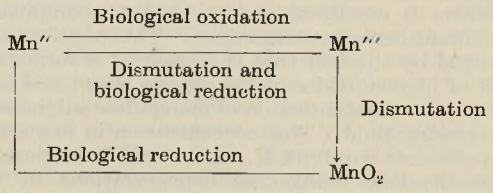

Fig. 3

The kinetics of the various phases of this cycle determine the rate of formation of divalent manganese at any time.

Full details of these and related experiments will be published in due course.

* Mn″ in soil was estimated by extraction of the soil with *N*$Ca(NO_3)_2$, (see S. G. Heintze, *J. Agric. Sci.*, 28, 175; 1938) followed by oxidation of the Mn″ in the extract by periodic acid to permanganate.

OBITUARIES

Prof. T. H. Laby, F.R.S.

The death of Prof. T. H. Laby, at the age of sixty-six, brings to an end the career of one devoted to the furtherance of physics and of science generally. His efforts in this direction, often in very difficult circumstances, undoubtedly undermined his health. Despite this, he was untiring in his work, the value of which to his native country, Australia, and to the world of science in general, is still inadequately recognized.

Laby was born in Victoria, Australia, and received his early academic education at the University of Sydney. After graduating, he was awarded an Exhibition of 1851 Overseas Research Studentship, and proceeded to Emmanuel College, Cambridge, and to research work at the Cavendish Laboratory under J. J. Thomson. After a successful period there, during which he held the Joule Studentship of the Royal Society, he took up an appointment as professor of physics at Wellington, New Zealand, in 1909. This he held until 1915, when he was elected to the chair of natural philosophy in the University of Melbourne, a post he retained until his resignation in 1942. His influence on Australian physics during this period was remarkable, and it is largely due to him that Australia holds a high place in the realm of physics.

Among the many reasons why Laby played such a unique part in the development of physics in Australia was his great interest in research and the wide range of his own activities in this direction. During his tenure of the chair, there existed throughout his department an air of enthusiasm and a feeling of complete confidence in the importance of the subject, which lent a distinction apparent to undergraduates as well as research students. This led to a remarkably regular production of very keen research students; so regular, in fact, that it was a matter of great surprise if, in any year, one of the Exhibition of 1851 Overseas Studentships did not fall to a member of Laby's department.

His primary interest was in precision experimental physics, but this did not prevent him from realizing the importance of other branches of the subject. Thus he was keenly aware of the importance of theoretical physics and encouraged any students with a bent in that direction. His unusual breadth of view is exhibited by his abolition of practical examinations in the subject, despite his own special interest in experiment.

It is difficult to say in which field of precise experiment Laby was most interested; thermal conduction, mechanical equivalent of heat, X-rays, geophysics, scientific radio all occupied his attention and were a continual source of research problems for his students and assistants. The precision determination of J by Laby and Hercus is well known, as are also the series of papers by Laby and by his assistant Kannuluik on problems of thermal conduction. Laby was actively interested in the work of the geophysical prospecting party, led by Broughton Edge in Australia in 1929, and collaborated with Edge in editing the final report of the work, which is by way of becoming a standard text-book on the subject. Besides these researches in which he, personally, took an active share, Laby encouraged work on nuclear physics, and a neutron generator was in operation just before the War.

Among his publications the most widely used is undoubtedly the "Tables of Physical and Chemical Constants", compiled in collaboration with Dr. G. W. C. Kaye, and now in its ninth edition.

Apart from his academic activities, Laby played a very important part in official developments in Australian science, such as the organisation of the radium supply for hospitals and the formation and operation of the Radio Research Board. As a result of the latter, Australian workers have made, and are continuing to make, very important contributions to problems of radio transmission through the atmosphere. Despite all his other interests Laby maintained a detailed knowledge of developments in radiophysics. Thus, during his visit to England in 1934, he read to the Royal Society a stimulating paper by Martyn and Pulley, and was instrumental in exciting the interest of atomic physicists in ionospheric problems. He was thoroughly convinced of the importance of physics in the development of Australian industry, and devoted a great deal of time and effort towards the often thankless and wearisome task of convincing others of this now generally accepted fact.

At the outbreak of war in 1939, there existed virtually no optical industry in Australia to meet the requirements of optical munitions supply. Laby took a leading part in the organisation of the Optical Munitions Panel of Australia, of which he was the first chairman. This body was vital to the establishment of a sufficiently productive industry. Laby's real value in the war crisis cannot be measured only by this. The great contribution that Australian physicists were able to make to the defence of their country and of the British Commonwealth could not have been made if in preceding years a firm tradition of high-quality physics had not been established in Australia, largely by the efforts of the Department of Natural Philosophy at Melbourne under Laby's direction. The difficulties of doing this under conditions of isolation imposed by the great distance of Australia from Europe and America cannot easily be over-estimated, and there is no doubt that Laby sacrificed himself unsparingly in achieving this end.

H. S. W. Massey

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

On June 23 there passed away 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 Hall, Somerset, and educated at Clifton College and Christ's College, Cambridge—of which he was later elected an honorary fellow; he also studied at the University of Heidelberg.

In 1896 Rogers became assistant geologist to the Geological Commission of the Cape of Good Hope, director thereof in 1903, and director of the Geological Survey of the Union from 1916 until his retirement in 1932. His forty-three 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. Schwarz, 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, Rogers' main work lay in the mapping of the Heidelberg goldfields, 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 great 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, Rogers 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 ill-health had debarred him from further field work. To many of us such minuter researches proved helpful indeed.

Rogers' 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 he completed 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 I indeed regard 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 had been 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 African 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. He received the degree of Sc.D. from Cambridge and an honorary degree of D.Sc from the University of the Witwatersrand.

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 man of science 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, I feel that a noteworthy geologist has been lost to the world. ALEX. L. DU TOIT

WE regret to announce the following deaths:

Dr. H. A. Colwell, known for his work on X-ray therapy and related subjects, on July 22, aged seventy.

Prof. J. Park, emeritus professor and formerly dean of the Faculty of Mining in the University of Otago, aged eighty-nine.

NEWS and VIEWS

Social Anthropology at Oxford: Prof. A. R. Radcliffe-Brown

PROF. A. R. RADCLIFFE-BROWN, who is retiring from the chair of social anthropology in the University of Oxford, took a Cambridge degree in moral philosophy and studied anthropology as a post-graduate student under Haddon and Rivers, lecturing also occasionally for the London School of Economics. He started work in the field with a visit to the Andamans as Anthony Wilkin Student in 1906, but his book on "The Andaman Islanders", in its first form presented as a fellowship thesis at Trinity College, though finished before the First World War, was not published until 1922. By that time Radcliffe-Brown had been lecturing on anthropology at Johannesburg and was the first professor of social anthropology at Cape Town. From Cape Town he went as the first holder of a chair of anthropology at Sydney, and his foundation of a school of research and teaching at these two universities has perhaps been the most important contribution to anthropology of his career. His series of very important papers on Australian kinship systems, originally published separately in *Oceania*, have since been incorporated and published as a single volume. From Sydney he went to Chicago, again as the first professor of anthropology, so that his choice in 1937 to occupy a newly founded chair in social anthropology at Oxford was almost a foregone conclusion.

Prof. Radcliffe-Brown received the Rivers Memorial Medal of the Royal Anthropological Institute for research in the field in 1938; he was president of the Institute in 1939 and 1940; he was Frazer Lecturer in Cambridge in 1939; and he was Henry Myers Lecturer at the Royal Anthropological Institute in 1945. His contributions to anthropology in the form of researches on Australian kinship systems

would by themselves have been notable, but his influence on the development of teaching and research generally in both hemispheres has been still more important, and it is to be hoped that his activity in that direction is still far from concluded.

Mr. E. E. Evans-Pritchard

Mr. E. E. Evans-Pritchard, who has been appointed to succeed Prof. Radcliffe-Brown, studied anthropology under the late Prof. C. G. Seligman at the London School of Economics and is well known for his researches among the peoples of the Anglo-Egyptian Sudan carried out during 1926–36. The results of these studies have been published in a number of papers in *Sudan Notes and Records* and other scientific journals, and in two notable books, "Witchcraft, Oracles and Magic among the Azande" (1937) and "The Nuer" (1940). The scientific value of these works lies in the penetrating analysis applied to carefully observed facts. Mr. Evans-Pritchard was for a time professor of sociology at the Egyptian University, Cairo. He left Egypt to take up the position of research lecturer in African sociology in the University of Oxford. With Dr. Fortes he edited and contributed to a book on "African Political Systems" (see *Nature*, August 10, 1940). In 1939, Mr. Evans-Pritchard joined the Army and served in the Abyssinian campaign and later in Syria and in Cyrenaica. In the last-named country he was in close contact with the Senussi, on whom he has written several papers. On his return from the Army he was appointed reader in anthropology in the University of Cambridge. Cambridge now loses and Oxford regains one of the most brilliant of the exponents of what may be called the newer social anthropology, in which theories of social institutions are tested and developed by experimental observations in the field.

Chemistry at Royal Holloway College, University of London : Prof. T. S. Moore

Prof. T. S. Moore is retiring this summer from the chair of chemistry which he has held at Royal Holloway College since 1914. As a student he was first at East London College and then at Merton College, Oxford, and he became a fellow of Magdalen College, Oxford, in 1906. He worked in Oxford with N. V. Sidgwick on the rates of reaction of dyestuffs and in Germany with Hantzsch, and this training gave him an interest in both organic and physical chemistry and especially in the borderland between them. This interest is exemplified in his best-known work, the study of the basicities of the aliphatic amines (*J. Chem. Soc.*, **91**, 1373, 1379 ; 1907. Moore and T. F. Winmill, *ibid.*, **101**, 1635 ; 1912), in which for the first time the existence of undissociated amine hydrates in solution was demonstrated and their concentrations measured. Prof. Moore deserves well from all chemists for his valuable services to the Chemical Society. He was one of its secretaries during 1928–34 and served for years almost without number on the Publication Committee. He succeeded J. C. Philip as chairman of the latter in 1934, and it was here that his wide interests proved of such value. The difficulties of this position are well known ; there are the interests—and sometimes the foibles—of the authors, the pressure on the space in the journal, the restricted funds. Moore's knowledge, human sympathies and charming manner enabled him to deal with these difficulties with great success. For this reason, but not for this reason alone, all will wish him many happy years of retirement.

Prof. Gwyn Williams

Dr. Gwyn Williams, who succeeds Prof. Moore, first graduated at the University College of North Wales, Bangor, under the late Prof. K. J. P. Orton, and was afterwards elected fellow of the University of Wales. After three years of research under Prof. Orton and Dr. F. G. Soper, he proceeded as a Strathcona research student to St. John's College, Cambridge, and for the next eight years worked in the laboratories of the late Prof. T. M. Lowry and Prof. E. K. Rideal. His wide experience has included two periods as a guest research worker in the research laboratories of the Eastman Kodak Company, Rochester, U.S.A. Since the beginning of the War he has been a member of the staff of King's College, London. A man of wide culture and varied interests Dr. Williams has also been active in the fields of adult education, student relief and assistance to refugee scholars from central Europe.

In his scientific work Dr. Williams, like his former chief Prof. Orton, has applied physical methods to the study of organic problems. In his earliest research on the chlorination of anilides he pointed out a significant generalization concerning the influence of polar substituents on reaction velocity. His studies have included gas and surface reactions and the kinetics of the polymerization of styrene. During the War he took a prominent part in the work on the kinetics and mechanism of nitration in sulphuric acid, carried out at King's College, which is only now being released for publication. This research has led to an important advance in our knowledge of aromatic nitration.

Dr. D. F. Twiss

Dr. D. F. Twiss, who has retired after thirty-two years as chief chemist to the Dunlop organisation, has played a great part in the scientific development of the rubber industry. Dr. Twiss has done a considerable amount of work on vulcanization with sulphur, and discovered the use of zinc isopropyl xanthate (Z.I.X.) as an accelerator of vulcanization. Another important discovery associated with his name is the use of metallic oxides, especially zinc oxide, in the presence of organic accelerators of vulcanization. Though now more than twenty years old, Dr. Twiss's theory of vulcanization is still one of the most useful. His suggestion is that the vulcanization of rubber with sulphur gives a rubber sulphide product which acts as a reinforcing agent for the rest of the rubber mass ; and, since this material is actually formed in the rubber itself, gives a very effective type of reinforcement. He was a pioneer in the use of preserved rubber latex for the direct production of rubber articles. His earlier experiments led to the great industry in latex rubber, producing rubber thread of improved properties and self-ventilating sponge rubber with intercommunicating pores of controlled size. In 1934 the Institution of the Rubber Industry awarded him its highest honour, the Colwyn Gold Medal, for his scientific contribution to the knowledge of rubber. Before joining the Dunlop Rubber Company in 1914, Dr. Twiss was a lecturer in chemistry at Birmingham Technical School, now Birmingham Central Technical College ; he was himself trained at Mason College, Birmingham, and was placed first on the roll of undergraduates when the college became the University of Birmingham. He holds research degrees of the Universities of London and Birmingham.

Cavendish Laboratory, Cambridge: The Austin Wing

In 1936, the gift by the late Sir Herbert (afterwards Lord) Austin was announced of a sum of approximately £250,000 for the work of the Cavendish Laboratory at Cambridge (see *Nature*, **137**, 765; 1936). This enabled the University to proceed with a scheme of reconstruction of some of the laboratories, including a new building for the Cavendish Laboratory on the site of the old Zoological Laboratory. An imposing building, known as the Austin Wing, was erected in due course, and immediately taken over by the Government for war-time investigations. Now it has been released for its proper use, and was formally opened by Sir John Anderson on July 24. The Physical Society was holding an international conference, which was attended by seventy-five foreign guests, on "Fundamental Particles and Low Temperatures" in Cambridge during July 22–27, and the opening of the Austin Wing in the middle of the week fitted appropriately into the general programme.

The whole of July 24 was devoted to the Cavendish Laboratory; during the morning, papers dealing with current work in the Laboratory were read by E. S. Shire on nuclear physics, by W. H. Taylor on the X-ray analysis of various kinds of matter, by J. A. Ratcliffe on the work on radio carried out in the Cavendish and its outlying stations, by E. Orowan on the physics of metals, and by J. F. Allen on the Royal Society Mond Laboratory and its work on helium II and on magnetic phenomena. In the afternoon, a general meeting, under the chairmanship of the Vice-Chancellor of the University, was held in the Examination Hall; some four hundred delegates attending the Conference and members of the staff of the Cavendish Laboratory were present. Prof. J. D. Cockcroft gave a short history of the Austin gift and of the new building, after which the Vice-Chancellor introduced Sir John Anderson. Sir Lawrence Bragg thanked Sir John for his address, and presented him with a key with which to open the new building. After the formal opening, an inspection was made of the work in progress in the Austin Wing, the High Tension Laboratory and the Royal Society Mond Laboratory.

Hydro-electric Power and its Utilization

In these days when the world is talking of power from fissionable matter, one is apt to forget the inexhaustible nature of hydro-power. Hydro-power remains the only source of solar energy in which Nature herself seems prepared to undertake the tedious task of concentration; but the civil engineering works—dams, intakes, pipe-lines, canals and power-stations—are themselves engineering works of major importance. It already plays an important part in the industrial economy of the United States of America, where nearly half the potential sources are already tapped. Similar developments are impossible in Great Britain; catchment areas are too small, or they are too near sea-level. As our power-consuming processes expand, it is inevitable that they must be moved to areas where power now flows unharnessed. Except for the United States, only a tiny fraction of world-power is at present utilized; much is, of course, in places remote from industrial regions, but half the world is now within one-day journey, and fear of isolation need no longer deter labour from migration. It seems that big fields are open to those specializing in the design and construction of hydro-plant, and that a subsequent export trade of considerable magnitude would accrue to the country responsible for building the plant.

Anticipating a demand for suitably trained engineers, the English Electric Co., Ltd., under the chairmanship of Sir George Nelson, is actively stimulating the post-graduate study of hydro-power. Appropriate courses of advanced lectures and training in laboratory technique have been arranged at the Imperial College of Science and Technology in connexion with the Hawksley Hydraulic Laboratory under the direction of Prof. C. M. White, recently appointed to the new chair of fluid mechanics and hydraulic engineering. The English Electric Co. has placed the specialized knowledge of its technical staff at the disposal of the College and is contributing experimental equipment as well as a sum of £10,000 towards the initial expenses. The courses are open to students with honours degrees in engineering, and the subjects include fluid mechanics, river mechanics, model technique, hydraulic machines, hydrology, soil mechanics and concrete technology, together with their application to the design of the relevant hydraulic structures. Six English Electric bursaries of £200 a year are to be offered annually as an inducement to students who otherwise might hesitate to prolong an already long training; and various researches in progress in the laboratory at the outbreak of war are to be started again when students of the right type become available. Unfortunately, in this connexion much delay must result from the ruling of the Ministry of Education as to how entrants to the universities are to be selected.

A Second Giant Sunspot

For the second time this year, an exceptionally large sunspot has appeared. Coming over the sun's eastern limb on July 19–20, the centre of this giant spot crossed the central meridian on July 26–28 (passing 17° north of the centre of the disk) and was due to reach the western limb on August 2. In structure the spot is complex with several nuclei, and its area up to July 27 hovered around 4,000 millionths of the sun's hemisphere. Its predecessor in February had a mean area of about 4,300 millionths and a maximum area of 4,900 millionths—the largest sunspot group ever recorded at Greenwich.

A number of radio fade-outs on short-wave long-distance communication have been reported by Cable and Wireless Ltd. since July 20, and in several cases synchronous solar flares were observed in 6563 A. ($H\alpha$) at Greenwich and elsewhere. By far the most notable of these dual phenomena to date (July 27) was an intense solar flare commencing shortly after 16h. U.T. on July 25 and a long-continued fade-out beginning at 16h. 15m. This intense flare was observed at the Solar Physics Observatory, Cambridge, and by Dr. M. A. Ellison at Sherborne using his combined spectrohelioscope and spectrograph. The position of the flare, closely associated with the sunspot, was about 15° east of the central meridian and 29° from the centre of the disk, that is, within the central region of the disk known statistically to be favourable for a geomagnetic storm to occur about 24 hours after an intense flare. Ellison's observations indicate that the peak brilliancy was at about 16h. 29m., when the hydrogen line, $H\alpha$, in emission, had the abnormal width of 18 A. The aggregate area of the flare filaments was half that of the sunspot itself. The helium line, D_3, was also

CAPE TECHNICAL COLLEGE

VACANCY FOR DIRECTOR

The Council of the Cape Technical College invites applications from men of high qualifications and suitable experience for the post of Director of the College, which will be falling vacant at the end of the present year.

The Director is a member of the College Council and the responsible head of the College, which is made up of full-time day and part-time evening schools divided into Departments, i.e., Engineering, Building, Printing, Commerce, Domestic Science, Chemistry and Pharmacy. There are branches at Stellenbosch, Worcester and Parow and non-European Continuation Branches.

Applicants should state fully and in detail their academic qualifications and their experience in education, industry and administration. The successful applicant will be expected to make himself proficient in Afrikaans within a reasonable time. Salary is according to the scale £1,100×50-1,400 plus temporary cost of living allowance of £84 per annum for a married man and £28 for a single man, but the commencing salary on the scale may be at a higher notch than the initial notch according to experience and qualifications. An allowance of £60 is made to the successful candidate to cover expenses to Cape Town and half substantive salary is paid from the date of embarkation until the date of reporting in Cape Town. The successful applicant will be expected to assume duty at the beginning of 1947.

Applications should be accompanied by certified copies of testimonials and should be submitted by August 31, 1946. Conditions of service and other relevant information may be obtained from J. A. Ewing & Co. (Ldn.), Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2, the representatives of the Cape Technical College in London.

CIVIL SERVICE COMMISSION

Applications are invited for the three posts of Associate Professor of (1) Chemistry, (2) Electrical Engineering, (3) Wireless Engineering at the Military College of Science. The posts will be filled by competitive interview of suitable applicants in London, probably in late September or early October, 1946. The College is at Shrivenham, near Swindon, Wilts. If, owing to the housing shortage, accommodation is unavailable War Department quarters may be allotted at a fair rent until such time as other accommodation becomes available. Applicants should be Chemists or Engineers of high standing with experience of teaching to honours degree standard.

The Associate Professors will be required to take charge of one of the branches of Organic Chemistry or Physical Chemistry in the faculty of Chemistry and of Electrical or Wireless Engineering in the faculty of Instrument Technology. They will be expected to lecture on their subjects during the periods of full term but they will have opportunity for research. The salary offered is £1,100×£50 to £1,300. Under present arrangements an additional payment of £120 attaches to the scale. Full particulars of the post together with a statement of the conditions of service and the intentions of the War Office regarding the Military College of Science and a form of application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, W.1, quoting No. 1577. Application forms must be returned to him by Monday, August 26, 1946.

CIVIL SERVICE COMMISSION

Applications are invited for posts at the Military College of Science, Shrivenham, near Swindon, Wilts, of permanent and temporary Principal Lecturers, Senior Lecturers and Lecturers. Vacancies in one or more of these grades exist in the following subjects: Ballistics, Chemistry, Applied Chemistry, Electrical Engineering, Heat Engines, Instruments, Machines, Materials and Structures, Mathematics, Mechanics, Metallurgy, Physics, Radar and Telecommunications. Applicants must have a University degree in an appropriate scientific subject with first or second class honours or an equivalent qualification. Experience in research or design as applied to military needs would be an advantage. The inclusive scales of salary are (Principal Lecturer) £840–£1,125, (Senior Lecturer) £610–£800, (Lecturer) £333–£560. Full particulars of the posts, together with a statement of the conditions of service and the intentions of the War Office regarding the Military College of Science, and a form of application, may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1575. Application forms must be returned to him by August 26, 1946.

Analytical Chemist for work in chemical manufacturing company situated East London. Permanent and progressive position offered to young man aged 25 to 30. Qualifications required Honours Degree or A.R.I.C. General industrial analytical experience essential. Salary £450. Box 653, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

CIVIL SERVICE COMMISSION

Applications are invited for the post of Experimental Officer (Librarian) in the War Office. The post will be filled by competitive interview of suitable applicants in London, probably early in October, 1946. Applicants must have been born on or before August 1, 1915, and be under 50. They should have a good scientific background and preferably a university degree in natural science, and should have had some experience of a Departmental Scientific Reference Library including the classification of scientific literature and the preparation of abstracts. The scale of pay (male) is £400×£18–£550, plus a consolidation addition of £90.

A form of application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, W.1, quoting No. 1574. Application forms must be returned to him by September 2, 1946.

ROYAL NAVAL COLLEGE, GREENWICH

DEPARTMENTS OF MATHEMATICS, APPLIED MECHANICS AND PHYSICS AND ELECTRICAL ENGINEERING

Applications are invited for appointments to the Professional Staff at the Royal Naval College, Greenwich, in September next as Lecturers in Mathematics, Applied Mechanics (2) and Physics. Applicants should possess high Honours degrees in Mathematics, Mechanical Engineering and Physics respectively. Every candidate must be a natural born British subject having at least one parent who is, or was at the time of death, a British subject. The salary scale for lecturers is at present £400×£25–£600 per annum plus consolidation addition of £90. These scales are now under review. Entry will normally be at the minimum of the scale but consideration will be given to the payment of starting salaries above the minimum for candidates who are specially suitable. Appointments will be temporary but there may be some possibility of permanency later. Permanent posts carry the benefits of the Federated Superannuation Scheme for Universities.

Applications, accompanied by the names of three referees and a statement of previous experience, should be sent as soon as possible to the Director, Education Department, Admiralty, from whom further particulars may be obtained.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer (Grade III) in the Department of Geology. Candidates should have special interest in Mineralogy and Petrology. The initial salary will be £350–£450 per annum, according to qualifications and experience, and other relevant circumstances. The appointment will date from October 1, 1946, or as soon afterwards as can be arranged.

Applications, which should include particulars as to age, academic qualifications and practical experience, together with references and copies of testimonials, should be received, not later than August 31, 1946, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

THE UNIVERSITY OF LIVERPOOL

The Council invites applications for the post of Lecturer (Ungraded) in Pharmacology. The appointment will be a whole-time one at a salary not exceeding £800 per annum, to be fixed according to qualifications and experience. The University will consider applications from candidates in the Forces or engaged upon other National Service, even though they have no immediate prospect of release. Applicants must have had training and experience in research methods in the Department of a Medical School or a similar Institution, and should hold a medical qualification.

Applications, which should include particulars as to age, academic qualifications and experience, together with a copy of three testimonials, should be received not later than September 7, 1946, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

THE UNIVERSITY OF LIVERPOOL

The University invites applications for the post of Lecturer (ungraded) in the Department of Botany, at a salary of £400–£500 per annum according to qualifications and experience. The appointment will be for one year in the first instance, and will be renewable. The University will consider applications from candidates in the Forces or engaged on National Service.

Applications, stating age, academic qualifications and practical experience, together with the names of three referees, should be received not later than August 21, 1946, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

THE UNIVERSITY OF CAMBRIDGE

The Appointments Committee of the Faculty of Mathematics intend to appoint two University Lecturers and one part-time Lecturer in Mathematics, to hold office from October 1, 1946. The appointments will be subject to the Statutes and Ordinances of the University. The initial basic stipend of a University Lecturer is £250 a year, and of a part-time Lecturer £170 a year, but an additional payment not exceeding £250 a year may be made to a Lecturer who is not a Fellow of a College, and additional payments may also be made for any teaching given at the request of the Faculty Board in excess of the basic amount. The revision of the basic stipends of Lecturers is under consideration. Special consideration will be given to candidates possessing qualifications in Algebra, Geometry, Atomic Physics or Statistics, but the choice will not necessarily be confined to these subjects.

Candidates are requested to state their age and to give the names of not more than three referees, together with any evidence of qualifications that they may desire to submit. Applications should reach Dr. R. Stoneley, Secretary of the Appointments Committee, Pembroke College, Cambridge, on or before August 24, 1946. Consideration will also be given to names submitted by the Colleges, or the friends, of those who are not in a position to communicate with the Secretary themselves.

UNION OF SOUTH AFRICA

Applications are invited on or before August 23, 1946, for the following posts in the National Building Research Institute of the South African Council for Scientific and Industrial Research: Research Officers: (present salary £500×£30–£680–£700 plus cost of living allowance).

(i) One architect possessing a recognised university degree in architecture who has had at least three years' practical training in this profession.

(ii) One chemist or physicist possessing a recognised university degree resulting from a four-year professional course, and preferably with experience in a research organisation or in industry.

(iii) Two engineers (civil, mechanical, electrical, or chemical) possessing recognised university degrees resulting from four-year professional courses, and with at least three years' experience after graduation directly connected with their profession.

Military service and other experience will be considered in determining the starting salaries of successful applicants.

Applicants are requested to write in the first instance to the Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2, for further information and official application forms which list the details required.

UNIVERSITY OF ABERDEEN

LECTURESHIP IN BACTERIOLOGY

Applications are invited for a Lectureship in the Department of Bacteriology. Salary £750–£900 according to qualifications and experience. Persons desirous of being considered for the office should be graduates in medicine and have experience of general hospital bacteriology.

Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than September 14, 1946.

H. J. BUTCHART,
The University, Secretary.
Aberdeen.

UNIVERSITY OF ST. ANDREWS

The University Court of the University of St. Andrews invites applications for appointment as Lecturer in Chemistry in the United College, St. Andrews. The salary scale is £600 rising by annual increments of £25 to £700 per annum. Candidates should be approximately of mature Ph.D. status with specialization in physical chemistry. The duties will include both teaching and research work. Particular importance will be attached to an ability to originate, conduct, and supervise research work. Applications, stating age, qualifications, experience, etc., with six copies of each testimonial and names of any further referees, should be sent not later than August 31, 1946, to the Secretary, The University, St. Andrews, Fife, from whom further particulars may be obtained.

DAVID J. B. RITCHIE,
The University, Secretary.
St. Andrews.

GUY'S HOSPITAL MEDICAL SCHOOL

A Demonstrator of Biology is required for general teaching duties, to commence on October 1, 1946. Commencing salary £450 per annum, F.S.S.U. applies. Facilities for research are available.

Apply with names of two referees to the Dean, Guy's Hospital Medical School, London Bridge, S.E.1.

RAFFLES COLLEGE, SINGAPORE

Applications are invited by the Council for the posts of Professor of Chemistry and Professor of Education. The appointments will be in the first instance for 3 years, with the possibility of selection for the permanent staff. Salary $850–30 (annually)–1,000 per month. ($ equals 2s. 4d.) Free return passages for appointee, wife and children. Quarters with heavy furniture, at a rental of 6 per cent of salary. Leave as approved for Government Officers. Provident Fund. Duplicate copies of applications, together with copies of three recent testimonials, and the names of not more than three referees, should be sent to the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1, not later than August 23, 1946.

RAFFLES COLLEGE, SINGAPORE

Applications are invited by the Council for the posts of Lecturer in Chemistry and Lecturer in English. The appointments will be in the first instance for 3 years, with the possibility of selection for the permanent staff. Salary $450–25 (annually)–800 per month ($ equal 2s. 4d.). Free return passages for appointee, wife and children. Quarters with heavy furniture, at a rental of 6 per cent of salary. Leave as approved for Government Officers. Provident Fund. Duplicate copies of applications, together with copies of three recent testimonials, and the names of not more than three referees, should be sent to the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1, not later than August 23, 1946.

NORTHAMPTON POLYTECHNIC

St. John Street, London, E.C.1

Applications are invited for the positions of: Head of Electrical Engineering Department, salary scale £1,000–£25–£1,100. Head of Applied Optics Department. Salary scale: £750–£25–£850. Head of Applied Chemistry Department. Salary scale: £600–£25–£750.

The salary is subject to a London addition of £48 (£36 up to the age of 37) and to additions of £15, £30 or £45 in respect of three, four or five years spent in approved study and/or training. In determining the initial salary regard will be had to previous service in a like capacity.

Further particulars on application to the Secretary. Applications should be received as early as possible and not later than August 26, 1946.

S. C. LAWS, O.B.E., M.A., M.Sc.,
Principal.

EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Applications are invited for the post of Junior Lecturer in the Botany Department. Salary £300 per annum, plus consolidated war bonus (£78). Candidates should be in possession of an Honours Degree in Botany and a knowledge of agriculture also horticulture is desirable.

Applications stating age, qualifications and experience, together with copies of not more than three testimonials, should be lodged with the undersigned.

THOMAS BLACKBURN,
13 George Square, Edinburgh. Secretary.

ROYAL TECHNICAL COLLEGE, SALFORD

Principal: J. E. Richardson, Ph.D., B.Eng., M.I.E.E., A.M.I.Mech.E.

APPOINTMENT OF FULL-TIME LECTURER IN PHYSICS

Applications are invited for the full-time post of Lecturer in Physics. Applicants should be graduates of a British University and should be able to teach the subject up to Honours Degree standard. Teaching and research experience will be regarded as additional qualifications. Salary in accordance with the Burnham Technical scale.

Forms of application may be obtained from the Principal, Royal Technical College, Peel Park, Salford 5, to whom applications should be returned by August 10.

H. H. TOMSON,
Clerk to the Governors.

UNIVERSITY OF BIRMINGHAM

Applications are invited for the post of Lecturer (Grade IIc) in the Department of Brewing and Industrial Fermentation, salary £500–£550. Applicants should have special knowledge of Microbiology and Biochemistry of Industrial Fermentation.

Further particulars may be obtained from the undersigned, to whom applications should be sent not later than September 15.

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

HULL ROYAL INFIRMARY

Applications are invited for the post of Biochemist who will be required to work under the direction of the Honorary Pathologist. He will be required to supervise the routine biochemical examinations and to carry out research into current biochemical problems. He must have a recent Honours Degree in Chemistry and have done some research in biochemistry. Salary £750 rising to £900 per annum. Further particulars may be had on application to the undersigned to whom applications should be addressed, stating age, qualifications and nationality, and with copies of recent testimonials.

R. J. CARLESS,
House Governor.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

Campden Hill Road, 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) not later than August 31, 1946.

NATIONAL MILK TESTING AND ADVISORY SCHEME

(MINISTRY OF AGRICULTURE & FISHERIES)

West Midland Province

Applications are invited for the post of home-based Area Supervisor (to live in the Newport, Shropshire area). Applicants should possess a B.Sc. or the National Diploma in Dairying, or a qualification of equivalent standing, from a recognized University or Agricultural College, and should have sound knowledge of bacteriological methods, particularly in the examination of milk. Commencing salary will be according to qualifications and experience. Salary range (excluding war bonus) as follows: Men: £200–£300 p.a. (lower range); £300–£400 p.a. (higher range). Women: £200–£275 p.a. (lower range); £275–£320 p.a. (higher range).

UNIVERSITY OF LEEDS

DEPARTMENT OF AGRICULTURE

Applications are invited for the following posts: Senior Lecturer in Agricultural Bacteriology, £800–£25–£1,000. Lecturer in Agricultural Engineering, £500–£25–£800. Demonstrator in Agricultural Chemistry, £300 to £350 according to qualifications.

Further particulars can be obtained from the Registrar, The University, Leeds, 2, who will receive applications up to August 24, 1946.

UNIVERSITY OF CAMBRIDGE

Applications are invited from honours graduates in Chemistry for research studentships in the field of polymerization to be held in the department of Physical Chemistry, Cambridge University. The studentships carry an emolument of £300 per annum tenable in the first instance for one year and renewable for a maximum of three. Successful applicants will be in a position to apply for registration as candidates for a research degree. Two testimonials and any other relevant data should be sent, before August 31 next, to the Secretary, the University Department of Physical Chemistry, Free School Lane, Cambridge.

THE UNIVERSITY OF MANCHESTER

Applications are invited for a Lectureship in Mathematics from applicants with qualifications in Pure Mathematics. Duties to commence September 29, 1946, or as soon thereafter as possible. Commencing stipend according to qualifications, within the range of £400 to £650 per annum. All applications should be sent not later than August 12, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF GEOGRAPHY

Applications are invited for the post of Lecturer (Grade II) or Assistant Lecturer (Grade III) in Geography. Stipend will depend on qualifications and experience. (The minimum salary of Grade II is £500 and of Grade III £400.) Duties will begin on October 1, or as soon after as possible.

Four copies of applications, giving details of any special qualifications, with names of three referees, must be sent to reach the undersigned by August 24. Further particulars may be obtained from

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

UNIVERSITY OF DURHAM

Applications are invited from investigators in any field of Cancer Research for the post of Director of Cancer Research in the Newcastle Division of the University (King's College). Salary £1,000 to £1,500 according to the qualifications and experience of the successful candidate.

Further particulars are obtainable from the undersigned, with whom 20 copies of application should be lodged by September 30, 1946.

W. S. ANGUS,
University Office, Registrar.
23 St. Thomas' Street, Newcastle upon Tyne, 1.

THE UNIVERSITY OF MANCHESTER

Applications are invited for appointment to Two Assistant Lectureships in Zoology. Candidates for one of the posts should possess special qualifications in Entomology. Stipend £350 per annum. Duties to commence September 29, 1946, or as soon thereafter as possible. All applications must be sent not later than September 1 to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF CHEMISTRY

Applications are invited for three posts as Assistant Lecturer in Chemistry, salary £400-£450, duties to commence as soon as possible.

Three copies of applications, together with copies of testimonials or names of referees, should be sent immediately to the undersigned, from whom further particulars may be obtained.

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

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

(CITY AND GUILDS COLLEGE)

Applications are invited for the post of Lecturer to teach Surveying in the Department of Civil Engineering. Candidates should have a good engineering degree or equivalent qualification and must have had good practical experience.

Commencing salary £500 p.a. with Federated Superannuation. It is desirable that the selected candidate should take up the post on October 1, 1946.

Applications should be sent to the Professor of Civil Engineering, Imperial College, London, S.W.7, so as to reach him not later than September 9, 1946.

CHESHIRE COUNTY COUNCIL

Cheshire School of Agriculture, Reaseheath

Applications are invited for the following posts: Principal, salary £900–£25–£1,000, with house; Vice-Principal and Lecturer in Agriculture, salary £600–£25–£750; Head of Horticulture Dept., salary £300–£15–£525. Forms of application from the Principal, Cheshire School of Agriculture, Reaseheath, Nantwich, to be returned by August 26, 1946.

SCOTTISH MARINE BIOLOGICAL ASSOCIATION

A Chemist and a Zoologist are required for research on hydrography and plankton at the Marine Biological Laboratory, Millport, Isle of Cumbrae. Initial salaries £350 to £500 according to age and qualifications with membership of the Federated Superannuation Scheme for Universities. Applications giving full particulars should be sent to the Secretary, Scottish Marine Biological Association, 185, St. Vincent Street, Glasgow, C.2, by August 31.

UNIVERSITY COLLEGE, SOUTHAMPTON

CHAIR OF MATHEMATICS

Council invites applications for appointment to the Chair of Mathematics. Further particulars may be obtained from the Registrar, with whom applications should be lodged not later than August 31.

UNIVERSITY COLLEGE, SOUTHAMPTON

Applications are invited for the post of Lecturer or Assistant Lecturer in Geography. Further particulars may be obtained from the Registrar, with whom applications should be lodged not later than August 31, 1946.

UNIVERSITY COLLEGE OF HULL

Applications are invited for the G. F. Grant Chair of Chemistry. Present salary £1,000 per annum minimum with superannuation benefits under the F.S.S.U. Particulars of the appointment may be obtained from the Registrar, to whom ten copies of the application should be sent not later than August 24.

(*Continued on page* xl.)

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visible over the area both in emission and absorption. According to preliminary information communicated by the Astronomer Royal, the expected geomagnetic storm—a 'great' one—began suddenly on July 26 at 18h. 46m. U.T., that is, 26¼ hours later. Up to 10h. on July 27, the ranges at Abinger in the three elements were : 1·3° in declination ; 900 γ in horizontal force and 560 γ in vertical force. An aurora was seen in Britain during the early hours of July 27.

Science Progress

With the July issue, *Science Progress* has reappeared after a lapse due to war-time difficulties. This well-known quarterly journal now has a more modern format, and the familiar green cover crowded with 'contents' has given place to a dignified buff cover containing the title and other essential bibliographical details only (London : Edward Arnold and Co. 7*s*. 6*d*. net). But although the outward form has changed, the general character of the journal has been retained, the contents consisting of general articles, notes on recent work in various branches of science, general notes, an essay review and shorter reviews. The first article is a lecture by Sir Charles Darwin on atomic energy ; Sir Edward Salisbury writes on the reproductive capacity of plants, Mr. E. J. Bowen on physical states of aggregation, Prof. P. G. H. Boswell on geology in water supply, Mr. A. Armitage on John Flamsteed, Prof. E. D. Hughes on the Walden inversion, Mr. H. W. Lee on new optical glasses and Dr. G. S. Carter on mimicry and animal behaviour—fare for the most diverse interests. There will be a general welcome for *Science Progress* on its resumption of publication ; with its general articles and surveys of scientific topics, it has taken an important part in recording and discussing scientific developments.

Transition of Neurotics from Army to Civilian Life

An investigation has been made by Dr. Eric Guttman and Elsie L. Thomas in order to find out how men discharged from the Army on account of neurosis readjusted themselves to civilian life (Min. of Health Rep. Pub. Health and Med. Subjects. No. 93. London : H.M. Stationery Office. 1*s*. 3*d*. net). The conclusions reached revealed that they had great difficulty in so adjusting, and that even after fifteen months they had a high incidence of neurotic complaints and illness. This inability to adjust themselves was shown by delay in taking up work, in frequency of job-changing and in a high rate of sickness absence. Socially they were difficult, being less sociable and less active than previously. An interesting observation confirms the findings noted in the First World War, namely, that three-quarters of the men had serious neurotic traits before enlistment. The writers conclude that the early period after a man's discharge is the critical time, and hence this is when he should receive experienced psychiatric treatment and advice. The investigation revealed the inadequacy of the possibilities for such treatment, and the hope is expressed that with the return of psychiatrists from the Services there will be increased facilities for out-patient treatment.

British Guiana : Products and Development

A memorandum by Dr. F. Benham, economic adviser to the Comptroller for Development and Welfare in the West Indies, entitled "The National Income of British Guiana, 1942", has been issued as Bulletin No. 17 in the series "Development and Welfare in the West Indies" (Bridgetown, Barbados : Advocate Co., Ltd. Pp. 28. 10 cents). The tables and notes in this memorandum bring together facts and estimates of the value of production in British Guiana and cover agricultural, forest and mineral products, manufactures, public utility services, central and local government services, distribution of imports, rental value of houses, with summaries of production, imports and domestic exports. The national income for 1942 is estimated at 49,924,000 dollars, equal to about £28 15*s*. per head of population. The net value of production was 52,274,000 dollars and was swollen by an abnormally large output of bauxite and exceptionally high prices for local foodstuffs. More than ninety per cent of the population of 361,000 live on the narrow coastal belt of alluvial soil, many parts of which are below high-water sea-level and require an annual expenditure of millions of dollars on sea- and river-defence and on irrigation and drainage. Except for machinery replacements, this expenditure has not been deducted.

Carnegie United Kingdom Trust : Grants Scheme for Museums

It is reported in the *Museums Journal* of January 1946 (p. 175) that the Trustees of the Carnegie United Kingdom Trust in drafting their plans for the period 1946–50 have set aside the sum of £30,000 for museum and art gallery development. Normally, grants will not exceed £750. Municipal and other museums (excluding the national institutions) which are members of the Museums Association and are open to the public will be eligible to make application. With certain reservations, the allotment of a grant generally requires that the museum in question (1) has an assured annual income normally equivalent to at least threepence per head of the population served, and (2) is, or will be, in the charge of a competent curator at an adequate salary. These terms are fair and commendable since they clearly aim at a general and all-round improvement of an important public service. Grants may be expended upon temporary professional and technical assistance, upon the training of recruits, upon the purchase of specimens necessary to fill in gaps in the sequence of exhibits, and upon such fittings (cases, etc.) as are essential to the scheme of reorganisation. They may not, however, be expended upon structural work on the main fabric of buildings.

George Westinghouse Newspaper Science Writing Award

In honour of the centenary of George Westinghouse, founder of the Company, the Westinghouse Educational Foundation has provided funds for the award by the American Association for the Advancement of Science of awards for the encouragement of better science reporting in newspapers. The first annual George Westinghouse Newspaper Science Writing Award of 1,000 dollars will be made in December next "to the working newspaper man or woman judged to have written the best science story or series of stories this year". Entries submitted must have appeared in a newspaper, published in the United States or its territories, between October 16, 1945 and October 15, 1946 inclusive. Entry forms can be obtained from Dr. Willard L. Valentine, Editor of *Science*, Smithsonian Institution Building, Washington, 25, D.C., to whom they are to be returned under post-mark not later than midnight, October 20, 1946.

British Iron and Steel Research Association: Appointments

THE following announcements have recently been made by the British Iron and Steel Research Association:

Mr. M. W. Thring has been appointed head of the Physics Department. Mr. Thring has been with the British Coal Utilisation Research Association for many years, and recently has been in charge of the Furnace Research Section and Combustion Research Laboratories. For the past eighteen months he and a large part of his team have been engaged on a co-operative research with Dr. J. H. Chesters and the United Steel Companies, Ltd., into the study of flames in furnaces; the 'down jet' method of combustion and the use of radon for studying gas flow in furnaces were originated by this team. Mr. Thring has also written papers on the laws governing energy flow in heating appliances, starting to form a link between Gibbsian thermostatics and industrial thermodynamics.

Dr. W. C. Newell, until recently on the staff of the Brown-Firth Research Laboratories, Sheffield, has been appointed head of the Steel Castings Division. Dr. Newell received his training and research experience at the Royal College of Science.

Mr. E. L. Diamond has been appointed mechanical engineer to the Plant Engineering Division. Mr. Diamond graduated in engineering with honours at King's College, London, in 1922, and then became a pupil of the late Sir Henry Fowler at the Derby locomotive works of the Midland Railway, later assisting in experimental work. Since 1926 he has been on the technical staff of the Institution of Mechanical Engineers, except during the war years. He has published a number of papers on technical locomotive problems.

Beit Memorial Fellowships for Medical Research

AT a recent meeting of the trustees of the Beit Memorial Fellowships, it was announced that Sir John Anderson and Sir Henry Dale had been elected trustees; Lord Rayleigh and Lord Macmillan have resigned from the board. The Trustees noted with pleasure that Dr. E. B. Verney (fellow 1922–26) had been elected professor of pharmacology, Cambridge; Dr. Janet Vaughan (1931–34), principal of Somerville College, Oxford; Dr. B. G. Maegraith (1933–34), professor of tropical medicine, Liverpool; Dr. J. S. Mitchell (1934–37), professor of radiotherapeutics, University of Cambridge; Dr. R. J. Kellar (1935–37), professor of midwifery, University of Edinburgh; and that Dr. R. J. Hill (1929–31) and Dr. G. R. Cameron (1930–33) had been elected to the fellowship of the Royal Society.

The following elections were made: *Fourth Year Fellowships*. Dr. G. J. Popjak, to study the behaviour of plasma lipids under different experimental conditions and the problem of fœtal fat metabolism (at the Department of Pathology, St. Thomas's Hospital, London); Dr. Ethel G. Teece, to study the chemistry of bacterial polysaccharides and nucleoproteins with special reference to the Gram complex and to the factors responsible for cell division (at the Department of Chemistry, University of Birmingham). *Junior Fellowships*. Dr. S. E. Dicker, to study the extrarenal water metabolism and renal function in rats (at the Department of Pharmacology, University of Bristol); P. M. Tow, to study prefrontal leucotomy and the function of the frontal area (at the Research Department, Runwell Hospital for Nervous and Mental Diseases).

University of London

THE following appointments have been announced:

Dr. Jaroslav Cerny, to the University chair of Egyptology tenable at University College as from October 1. During 1927–33 he worked in the Department of Antiquities, Egyptian Government; he accompanied the Harvard University Expedition to Sinai in 1935 and during 1942–45 he was in the Czech Diplomatic Service.

Dr. N. H. Fairley, to the Wellcome chair of tropical medicine tenable at the London School of Hygiene and Tropical Medicine as from October 1. He has been lecturer in clinical tropical medicine at the School and lecturer in tropical medicine at Westminster Hospital. During 1916–19 he was pathologist and later senior physician in the 14th Australian General Hospital; since 1942 he has been Director of Medicine to the A.M.F.

Dr. George Macdonald, to the University chair of tropical hygiene tenable at the London School of Hygiene and Tropical Medicine as from October 1. In 1939 he was appointed assistant director of the Ross Institute at the London School of Hygiene and Tropical Medicine, but he joined the R.A.M.C. and became officer commanding various malaria field laboratories in the Near and Middle East. During 1943–44 he was consultant malariologist to the Middle East and Central Mediterranean Forces, and in 1945 he was appointed director of the Ross Institute of the School.

Prof. J. T. Randall, to the Wheatstone chair of physics tenable at King's College as from October 1; since 1944, he has been professor of natural philosophy in the University of St. Andrews (see *Nature*, 156, 685; 1945).

Dr. R. M. Barrer, to the University readership in chemistry tenable at Bedford College as from October 1. During 1935–39 he was supervisor in chemistry and research fellow of Clare College, Cambridge, and since 1939 he has been head of the Chemistry Department at Bradford Technical College.

Mr. Edward A. Shils, to the University readership in sociology tenable at the London School of Economics from October 1. During 1942–44 he was in London on work in connexion with the Federal Communications Commission and SHAEF; he is at present associate professor of sociology in the University of Chicago.

Dr. F. C. O. Valentine, to the University readership in chemotherapy tenable at the London Hospital Medical College as from October 1. Since 1939 he has been pathologist, Emergency Medical Service.

British Association: New Officers

IT is announced by the British Association that the following changes in office bearers have been approved by the General Committee: *President*, Sir Henry Dale, to succeed Sir Richard Gregory on January 1, 1947 (see *Nature*, July 27, p. 124); *General Officers* (with effect from July 20, 1946): *Treasurer*, Mr. M. G. Bennett, to succeed Sir Harold Hartley; *General Secretaries*, Dr. E. Hindle and Sir John Lennard-Jones, to succeed Prof. F. T. Brooks, Prof. D. Brunt and Prof. Allan Ferguson; *Secretary*, Mr. D. N. Lowe, to succeed Dr. O. J. R. Howarth.

ERRATUM. The author of a paper, referred to in *Nature* of March 9, p. 311, on the residual toxicity of D.D.T. to bedbugs, is incorrectly given as Miss Sarah Banks; the author is Dr. Sarah Barnes.

LETTERS TO THE EDITORS

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

Fission Products of U^{235}

THE first quantitative measurements on the formation of fission products in thermal neutron bombardment of uranium were made by Anderson, Fermi and von Grosse[1]. The fission yield of a fission isotope is the probability of the isotope being formed per thermal neutron fission. In bombardment, the rate of production of any active isotope from fission, that is, the fission rate multiplied by the fission yield, is equal to the disintegration rate of the active isotope referred to saturation of bombardment for the isotope. Thus data required for measurement of the fission yield of an active fission isotope are : (*a*) number of fissions occurring in a given sample per unit time ; and (*b*) disintegrations per unit time of the isotope referred to saturation of bombardment.

Grummitt, Gueron, Wilkinson and Yaffe[2] determined the fission yields for Ba^{139} (86 min.), Ba^{140} (12·7 days) and La^{140} (40 hr.) produced in thermal neutron fission of U^{235}. The direct determination of fission rate in the bombarded sample was avoided by comparison of U^{239} (23 min.) and fission product β^- activities : accepting the ratio of the capture (σ_c) and fission (σ_f) cross-sections for thermal neutrons on natural uranium, the fission yield Yf is given by the expression

$$\frac{\text{U}^{239}\text{ activity (referred to saturation of bombardment)}}{\text{Fission product activity (referred to saturation of bombardment)}} = \frac{\text{Thermal neutron capture rate}}{Yf \times \text{thermal fission rate}} = \frac{\sigma_c}{Y f \sigma_f}.$$

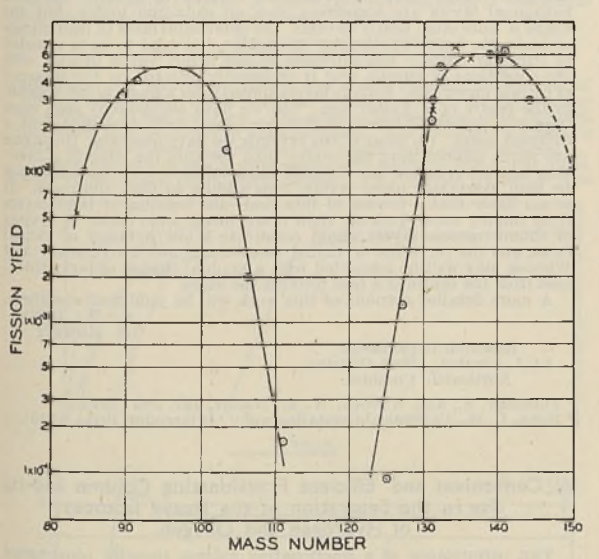
For Ba^{139} and La^{140}, values of $6{\cdot}1 \times 10^{-2}$ and $5{\cdot}8 \times 10^{-2}$ respectively were obtained. The fission yield for Ba^{140} was $4{\cdot}3 \times 10^{-2}$. In the growth of La^{140}, from the parent Ba^{140}, 1·43 times as many La^{140} as Ba^{140} disintegrations were observed. Corrections were made for self-weakening of β^- rays in the samples, and for external absorption of β^- rays in the counting arrangement used. The latter was such that β^- rays of maximum energy below 0·1 Mev. were not observable. In subsequent work with the β^- ray spectrometer, L. G. Elliott[3] has shown that a large fraction of the electrons from Ba^{140} are below 32 Kev. These electrons would be completely stopped in the mica window of the counters used. If these are a low-energy β^- ray spectrum, and not conversion electrons, they would, of course, give rise to La^{140}, and could account for the observed growth of La^{140}. Further indication has been obtained using a windowless counter.

Fission yields of other fission isotopes can be obtained by activity comparisons to Ba^{140} in the same counting arrangements using the apparent or reference yield of $4{\cdot}3 \times 10^{-2}$ for Ba^{140}. The longer-lived fission products of uranium have been studied by this method. If Y_i, A_i and Y_{Ba}, A_{Ba} are respectively the fission yields and activities (referred to saturation of bombardment) of any fission product i and Ba^{140}, then

$$Y_i = \frac{A_i}{A_{Ba}} \times Y_{Ba}, \text{ where } Y_{Ba} = 4{\cdot}3 \times 10^{-2}.$$

Fission yields have been obtained in this way for twenty-two fission isotopes.

In the graph, the logarithm of the fission yield is plotted against the mass number of the fission isotope. In addition to the present results, fission yields for krypton and xenon isotopes of masses 83, 84, 86, 131, 132, 134 and 136 are included. These were obtained for mass-spectrographic determinations of isotopic abundances in fission product gases by H. G. Thode *et al.*[4], using as a reference the fission yield of I^{131} obtained by activity comparison to Ba^{140}, with the assumption that I^{131} decays directly to Xe^{131}.



FISSION YIELD *vs.* MASS NUMBER FOR THERMAL NEUTRON FISSION OF U^{235}

⊙, From activity comparisons

×, Calculated from mass-spectrographic abundance data for krypton and xenon

(*A*) Two symmetrical groups of fission products are formed with maxima at mass numbers 96 and 138 and a fission yield of $\sim 6 \times 10^{-2}$. The sum of the maxima is approximately 234, inferring that on the average, between one and three secondary neutrons are emitted per fission.

(*B*) The masses at a fission yield of 1×10^{-2} are 89 and 104 in the 'light group' and 130 and 151 in the 'heavy group'.

(*C*) The total of fission yields is 0·9 for each group. The divergence from unity is almost certainly due to a low value for the reference yield of Ba^{140}. A value of $4{\cdot}8 \times 10^{-6}$ would remove the discrepancy and place the maxima at about $6{\cdot}5 \times 10^{-2}$.

(*D*) The greater part of the heavy group lies in the rare earth region, and fission isotopes up to europium might be expected.

(*E*) After about 100 days, the measured gross activity of U^{236} fission products is accounted for by activities of the separated isotopes.

(*F*) Several previously unreported isotopes have been observed during the course of the present work, namely, $Sn^{>120}$ (136 days, 1·2 Mev.); $Sn^{>120}$ (17·5 days, 1·7 Mev.); $Sn^{>120}$ (7·0 days, 1·8 Mev.); $Sb^{(125)}$ (several years, 0·56 Mev.); $Sb^{>125}$ (28 days, 1·86 Mev.); $Cs^{(136)}$ (~ 20 days). Fission yields of these and the following β^- active isotopes were measured : Sr^{89} (54·5 days, 1·5 Mev.); Sr^{90} (~ 70 years, 0·6 Mev.), Y^{90} (72 hr., 2·2 Mev.); Y^{91} (61 days, 1·4 Mev.); Zr^{95} (65 days, 0·5 Mev.), Nb^{95} (33 days, 0·15 Mev.); Ru^{103} (37 days, 0·25 Mev.); $Ru^{(106)}$ (290 days), $Rh^{(106)}$ (30 sec., 3·3 Mev.); Ag^{111} (7·5 days, 0·9 Mev.); Sb^{127} (95 hr., 0·8 Mev.), Te^{*127} (90 days I.T.), Te^{127} (9·3 hours, 0·77 Mev.); Te^{*129} (32 days I.T.), Te^{129} (72 min., 1·5 Mev.); I^{131} (8·1 days, 0·6 Mev.); I^{132} (2·30 hr., 1·35 Mev.); $Cs^{(135)}$ (~ 100 years, 0·8 Mev.); Ba^{139} (86 min., 2·2 Mev.); Ba^{140} (12·7 days, 0·92 Mev.), La^{140} (40 hr., 1·4 Mev.); $Ce^{(141)}$ (18 days); Ce^{144} (290 days, 0·4 Mev.), Pr^{144} (17 min., 2·5 Mev.).

A detailed account of the experimental work is in preparation.

W. E. GRUMMITT
G. WILKINSON

Atomic Energy Division,
National Research Council,
Chalk River Laboratory,
Chalk River, Ontario.
June 1.

[1] Anderson, H., Fermi, E., von Grosse, A., *Phys. Rev.*, **59**, 52 (1941).
[2] Grummitt, W. E., Gueron, J., Wilkinson, G., Yaffe, L., unpublished work (Montreal, 1944).
[3] Elliott, L. G., unpublished work (Montreal, 1945).
[4] Thode, H. G., Graham, R. L., Harkness, A. L., unpublished work (Hamilton, Ont., 1945).

Polyatomic Electronic Spectra : Further Analysis of the Vibrations of the $^1B_{2u}$ State of Benzene

IN a previous communication[1] we indicated how, in the example of the $^1B_{2u}$ state of C_6H_6 and C_6D_6, the product theorem and computations of force constants could be used to calculate or verify vibrational frequencies in electronically excited molecules. The discussion was almost entirely confined to the out-of-plane vibrations of both molecules, as insufficient experimental data were then available to permit calculations of the product ratios or force constants of the in-plane vibrations. It has now, however, been found possible to apply these methods to the in-plane vibrations, thus completing the first determination of a force system of an excited polyatomic molecule.

It was pointed out that Sponer's assignment of the frequencies 2565 cm.$^{-1}$ in C_6H_6 [2] and 1821 cm.$^{-1}$ in C_6D_6 [3] to the A_{1g}(H) vibration of the excited state, when combined with the known A_{1g}(C) frequencies, 923 cm.$^{-1}$ and 879 cm.$^{-1}$, of excited C_6H_6 and C_6D_6 respectively, was not in agreement with the product theorem. We now propose that the C_6H_6 progression previously regarded as

$$0-0 + 520\ (\overset{+}{E_g})' + 2565\ (A_{1g})' + \nu_1' \times 923\ (A_{1g})'$$

and the corresponding C_6D_6 progression

$$0-0 + 499\ (\overset{+}{E_g})' + 1821\ (A_{1g})' + \nu_1' \times 879\ (A_{1g})'$$

should be formulated

$$0-0 + 3085\ (\overset{+}{E_g})' + \nu_1' \times 923\ (A_{1g})'$$

and $\quad 0-0 + 2320\ (\overset{+}{E_g})' + \nu_1' \times 879\ (A_{1g})'$ respectively.

The frequencies 3085 cm.$^{-1}$ in C_6H_6 and 2320 cm.$^{-1}$ in C_6D_6 are assigned to the $\overset{+}{E_g}$ (H-stretching) vibration of the excited state. The frequencies of the same vibration in the electronic ground-state are 3047 cm.$^{-1}$ in C_6H_6 and 2264 cm.$^{-1}$ in C_6D_6. The assignment thus implies that the hydrogen-stretching force constant is higher in the excited state than in the ground-state, unlike other force constants, which we find to be reduced as a result of excitation. If the electron which is excited is one of the π-electrons then it seems plausible, not only that forces involving deformations of C–C bonds should be reduced, but also that the C–H bonds may slightly increase their order at the expense of the weakened ring system, with the result that the hydrogen-stretching constant becomes increased.

An immediate consequence is that the A_{1g}(H) frequencies should be raised. Consistent values are obtained from the hitherto unassigned progressions

$$0-0 + 520\ (\overset{+}{E_g})' + 3130\ (A_{1g})' + \nu_1' \times 923\ (A_{1g})'$$

in the absorption spectrum of C_6H_6 and

$$0-0 + 499\ (\overset{+}{E_g})' + 2361\ (A_{1g})' + \nu_1' \times 879\ (A_{1g})',$$

in that of C_6D_6. The frequencies 3130 and 2361 cm.$^{-1}$ are assigned to the A_{1g}(H) vibration of the excited state. The product ratio,

$$\Pi A_{1g}(C_6H_6)'/\Pi A_{1g}(C_6D_6)' = 923 \times 3130/879 \times 2361 = 1{\cdot}392,$$

is in satisfactory agreement with the ground-state value 1·404.

Confirmation of this idea has been forthcoming in the analysis of the electronic spectra of several partly deuterated benzenes. In 1 : 3 : 5-$C_6H_3D_3$, the excited state frequencies, 3138 cm.$^{-1}$ and 2337 cm.$^{-1}$, can be assigned to A_1'(H) and A_1'(D) vibrations respectively. The corresponding values for the ground-state are 3053 cm.$^{-1}$ and 2282 cm.$^{-1}$ [4]. Perhaps the strongest argument is that, in the absorption spectrum of 1 : 4-$C_6H_4D_2$, the progression corresponding to the C_6H_6 progression $0-0 + 3085 + 923\ \nu_1'$ is doubled, while that corresponding to the C_6D_6 progression $0-0 + 2320 + 879\ \nu_1'$ remains single; whereas, in the spectrum of 1 : 2 : 4 : 5-$C_6H_2D_4$, the former progression is single and the latter double. In C_6H_6 and C_6D_6, Sponer assigned the frequencies 3085 and 2320 cm.$^{-1}$ to a combination of an $\overset{+}{E}_g$(C) and an A_{1g}(H) vibration, whereas we have assigned them to a fundamental $\overset{+}{E}_g$(H) vibration. For $C_6H_4D_2$ and $C_6H_2D_4$ the distinction follows that, whereas Sponer's view would permit only the two A_g hydrogen-stretching vibrations to start progressions, our analysis additionally allows the related B_{1g} vibration to give the extra progression which in each case is observed. A summary of the ground- and excited-state frequencies (in cm.$^{-1}$) of the A_{1g}-, B_{1u}- and $\overset{+}{E}_g$-like hydrogen-stretching vibrations of some isotopic benzenes is given below.

State	D_{6h}			D_{3h}		V_h		
	Sym.	C_6H_6	C_6D_6	Sym.	$C_6H_3D_3$	Sym.	$C_6H_4D_2$	$C_6H_2D_4$
Ground	B_{1u}	3060	2290	A_1'	2282			
Excited		3138	2337		2337			
Ground	A_{1g}	3062	2293		3053		2280	3045
Excited		3130	2361		3138	A_g	2353	3132
Ground	$\overset{+}{E}_g$	3047	2264				3055	2285
Excited		3085	2320				3085	2356
Ground		3047	2264				3042	2272
Excited		3085	2320			B_{1g}	3077	2334

In 1 : 3 : 5-$C_6H_3D_3$ two main progressions are observed. One, in 893 cm.$^{-1}$, corresponds to the A_{1g}(C) progression, 923 cm.$^{-1}$ in C_6H_6, and 879 cm.$^{-1}$ in C_6D_6. The other, in 987 cm.$^{-1}$, corresponds to the B_{1u}(C) vibration, which in C_6H_6 and C_6D_6 cannot produce progressions; but, as modified in $C_6H_3D_3$, can do so. The frequencies 893 and 987 cm.$^{-1}$ belong to the A_1' class of $C_6H_3D_3$ vibrations, and, from these and other known frequencies, we can, using the product theorem, calculate, for the inactive B'_{1u}(C) frequencies of excited C_6H_6 and C_6D_6, the values 1001 and 948 cm.$^{-1}$ respectively.

Sklar, Sponer, Nordheim and Teller have determined the frequencies of the two E_g(C) vibrations of excited C_6H_6 and C_6D_6 [2,3], and we have dealt above with the $\overset{+}{E}_g$ (H-stretching) vibration. The frequencies of the $\overset{+}{E}_g$ (H-bending) vibration are identified through the observed progressions $0-0 + 1045 + 923\ \nu_1'$ of C_6H_6 and $0-0 + 775 + 879\ \nu_1'$ of C_6D_6. The frequencies 1045 and 775 cm.$^{-1}$ must belong to vibrations having $\overset{+}{E}_g$ symmetry, and we have assigned them to the $\overset{+}{E}_g$ (H-bending) vibration. The resulting product ratio,

$$\Pi\overset{+}{E}_g(C_6H_6)'/\Pi\overset{+}{E}_g(C_6D_6)' = 1{\cdot}965,$$

compares well with the ground-state value 1·967. Further confirmation arises from assignments in the A_g class of 1 : 4-$C_6H_4D_2$ and 1 : 2 : 4 : 5-$C_6H_2D_4$ vibrations.

Wilson's potential function for benzene contains four in-plane force constants, which may be considered as denoting C-stretching (F), H-stretching (f), C-bending (D), and H-bending (d) [5,6]. The C_6H_6 and C_6D_6 frequencies which are now available for the calculation of these constants for the excited state of benzene are listed below, together with the corresponding ground-state frequencies and the percentage changes which accompany electronic excitation.

Vibration	C_6H_6			C_6D_6		
	Ground	Excited	% change	Ground	Excited	% change
A_{1g}(C)	992	923	−7	943	879	−7
A_{1g}(H)	3062	3130	+2	2293	2361	+3
B_{1u}(C)	1010	1001	−1	963	948	−2
B_{1u}(H)	3060	3138	+2	2290	2337	+2
$\overset{+}{E}_g$(C1)	606	520	−14	577	499	−14
$\overset{+}{E}_g$(C2)	1596	1476	−8	1551	1408	−9
$\overset{+}{E}_g$(H1)	3047	3085	+1	2265	2320	+2
$\overset{+}{E}_g$(H2)	1178	1045	−11	867	775	−11

Some force constants (in 10^5 dynes/cm.), calculated from these frequencies using Kohlrausch's form of Wilson's equations, are listed below, together with the ground-state values calculated from the same equations. The constants F and f were calculated from the A_{1g} frequencies, while D and d were obtained from the B_{1u} and $\overset{+}{E}_g$ frequencies.

		F	f	D	d
C_6H_6	ground	7·6	5·0	0·77	0·60
	excited	6·5	5·3	0·56	0·45
C_6D_6	ground	7·6	5·1	0·82	0·57
	excited	6·5	5·3	0·57	0·46

These constants cannot be regarded as more than provisional, and are given to indicate the approximate amounts by which force constants change as a result of electronic excitation. It is interesting to note the smaller changes in these in-plane force constants, as compared with reductions of the out-of-plane constants by 50 per cent or more[1].

C. K. Ingold
Francesca M. Garforth

Sir William Ramsay and
Ralph Forster Laboratories,
University College, London.
June 22.

[1] *Nature*, **157**, 46 (1946).
[2] *J. Chem. Phys.*, **7**, 207 (1939).
[3] *J. Chem. Phys.*, **8**, 705 (1940).
[4] *J. Chem. Soc.*, 256 (1946).
[5] *Phys. Rev.*, **45**, 712 (1934).
[6] *Z. Phys. Chem.*, **30**, 307 (1935).

Topography of Crystal Faces

In *Nature* of May 4, Tolansky and Wilcock[1] report various features of the topography of the face of a diamond crystal, and conclude that the triangular pits often seen on the faces are due to growth, not to solution: a layer, spreading across the crystal face, does not at first cover a particular region but grows all round it, afterwards closing in on it from three directions to form a triangular pit. We wish to report that, in observing certain crystals growing from solution, we have often seen this sort of thing actually happening—not of course on diamond, but on crystals of water-soluble substances, notably potassium dihydrogen phosphate. The layers we have seen, since they are easily visible under the microscope, are much thicker than those seen by Tolansky and Wilcock on diamond. Two further points are worth mentioning. One is that these pits are often irregular in shape; this is natural enough when the advancing edges of the layers are irregular, as is the case more often than not when growth is rapid. Irregular pits found on finished crystals may therefore be due to growth, no less than regular ones. The second point is that the pits often become completely filled in, there being afterwards no visible trace of their existence.

With regard to the stepped pyramids seen by Tolansky and Wilcock on diamond, we have seen similar features on a number of crystals, again on a much larger scale. Two photographs showing examples of this are shown in a recently published book by one of us[2]. Layers of octagonal shape have been seen on crystals of sodium chloride; hexagonal layers are sometimes seen on cadmium iodide, but the shape is more often nearly circular. On octahedral faces of lead nitrate crystals, the layers are roughly triangular, but tend to have rounded or irregular edges. The thickness of the layers varies greatly with the conditions of growth, and is profoundly affected by the presence of certain impurities. Usually layers spread from a single point, roughly in the centre of a crystal face: but we have occasionally seen more than one system of layers on the same face, each spreading from a different point. On most of the crystals we have observed, the layers are much thinner near the centre than towards the edge of a face: thin layers, spreading more rapidly than thicker ones, can sometimes be seen overtaking lower layers, thus adding to their thickness. It seems likely that a process of this kind—the building of thick layers from thinner ones—goes on, right down to the ionic scale. A system of submicroscopic layers would constitute a low pyramid of vicinal faces, and the curvature of vicinal faces mentioned by Tolansky and Wilcock may well be connected with a gradual change of layer thickness from the centre of a face towards the edges.

A more detailed account of this work will be published elsewhere.

C. W. Bunn
H. Emmett

Research Department,
I.C.I. Limited, Alkali Division,
Northwich, Cheshire.

[1] Tolansky, S., and Wilcock, W. L., *Nature*, **157**, 583 (1946).
[2] Bunn, C. W., "Chemical Crystallography" (Clarendon Press, 1945).

A Convenient and Efficient Fractionating Column and its Use in the Separation of the Heavy Isotopes of Hydrogen and Oxygen

The performance of a fractionating column recently constructed and used in this Department prompts us to place on record its chief characteristics. The column is packed with miniature (1/16 in.) Θ-shaped 'rings' of phosphor-bronze gauze (100 mesh) and is enclosed in a vacuum jacket containing multiple, concentric aluminium reflectors. The length of the packed section is 12 ft. and its internal diameter is

20 mm. The column is supported on a specially designed 'grid'. The 'grid' is a three-sided structure of metal piping built in the centre of a small laboratory, so that all points outside and inside the [_]-shaped assembly are easily accessible. The whole structure acts as a convenient supporting device, and the various metal pipes from which it is constructed serve to bring the usual services (gas, inlet and exit water) to numerous points suitably spaced for serving different types of fractionating columns and other items of equipment. The 'grid' also supports a large slate switchboard, from which all the electrical services can be controlled, and 'hard' and 'soft' vacuum lines are included in the assembly.

For the enrichment of the heavy isotopes of hydrogen and oxygen by the fractionation of water, the 'boiler' used was a 750 ml. glass vessel which was charged with 500 ml. of water and heated by internal electrical heaters. The total condensate was delivered into a full reservoir (containing 20 litres of water) from which an identical quantity of water was returned to the top of the column through a small pre-heater. After twenty-four days of continuous distillation, we obtained 500 ml. of water which was 200 parts per million heavy in deuterium and 350 parts per million heavy in O^{18}. We have not yet had the opportunity of running the column to equilibrium, and thus to determine its platage, but we estimate from our preliminary results for the enrichment of O^{18} after various times, using the vapour pressure data of Wahl and Urey[1], that the efficiency of the unit is equivalent to about 450 theoretical plates for a boil-up rate of 500 ml. of water per hour.

Up to the present we have operated this type of column at atmospheric pressure, but experiments under reduced pressure are in hand. The column has been running almost continuously, day and night, for weeks, requiring no attention, various automatic safety devices and controls having been incorporated. The importance of fractionating columns of this degree of efficiency cannot be overstressed, particularly in connexion with the separation of isotopes and the close fractionation of mixtures of organic compounds.

Work on the design of efficient laboratory fractionating columns and their use in the separation of isotopic and other mixtures is continuing; our detailed results will be published elsewhere.

We are indebted to Dr. M. P. Applebey and Imperial Chemical Industries, Ltd., Billingham Division, for advance information concerning their metal gauze packing and distillation technique, and to Mr. T. R. Jacobs for most valuable assistance in the construction of the apparatus.

I. Dostrovsky
E. D. Hughes

Department of Chemistry,
University College of North Wales,
Bangor.
July 3.

[1] *J. Chem. Phys.*, **3**, 411 (1935).

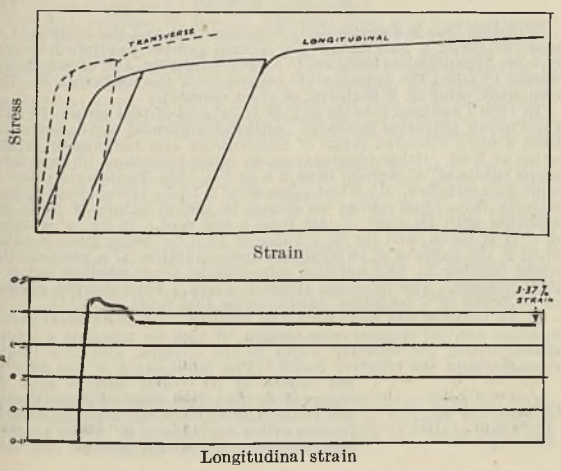
'Plastic' Transverse Contraction of a Longitudinally Strained Metal

Some experimental work has been done to examine the parameters in my theory of stress-strain relationships beyond the yield point of metals[1]. This theory includes the classical equations of elasticity as a particular case. The total strain in a specimen under simple tensile loading is called 'inelastic' and divided into the two idealized components 'elastic' and 'plastic'. When load is removed, the elastic strains disappear, but the plastic strains remain. Attention was directed in the theory to the importance of the ratio of the transverse to the longitudinal plastic or permanent deformations in the simple tensile test of the metal considered. The ratio

$$p = \frac{\text{Transverse plastic strain}}{\text{Longitudinal plastic strain}}$$

was given the value $\frac{1}{2}$ because it was stated that the plastic part of the inelastic strain would occur at constant volume in the absence of evidence to the contrary. The present experiments were designed to correct this deficiency in our knowledge. The well-known Poisson's ratio is that of the transverse to the longitudinal elastic strains.

Measurements of strain were made with Baldwin *S.R.*4, 120 ohms, $\frac{1}{2}$-in. gauge-length orthogonally crossed *AX*5 electric resistance wire strain-gauges stuck to a duralumin simple tensile specimen with 'Duco Household Cement'. The specimen had a working section 4 in. × 1$\frac{1}{4}$ in. × $\frac{1}{4}$ in. An optical extensometer of 2$\frac{1}{4}$ in. gauge-length spanned longitudinally over the electric gauge and its readings were used to calibrate the Baldwin gauges.



The ratio p was found to reach a maximum value 0·42 at the corner of the stress-strain curve and then drop quickly to a constant value 0·37 up to the maximum longitudinal strain 3·37 per cent, at which the electric strain-gauge wire broke. This value 0·37, instead of the ideal $\frac{1}{2}$, indicates that volume changes *do* occur in the plastic component of the strain as well as in the elastic part. Further tests will be made to check this value and to find the value for other materials than duralumin.

It is suggested tentatively, as a result of the few tests available up to the present, that p will have a value appropriate to each material tested. When giving the properties of metals for use by designers, it will be necessary to state p as well as Poisson's ratio q for use in a stress analysis.

K. H. Swainger

Civil Engineering Department,
Imperial College of Science and Technology,
London, S.W.7.
July 1.

[1] *Phil. Mag.*, July 1945.

The Mass of the Universe

One of the comparatively few points of similarity in current cosmological theories is the occurrence in each of a parameter of mass of the order of 10^{55} gm., equivalent to about 10^{79} protons. In Eddington's cosmology this parameter is fundamental; and in Milne's, although he assumes that the world is infinite, there appears a similar constant[1] which he calls the 'fictitious mass of the universe'. This common feature in theories otherwise so different suggests that there may be a less sophisticated method of derivation, possibly within the framework of classical mechanics, the far-reaching cosmological applications of which were first pointed out by Milne[2] and McCrea[3] and have since been emphasized by Heckmann[4].

It is well known that the classical formula for the *gravitational* energy of a homogeneous sphere of mass M and radius R is

$$V = \frac{3GM^2}{5R}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where G is the constant of gravitation. In general, this is very much smaller than the *inertial* energy assigned by Einstein,

$$E = Mc^2, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where c is the velocity of light.

According to Mach's principle, the inertia of a body is due to the background influence of the whole physical universe. According to Einstein's principle of equivalence, gravitation is akin to inertia. Thus, the gravitational background influence of the whole universe should be equivalent to its inertial influence. Formula (1), however, is derived on the assumption that we can neglect the gravitational influence of all matter other than that constituting the sphere in question. Presumably this omission accounts for, or at least accentuates, the great numerical discrepancies between (1) and (2) (a crude calculation for the earth gives $E \sim 10^9\ V$, and for the sun $E \sim 10^4\ V$); but, if it is legitimate to regard a certain homogeneous 'sphere' as a first approximation to the universe 'in the large', then for such a body we should expect the discrepancy, if any, to be much less. Hence, if we tentatively assume that, for our model universe,

$$E = V, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

we find that its mass and radius must be related by the law,

$$M = \frac{kc^2R}{G}, \quad . \quad . \quad . \quad . \quad (4)$$

where $k = 5/3 \sim 1{\cdot}67$. This law can also be obtained by a simple dimensional argument, assuming that the constant of gravitation is determined by c, R and M only; but k cannot be determined in this way.

It is remarkable that formula (4) is identical with the corresponding formula connecting the mass and radius of the Einstein universe, except that, in the latter case, $k = \pi/2 \sim 1{\cdot}57$. Thus the crude estimate given by (4) lies within about six per cent of the precise value for the mass of the Einstein universe of the same radius. The latter, of course, has a non-Euclidean metric.

Furthermore, if following Milne we substitute in (4) the relation,

$$R = ct, \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where t is approximately 2×10^9 years, we immediately obtain his well-known formula[5],

$$M = \frac{c^3t}{G}, \quad . \quad . \quad . \quad . \quad . \quad (6)$$

except for an extraneous factor 5/3; hence, in Milne's case, $k = 1{\cdot}00$.

In all three cases, if R is of the same order of magnitude as ct, M is of the order of 10^{55} gm. or 10^{79} protons. This figure cannot be compared directly with observation, but nebular counts provide an estimate for the local density, ρ. According to Hubble[6], this is not greater than about 10^{-29} gm./cm.^{3}, but this figure must be regarded as provisional and may have to be increased. In Milne's model, space is Euclidean; consequently,

$$M = \frac{4}{3}\pi\rho R^3, \quad . \quad . \quad . \quad . \quad (7)$$

and hence Milne's predicted value of ρ is of the order of 10^{-27} gm./cm.^{3}. On the other hand, in the Einstein universe, which is the basis of Eddington's system, space is hyperspherical; consequently,

$$M = 2\pi^2\rho R^3. \quad . \quad . \quad . \quad . \quad (8)$$

With the value assigned by Eddington to the Einstein radius of space, ρ is again of the order of 10^{-27} gm./cm.^{3}, but at the present epoch of expansion Eddington considered that the radius is about five times[7] the Einstein radius, giving ρ of the order of 10^{-29} gm./cm.^{3}.

Hence, rival theories assign numerically different values for the local density distribution. Nevertheless, they agree in isolating mass parameters of the same order of magnitude. As a tentative physical explanation of this theoretical phenomenon, it is suggested that 10^{55} gm. is the *order* of mass which a homogeneous and spherically symmetrical continuous material system must possess if: (i) its gravitational potential energy is comparable with its inertial potential energy; and (ii) its radius is of the *order* of 2×10^9 light-years.

G. J. Whitrow

Department of Mathematics and Mechanics,
Imperial College of Science and Technology,
London, S.W.7.
June 21.

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Cascade Showers under Thin Layers of Materials

In a previous paper, Bhabha and Chakrabarty[1] discussed the general theory of the production of cascade showers. The solution obtained there was finally evaluated by the saddle-point method, and it was shown that the same expression cannot be used for small values of t and y_0, where t is the thickness of the material in radiation units and y_0 is $\log (E_0/\beta)$, where E_0 is the energy of the primary particle and β is the critical energy for the material. Consequently in that paper numerical values were obtained only for values of $y_0 \geqslant 3$ and $t \geqslant 2$.

It can be seen, however, that $P(E,t)dE$, which represents the number of particles (electrons and positrons) having energies between E and $E + dE$ (produced by a primary particle of energy E_0) at a depth t below the surface of the material, is *exactly* given by

$$P(E,t) = \frac{1}{2\pi i}\int_{\kappa - i\infty}^{\kappa + i\infty} e^{rt}dr \cdot \frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty}\left(\frac{E_0}{E}\right)^s \left\{\sum_{n=0}^{\infty}\left(-\frac{\beta}{E_0}\right)^n \cdot \frac{\Gamma(s)}{\Gamma(s-n)} \prod_{i=0}^{n}\frac{D + r}{(r + \lambda_{s-i})(r + \mu_{s-i})}\right\} ds, \quad . \quad (1)$$

where λ_s, μ_s are functions of s (see ref. 1). For convenience in calculations, we can express (1) in the form

$$P(E,t) = \frac{1}{2\pi i}\int_{\kappa - i\infty}^{\kappa + i\infty} e^{rt}dr \cdot \frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty}\left(\frac{E_0}{E + \beta g(s,r)}\right)^s f(s,r,\beta)ds. \quad . \quad . \quad (2)$$

where

$$f(s,r,\beta) = f(s,r) - \frac{\beta}{E_0}f_1(s,r) + \left(\frac{\beta}{E_0}\right)^2 f_2(s,r) - \left(\frac{\beta}{E_0}\right)^3 f_3(s,r) + \ldots \quad (3)$$

and $g(s,r)$ is to be so chosen as to make the series (3) rapidly convergent. It can be shown that if we take

$$f_0(s,r) = \frac{D + r}{(r + \lambda_s)(r + \mu_s)} \quad \text{and} \quad g(s,r) = f_0(s + 1, r),$$

then by taking only the first term $f_0(s,r)$ in place of $f(s,r,\beta)$ in (2), we get practically the whole of $P(E,t)$; and this is particularly so for smaller values of t. We therefore have, to a very high degree of accuracy,

$$P(E,t) = \frac{1}{2\pi i}\int_{\kappa - i\infty}^{\kappa + i\infty} dr \cdot \frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty} e^{rt}\left(\frac{E_0}{E + \beta g(s,r)}\right)^s \cdot \frac{D + r}{(r + \lambda_s)(r + \mu_s)}ds. \quad (4)$$

The integral in (4) can be evaluated by the saddle-point method for *all* values of t and y_0, and as such is an improvement on the solution given in ref. 1. Hence if $\exp \psi(s,r)$ represents the integrand of (4), then

$$E_0 P(E,t) = \frac{1}{2\pi}\left[\exp \psi(s_0,r_0) \cdot \left\{\frac{\partial^2\psi}{\partial r^2} \cdot \frac{\partial^2\psi}{\partial s^2} - \left(\frac{\partial^2\psi}{\partial r \partial s}\right)^2\right\}^{-1/2}\right]_{\substack{s = s_0, \\ r = r_0}} \quad . \quad (5)$$

where s_0 and r_0 satisfy the equations $\frac{\partial\psi}{\partial r} = 0 = \frac{\partial\psi}{\partial s}$, simultaneously.

The total number of particles $N(t)$, at any depth t in the shower-producing layer, can be easily obtained from (4). The values of $N(t)$ thus obtained for some different values of y_0 and t are given in the accompanying table.

Values of $N(t)$ for a particle excited shower

t \ y_0	1	2	3	4	5	6
0·2	1·12	1·20	1·27	1·34	1·40	1·48
0·5	1·15	1·50	1·84	2·18	2·51	2·85

Janossy and Tzu[2] have suggested that the solution given by Bhabha and Chakrabarty[1] can also be used for smaller values of t, provided we retain also the term containing $\exp(-\mu_s t)$ occurring there in the integrand. That this is not so will be evident when the values of $N(t)$ for $t = 0{\cdot}5$ and $0{\cdot}2$ are obtained from that expression. For smaller values of E_0 which are interesting from the practical point of view, the error comes to about 40 per cent for $t = 0{\cdot}5$ and to 100 per cent or more in the case of $t = 0{\cdot}2$.

With the above solution it is now possible to deduce the energy spectra of the shower particles at all thicknesses and for all energies of the primary particle.

S. K. Chakrabarty

Alibag Observatory,
Alibag, Bombay.
June 17.

[1] Bhabha and Chakrabarty, *Proc. Roy. Soc.*, A, **181**, 267 (1943).
[2] Janossy and Tzu, *Nature*, **157**, 624 (1946).

Turbulent Flow in Alluvium

Several years ago, I put forward[1] two original equations for the flow of water in alluvium: the first for the wetted perimeter P in terms of the discharge Q, the second for the mean velocity V in terms of the hydraulic mean depth R and water surface slope S. Both expressions had the curious characteristic that they appeared to be independent of the grade of alluvium transported. They may be written in general terms

$$P = {}'x'Q^{1/2} \quad . \quad . \quad . \quad . \quad (1)$$

$$V = {}'y'R^{2/3}S^{1/3} \quad . \quad . \quad . \quad (2)$$

The equations were empirical and derived from a mass of hydraulic data. Their simplicity gave cause for the hope that eventually a dynamic theory to justify them would be evolved, and basic dimensionally homogeneous equations for the turbulent flow of water in alluvium derived. In this connexion the following analysis is fruitful.

From equation (1)

$$(RV)^2 = Q/x^2.$$

From equation (2)

$$V^5 = y^3(RV)^2S.$$

Eliminating (RV), which is a proportional to the Reynolds number,

$$S = x^2V^5/y^3Q; \quad . \quad . \quad . \quad (3)$$

or, on introduction of 'g' the acceleration due to gravity,

$$S = KV^5/g^2Q \quad . \quad . \quad . \quad (3a)$$

in which the coefficient is given by the equation

$$K = g^2x^2/y^3 \quad . \quad . \quad . \quad . \quad (4)$$

Equation (3a) is dimensionally homogeneous, and the coefficient K must be either a pure number or a pure number multiplied by one or more dimensionless numbers to a very low power, and of insufficient weight to affect the approximate constancy of the coefficient K. The computed value of K is clearly of great moment.

In 1930 I assigned a value of 2·67 to 'x' and of 16·1 to 'y'. In 1937 the Punjab Irrigation Research Institute[2] confirmed my equation (1) from a more extended range of observations and assigned to 'x' the value of 2·80. Other observations on other collections of data have given values of 'x' ranging from 2·5 to 3·0. The Punjab collection is more authoritative. My latest value of 'y' is 16·0. It would not appear possible from observations on canals to obtain values of these coefficients with an error of less than 5 per cent. If for 'x' a value of 2·81 is taken, and for 'y' a value of 16·0, 'g' being given a value of 32·2, the value of K as computed from equation (4) is precisely the round number 2. The question immediately arises whether this is a pure number. The following theorem which I have derived enables us to arrive at a tentative conclusion on this point.

If we consider the horizontal and vertical axes of an ideal asymmetrical alluvial channel cross-section, W can be taken as a length characterizing the effective width of the channel, and D a length characterizing the effective depth. The intersection of the axes at the centre of the water surface may be regarded as the polar origin of generation of the channel section by the turbulent water flowing with a discharge of Q. There are thus two lengths involved, $\frac{1}{2}W$ and D.

The first dimensionless number, involving the width is, I suggest, a new Froude number $V^2/\frac{1}{2}gW$.

The second dimensionless number, involving the depth, is none other than the familiar V^2/gDS.

These two numbers on correlation give the original equation

$$V^2/\tfrac{1}{2}gW = gDS/V^2 \quad . \quad . \quad . \quad (5)$$

In this expression W and D are appropriate measures of the width and depth, subject to the restriction that their product is equal to the cross-sectional area of the channel. The wetted perimeter and the hydraulic mean depth are not of necessity the best variables to employ in alluvial channels with the greater part of the transported load on or near the bed. In the sequel, whether W and D are employed, or, alternatively P and R, equation (5) on transformation gives the new equation for turbulent alluvial flow

$$S = 2V^5/g^2Q \quad . \quad . \quad . \quad (6)$$

As soon as any attempt is made to introduce the size of the silt particle into this equation, dimensional difficulties will arise; nor can the difficulty be entirely overcome by employing, as Dr. C. M. White has suggested[3], the terminal velocity of the alluvial particle in still water, V_S, as a measure of grade.

If, however, we introduce (VS) the vertical component of the mean velocity as a criterion, all difficulties are removed. Thus

$$S = 2^{1/6}(VS)^{5/6}/(g^2Q)^{1/6} \quad . \quad . \quad (6a)$$

This equation should be compared with the empirical equation of Dr. Bose[2]

$$S = 0{\cdot}00209\, m^{0{\cdot}85}/Q^{0{\cdot}21},$$

in which m is the diameter of the bed sand in millimetres.

The criterion (VS) is basic, as it is a proportional to the rate of dissipation of energy by unit volume of the water, and is also linked with the terminal velocity of the alluvial particles.

It must be emphasized that equation (6) can apply rigidly only to an active turbulent alluvial channel flowing uniformly in an ideal unlimited incoherent medium of the same grade, or range of grades, as the material transported. The amount of the load, the grade, the degree of scouring or silting are all implicit in the energy criterion (VS). It remains to examine the numerical coefficient K and to ascertain from rigid analysis whether it is a pure number as I believe it to be.

It is hoped that this brief note may encourage other workers in this field, and prove of assistance to those who contemplate initiating original researches in the subject of turbulent alluvial flow.

GERALD LACEY

Thomason College,
Roorkee, U.P.
June 1.

[1] Lacey, G., *Proc. Inst. Civ. Eng.*, **229** (1930); **237** (1934).
[2] Bose, Annual Report of the Punjab Irrigation Research Institute, Lahore (1937).
[3] White, C. M., Report to International Union of Geodesy and Geophysics (Washington, 1939).

MR. GERALD LACEY has discussed the dimensions of rivers flowing in beds of incoherent alluvium and gives certain relations connecting their speed, width, depth, slope and discharge. I find his steps difficult to follow because I do not know which of the variables he regarded as dependent and which independent. Without such definition, there is the risk that one may derive two empirical formulæ which look different but which do in fact state the same thing though containing different errors of field measurement. On algebraically combining two such formulæ one could prove anything.

In broad outline, there appear to be four basic independent factors which together define a river; they are: (1) the rains, and area of catchment; (2) the gravitational field causing the flow; (3) the physical properties of the rock or soil of the catchment; (4) the physical properties of the water. To this list could be added the slope, S, in the case of rivers which have not yet completely cut their own channels, but strictly speaking, in the case of old rivers, where erosion and building has settled down to some stable cycle, the slope is determined by the four factors above and S is not an independent.

The first problem is how to represent these four quantitatively: (1) may be represented well enough by the flow Q $[L^3/T]$ at 'bank-full' stage; (2) is $g[L/T^2]$; (3) and (4) can perhaps be described by the resulting flow of subdivided solids: the particle size in relation to the physical properties of the water is described approximately by the terminal speed, V_S $[L/T]$, of a typical particle, while the quantity of solids flowing is conveniently expressed as a fraction N of the water flow. Here then are four measurable quantities to represent the four independents.

In 1939 I directed attention[1] to the possibility that Q, g, V_S, and N served as four independents the values of which might together determine river dimensions, and suggested that of the possible dependants, the cross-sectional area $a[L^2]$ of the resulting channel, reckoned up to bank-full level, was easy to measure at any time of the year, and not sensitive to local peculiarity. This dependant a can be reduced to a pure number in several ways; the simplest is to divide it by $Q^{4/5}/g^{2/5}$: here Q and g are arbitrarily chosen, but their exponents 4/5 and 2/5 are the only values which can satisfy dimensions. Expressed thus as a pure number the dependant is

$$\frac{ag^{2/5}}{Q^{4/5}},$$

and its value lies between 3 and 10 for most rivers at bank-full stage. With regard to its dependence on Q, g, V_S and N, the last, the ratio of solids to water, is already a pure number, and the other three can form only one dimensionless group, namely,

$$\frac{g^{2/5}Q^{1/5}}{V_S}.$$

Assuming the list of independents to be complete, then there is no alternative but to expect $ag^{2/5}/Q^{4/5}$ to be a function of the two numbers $g^{2/5}Q^{1/5}/V_S$ and N.

Therefore I examined data for a typical selection of rivers in which N probably lay between 1/1,000 and 1/5,000, but the flows of which varied over a range as great as 10^8, and found that the cross-sectional areas of all at bank-full stage could be represented by

$$\frac{ag^{2/5}}{Q^{4/5}} = 2{\cdot}4\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}22} \pm 20 \text{ per cent} \quad . \quad \text{W(1)}$$

valid for $5 < g^{2/5}Q^{1/5}/V_S < 2{,}000$. The slope of these same rivers was given, though with some diffidence, since other factors may be involved, as

$$S = 0{\cdot}012\left(\frac{V_S}{g^{2/5}Q^{1/5}}\right)^{0{\cdot}9} \pm 50 \text{ per cent} \quad . \quad \text{W(2)}$$

Other dependants such as the ratio of width to depth P/R, or the ratio meander-wave-length to depth, are also readily expressed by similar formulæ.

It is significant that Mr. G. Lacey's formulæ 1 and 2 were based on data quite other than those I used. He now combines them into a group similar to my $ag^{2/5}/Q^{4/5}$ and his resulting formula 3a (with his new constants) is

$$\frac{ag^{2/5}}{Q^{4/5}} = 1{\cdot}15S^{-1/5} \quad . \quad . \quad \text{G. Lacey (3}a\text{)}$$

Here he probably regards slope as an independent fixed by geographical and geological factors rather than by the cutting of the river. However this may be, $S^{1/5}$ as given by my formula W2 is

$$S^{1/5} = 0{\cdot}41\left(\frac{V_S}{g^{2/5}Q^{1/5}}\right)^{0{\cdot}18} \quad . \quad \text{W(2}a\text{)}$$

and inserting this (the kind of step not permissible algebraically; but in the present instance only a low power of S is being used, and the resulting expression is not going to be further manipulated), L3a becomes:

$$\frac{ag^{2/5}}{Q^{4/5}} = 2{\cdot}8\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}18},$$

which only differs from my W1 by the factor $0{\cdot}86\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}04}$, the value of which over the whole practical range lies between 1 and 1·2, and river data are not so exact as this. Incidentally, my formula W1 is for rivers; straight canals are stable when their areas are 20 per cent less than W1, which further reduces the difference since the data used by Lacey in determining the constants in his original formulæ included many canal measurements.

So, numerically, formulæ W1 and L3a agree, though the particular way in which Lacey writes 3a eliminates bed material from the formula. That he can do so is no proof that bed material is unimportant; rather, he treats bed material as if it were dependent and slope as independent. From the practical point of view, rivers can play havoc when their slopes are in process of changing, and in connexion with the regulation of rivers we need information as to the ultimate slope towards which they are tending, so that we can plan our works accordingly. There is little we can do to make rivers adopt some other slope, and S is best treated as a variable dependent on the hydrological and geological data. We may make the river behave itself when we short-circuit a piece of it, but our success is not because we have imposed an increased slope on it; rather we have hastened its approach to that slope which gives equilibrium.

The Punjab data, as represented by Dr. Bose's formula,

$$S = 0{\cdot}00209\, m^{0{\cdot}86}Q^{-0{\cdot}21}$$

within the ranges to which it relates is also not inconsistent with my W2. So it seems that the channels cut by very complicated actions in which solids are conveyed by rivers with erodible beds are consistent with the simple picture I gave involving only four independent variables: this simplification does at least provide some sort of framework on which to hang the field data, and it is not grossly in error when tested numerically. I think this justifies the assumption about the four variables, one of which, V_S, is a gross simplification, and Mr. Gerald Lacey is correct in regarding it as faulty; but a better one has not yet been found.

C. M. WHITE

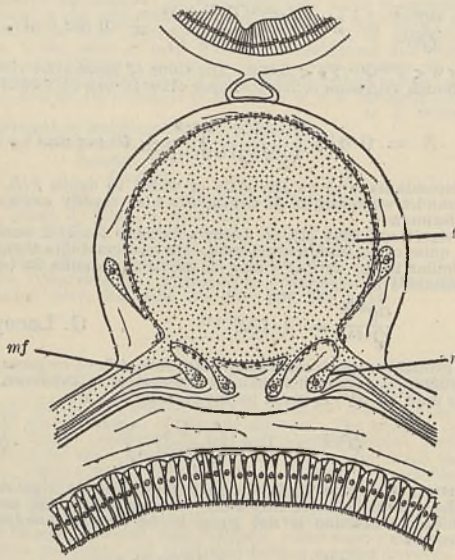
Imperial College of Science and Technology.
London, S.W.7.
June 23.

[1] White, C. M., *Proc. Int. Union Geod. Geophys.* (Washington, 1939).

Giant Nerve Fibre of *Myxicola infundibulum* (Grube)

MANY of the Annelids possess relatively large nerve fibres in their central nervous system, and those of the earthworm among the Oligochætes, and of *Halla*, *Arenicola*, *Clymenella* and *Axiothea* among the Polychætes, have been studied. The giant fibres in these forms arise either from a single nerve cell in the case of *Halla*[1], or each fibre from numerous nerve cells in the case of the other forms mentioned[2]. According to several writers[3], the single nerve fibre in the ventral nerve cord of the Sabellid, *Myxicola infundibulum*, is exceptionally large and we have, therefore, prepared serial sections of this species.

The fibre is truly giant, attaining up to 1 mm. in diameter, greates in the thorax and anterior abdomen and tapering to about 100 μ in the posterior extremity. It thus compares favourably with the giant nerve fibres of the Cephalopods, *Sepia* and *Loligo*[4]. It extends throughout the length of the ventral nerve cord, lying dorsally to the nerve cells and neuropil and constituting the major part of the cord (*gf*). In spite of its large size, it appears as a single nerve fibre consisting of a uniform mass of axoplasm with faint longitudinal striations but no transverse or longitudinal subdivisions.



TRANSVERSE SECTION OF THE VENTRAL NERVE CORD OF *Myxicola infundibulum* IN THE THORACIC REGION. *gf*, GIANT FIBRE; *mf*, MOTOR BRANCH; *nc*, NERVE CELL BODY. × 33

Anteriorly, in the first few thoracic segments, both the ventral nerve cord and its contained giant fibre bifurcate, forming two discrete cords with a giant fibre in each. Transverse commissures connect the two halves of the cord together, and anastomoses between the two giant fibres occur in each of these commissures. The two fibres unite again in the sub-œsophageal ganglion, and a branch passes up through each of the circum-œsophageal connectives into the supra-œsophageal ganglia. Here the branches from either side connect with one another in the lower part of the supra-œsophageal ganglia.

By employing buffered solutions of silver nitrate[5], it has been possible to impregnate the nerve cells and smaller fibres and reveal some of the connexions of the giant fibre. Numerous unipolar nerve cells (*nc*) send their processes into the giant fibre in each segment. Larger motor branches (*mf*) proceed peripherally in the segmental nerves to the strongly developed longitudinal musculature.

The sheath of the giant fibre is composed of a fine network of fibrils, forming a dense investing envelope distinct from the collagenous sheath of the nerve cord. The sheath does not blacken on treatment with osmium tetroxide, indicating the absence of any appreciable amount of myelin. Nuclei occur throughout the thickness of the sheath.

One of the most characteristic behavioural reactions of this animal is the sudden shortening which can be induced by mechanical stimulation of any part of the body. Following section of the cord, isolated ends of the animal still showed this quick contraction in specimens observed for sixteen days. Sections of the giant fibre either anterior or posterior to the injured region showed no histological signs of degeneration, corroborating the observation that the cell bodies of the giant fibre occur along the length of the cord. The giant fibre thus constitutes a unique example of a final common path produced by fusion of the processes of many nerve cells, so that afferent impulses from any part of the body are directed into a single effector unit and activate all the longitudinal muscle fibres of the body. The whole living nerve cord can be removed from the body, but it has not proved possible to obtain a stretch of giant fibre free from cord and investing sheath. Action potentials obtained from a dissected cord show that the giant fibre, like those of the squid, though a syncytium, yet acts as a single functional unit.

J. A. C. NICOL
Department of Zoology and Comparative Anatomy,
University Museum, Oxford.
J. Z. YOUNG
Department of Anatomy,
University College, London.
June 3.

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Origin of the First European Potatoes and their Reaction to Length of Day

MR. HAWKES[1] has stated, with reference to the first European potatoes, that "*S. andigenum*, although mainly short day in photoperiodic reaction, does possess certain day neutral and even long day clones. . . . If, by any chance, one of these was introduced into Europe, then there would be no reason at all why it should not have yielded well from the very first." Recently, he and Mr. Driver[2] stated in *Nature*: "There is no reason why the original short-day forms from the Andes could not maintain themselves under European conditions though giving a reduced yield. This is what happens when the recently collected Andean forms are grown under the longer days of Great Britain." In both quotations the underlying idea is that the first European potatoes would have been at a disadvantage as regards yield, if they had been short-day in reaction. This idea is substantially the same as that of Russian workers. It is not supported by the evidence, as I have already pointed out[3], but it is very prevalent and further comment seems desirable.

One need consider only Spain and the British Isles, typical representatives of the countries where the potato was first widely grown as a crop. It was suggested[3] that in Spain potatoes were grown as an autumn crop; and if they yielded badly, it was at least no fault of a short-day reaction. In the British Isles, the west in particular, potatoes could be, and were, grown deep into the autumn, November being a popular harvesting date. Here potatoes seemingly made good use of the conditions; haulms grew during summer, when conditions are optimal for haulm growth, and tubers probably grew mostly after the approach of autumn, when conditions are optimal for tuber growth. For it is fairly clear from experiments on photoperiodism that the rate of production of tubers by unit mass of haulm is greatest in short days, and the physiological efficiency of short days has often been pointed out before.

What has happened during the course of the centuries in Britain, and north-western Europe generally, is that there has been a shift from autumn tuber-growth to summer tuber-growth. (The shift, of course, is not complete.) The result may be more convenient to modern farmers, but there is no evidence of greater yields, at least in the absence of blight. One grants that the best yields should be given by varieties which use both the summer and the autumn, and admits that varieties like Epicure and Arran Banner make remarkable use of long days, but in view of the evidence of photoperiodism it would be rash to assume that breeders could not have made as good use of the short days of autumn. Any tendency towards satisfaction with modern achievements should be tempered by the reflexion that average potato yields have not risen in Britain during the last 100–150 years[4], despite a vast amount of research in all directions. Although many early varieties existed at the beginning of last century, the impression one gets is that the shift from autumn to summer tuber-formation had not yet gone so far as it has now, and it would be interesting to know to what extent autumn growth has determined not only the early history and geography of the potato in Europe but also the yield. Unfortunately, there is little evidence about this. Even with the Andean potatoes no attempts to ascertain yields in Europe in autumn have been published. Research has centred around the determination of photoperiodic response. Hackbarth[5] was so concerned with the difference between long and short days that he did not see fit to record the dates of planting and harvesting or whether the maturity was early or late, but one infers that the plants were mature before the autumn equinox. In the experiments at Cambridge the potatoes were planted early and all surviving plants harvested on September 30—most lines matured before then—to prevent the possibility of increased yield in short autumn days, a procedure which was necessary for the particular purpose of the experiment. No doubt many—perhaps most—of the Andean varieties are poorly bred and inherently weak yielders under any conditions of length of day; but it must be admitted that workers in Europe have made their adaptation seem worse than it is by growing them during a season to which they are least adapted and which differs from that in which the first European potatoes were grown.

To change the topic in conclusion, an explanation about the Basutoland potatoes seems called for. Readers of the recent communication by Mr. Hawkes and Mr. Driver might assume that I believe that all these potatoes have an extreme short-day response. This is not the case. Several varieties mature early; and if they, and other European early varieties of the first part of last century, were not discussed in my original communication[3], it was because they are irrelevant to the point which was being argued.

J. E. VAN DER PLANK
Department of Agriculture, Pretoria.

[1] Bull. Imp. Bur. Plant Breed. and Genet. (1944), 109.
[2] *Nature*, **157**, 591 (1946).
[3] *Nature*, **157**, 503 (1946).
[4] See editorial comment, *Gardeners' Chronicle*, Jan. 12 (1946). Yields in Lincolnshire at the end of the eighteenth century are discussed by Wallace in Bull. 94, Min. Agric. Fish. England (1941).
[5] *Züchter*, **7**, 95 (1935).
[6] Driver, C. M., and Hawkes, J. G., Bull. Imp. Bur. Plant Breed. and Genet. (1943), 36.

THE point at issue between Dr. van der Plank and ourselves seems to be whether the Andean short-day potatoes were or were not at a disadvantage when brought to Europe in the late sixteenth century. We have stated that we consider they were at some disadvantage[1], at any rate in Great Britain, where they would normally have been cut down by frost before maturity. Although occasionally we have been able to leave some of our *S. andigenum* varieties in the field so late as November 26, even then they were far from being mature, nor was the yield so high as was obtained from commercial varieties under similar conditions. Under such conditions the potato plants would have been subjected to short days for at least ten weeks, but possibly the temperature and light intensity at that time of the year were unsuitable for rapid tuber development. The experiment to which Dr. van der Plank makes reference[2] was conducted under glass and hence is scarcely referable to the point at issue.

What would have happened in Ireland where frosts are late or only slight we do not know, since no tests have been carried out in the south-west; and in any event the incidence of blight might now obscure the issue. For Dr. van der Plank to state, therefore, that the Andean potatoes would not have been at a disadvantage when grown in Ireland in the early seventeenth century is pure supposition, since there is not a single piece of evidence to support this view. Evidence of high yields in England was not available until about two hundred years later, by which time some breeding and selection had no doubt taken place.

Whatever may be Dr. van der Plank's opinion, we still feel ourselves perfectly justified in maintaining that the extreme short-day reaction of most of the Andean potatoes was an undesirable feature, and one which had to be removed before the potato crop could assume the importance it has to-day. It might be mentioned that while both Andean potatoes and European varieties have hereditary capacities for high yield, in the former case the greatest single limiting factor under British conditions is the day-length requirement, while in the latter case cultural conditions and disease play a greater part. Nevertheless, the yield obtained from the early introductions would be by no means negligible, but would be sufficient to encourage their culture as soon as farming conditions became suitable.

J. G. Hawkes
C. M. Driver

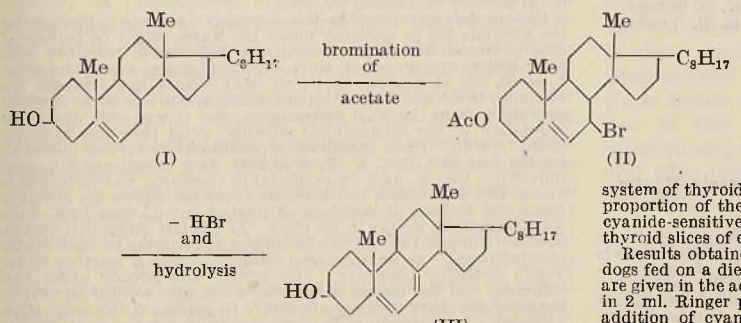
Imperial Bureau of Plant Breeding and Genetics
School of Agriculture, Cambridge.

[1] *Nature*, **157**, 591 (1946).
[2] Driver, C. M., and Hawkes, J. G., Bull. Imp. Bur. Plant Breed. and Genet. (1943), 36.

A New Route to 7-Dehydrocholesterol, Provitamin D_3

In 1935, Windaus, Lettré and Schenck[1] described the preparation from cholesterol (I) of 7-dehydrocholesterol (III), which on irradiation gave a highly antirachitic product (vitamin D_3), later[2] shown to be identical with the naturally occurring vitamin D isolated from tunny liver oil. The original route to provitamin D_3, giving an overall conversion from cholesterol of about 4 per cent, has since been employed for the synthesis of several related dehydrosteroids[3], but it has not been materially improved, although some useful minor modifications have been described[4]. Claims[5] have been made for alternative and improved methods, but, so far as we are aware, none of these has proved entirely satisfactory.

We have now discovered that the reaction of N-bromosuccinimide[6] or related compounds with cholesteryl acetate gives a product from which *'β'-7-bromocholesteryl acetate* (II) (m.p. *c.* 105–110°; $[\alpha]_D^{20°}$ −245° in chloroform) can be isolated. On heating this monobromo compound with diethylaniline, hydrogen bromide is eliminated;



after hydrolysis of the product, 7-dehydrocholesterol (III) can be isolated, either by chromatography or as its readily purified 3:5-dinitrobenzoate. Under suitable conditions, cholesterol can be converted by this route into its 7-dehydro-derivative in yields of about 30 per cent.

Detailed accounts of this process, of its application to other steroid derivatives, and of the characterization and reactions of the 7-bromo-steroids, will be published elsewhere[7].

H. B. Henbest
E. R. H. Jones

Imperial College of Science and Technology,
London, S.W.7.

A. E. Bide
R. W. Peevers
P. A. Wilkinson

Glaxo Laboratories, Ltd.,
Greenford, Middlesex. June 25.

[1] Windaus, A., Lettré, R., and Schenck, F., *Ann.*, **520**, 98 (1935).
[2] Brockmann, H., *Z. physiol. Chem.*, **241**, 104 (1936); **245**, 96 (1937).
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[6] Ziegler, K., *et al.*, *Ann.*, **551**, 80 (1942).
[7] See also B.P. 574,432.

Antithyroid Drugs and Cytochrome Oxidase Activity

Schachner, Franklin and Chaikoff[1] found that the *in vitro* formation of diiodotyrosine and thyroxine by thyroid slices, using radioactive iodine, I^{131}, as indicator is inhibited by cyanide, azide, sulphide and carbon monoxide (particularly in the dark). This indicates that the cytochrome oxidase system is involved in the synthesis of thyroxine by the thyroid gland. Franklin, Chaikoff and Lerner[2], using the same technique, showed that thiourea and thiouracil in a concentration of 10^{-3} *M* inhibited the *in vitro* synthesis of diiodotyrosine and thyroxine.

It has been repeatedly suggested that thiourea and thiouracil exert their antithyroid effect by inhibiting the cytochrome oxidase system in the thyroid gland. Paschkis, Cantarow and Tillson[3], determining cytochrome oxidase activity colorimetrically with *p*-phenylene diamine as substrate, found that 0·002 *M* thiouracil added to thyroid tissue *in vitro* inhibited the oxidase activity significantly. They also found a significant decrease in the oxidase activity of the thyroids of adult rats fed thiouracil in the drinking water for 11–21 days. They state, however, that after several months treatment, the oxidase activity of the thyroids increases, approaching normal values. Stotz, Sidwell, and Hogness[4] consider *p*-phenylene diamine to be not very suitable as a substrate for measuring cytochrome oxidase activity since its potential is so low that it is also oxidized by cytochrome *b*. Keilin and Hartree[5], moreover, emphasize that results obtained using colorimetric methods for assessing cytochrome oxidase activity should be accepted with reserve unless corroborated by measurements of oxygen uptake.

The conclusion that thiouracil exerts its effect on the thyroid by inhibiting cytochrome oxidase activity is not supported by results obtained in these Laboratories.

The cytochrome oxidase activity of horse heart muscle preparations prepared according to Keilin and Hartree[4] has been determined using hydroquinone, ascorbic acid and *p*-phenylene diamine as substrates, the oxygen uptake being measured at 37° C. over a period of 30 minutes in Warburg manometers. When hydroquinone and ascorbic acid were used as substrates, the activity was unaffected in the presence of a total concentration of 0·03 *M* thiourea, 0·03 *M* 2:aminothiazole or 0·003 *M* thiouracil, even if the enzyme preparation was previously incubated with the drug for several hours. Using *p*-phenylene diamine as substrate, however, the above concentration of thiouracil inhibited the activity 28–41 per cent. Thiourea and aminothiazole had no effect. Mann and Keilin[6] have shown that sulphonamides, which also possess antithyroid activity, do not inhibit cytochrome oxidase activity, although Paschkis, Cantarow and Tillson[3], using the procedure described above, found 30 per cent inhibition in the presence of 0·001 *M* sulphadiazine.

Since a large proportion of the total respiratory exchange of all organs is effected through the cytochrome oxidase system, the respiration-rate of tissue slices should be reduced by a substance which inhibits cytochrome oxidase activity. The respiration-rate of slices of horse, dog and rat thyroids, however, is not affected by the addition of thiourea (0·02 *M*) or thiouracil (0·005 *M*). Moreover, the respiration-rate of diaphragm and liver slices from rats fed 0·5 per cent thiourea or 0·1 per cent thiouracil in the diet for several months is not significantly different from that of control animals. (The Q_{O_2} of thyroid slices from these rats is considerably greater than that of the controls, due presumably to an increase in the proportion of the cellular components in hyperplastic rat thyroids.)

If the activity of the cytochrome oxidase system of thyroid were inhibited by feeding thiourea or thiouracil, the proportion of the total respiratory exchange of thyroid slices which is cyanide-sensitive should be decreased. This is not the case with thyroid slices of either rats or dogs fed thiouracil.

Results obtained with thyroid slices from one control dog and two dogs fed on a diet containing 0·1 per cent thiouracil for eight months are given in the accompanying table. The thyroid slices were suspended in 2 ml. Ringer phosphate solution at *p*H 7·4, with and without the addition of cyanide, and the oxygen consumption measured in an atmosphere of oxygen at 37° C. in Warburg manometers over a period of 60 minutes. When *p*-phenylene diamine was used as substrate, 0·2 ml. of 0·2 *M* *p*-phenylene diamine adjusted to *p*H 7·4 was introduced into the side bottle and tipped into the main bottle at the end of the first 60-minute period. The oxygen consumption was then measured for a further 60 minutes.

RESPIRATION-RATE OF THYROID SLICES FROM CONTROL AND THIOURACIL-TREATED DOGS

Diet	No added substrate	In presence of 0·002 *M* sodium cyanide		In presence of 0·018 *M* *p*-phenylene diamine	
	Q_{O_2}	Q_{O_2}	% inhibition	Q_{O_2}	% of original value
Control	−3·93	−2·35	40	− 8·7	221
Thiouracil	−6·90	−4·35	37	−14·9	216
	−5·73	−3·22	44	−11·7	204

These results show that the degree of inhibition of the respiration-rate in the presence of 0·002 *M* sodium cyanide is not markedly different for thyroid slices from control and thiouracil-fed dogs. The ability to oxidize added *p*-phenylene diamine is also not interfered with by feeding thiouracil.

Moreover, thiouracil (0·005 *M*) added to slices of horse and dog thyroids does not inhibit the rate of oxidation of *p*-phenylene diamine or ascorbic acid: in fact, in the case of horse and dog thyroid slices, the rate of oxidation of *p*-phenylene diamine is increased some 35–67 per cent.

These results support the view that the prevention of thyroxine synthesis in the thyroid by thiourea and thiouracil is not due to inhibition of cytochrome oxidase activity.

GERTRUDE E. GLOCK
Wellcome Physiological Research Laboratories,
Langley Court,
Beckenham, Kent.
July 2.

[1] Schachner, H., Franklin, A. L., and Chaikoff, I. L., *J. Biol. Chem.*, **151**, 191 (1943).
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[4] Stotz, E., Sidwell, A. E., and Hogness, T. R., *J. Biol. Chem.*, **124**, 733 (1938).
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[6] Mann, T., and Keilin, D. *Nature*, **146**, 164 (1938).

Grignard Compounds as Condensing Agents

IN connexion with the communication on this subject by Hickinbottom and Schlüchterer[1], we think it would be of general interest to record similar observations made in and since June 1945 in the course of work on hydrocarbon syntheses for the Institute of Petroleum.

We have found that the interaction of *iso*propylmagnesium bromide and methyl*iso*butylketone gives a considerable yield of 2 : 4 : 8-trimethylnon-4-en-6-one

$$(CH_3)_2CH.CH_2.C(CH_3) = CH.CO.CH_2.CH(CH_3)_2$$

but no appreciable quantity of methyl*iso*butylcarbinol. The same ketone is produced in much smaller yield by the action of *iso*butylmagnesium bromide on methyl*iso*butylketone, the main by-product in this case being methyl*iso*butylcarbinol.

A more interesting observation was that both this ketone and methyl*iso*butylcarbinol were formed by the action of *iso*butylmagnesium bromide on methyl acetate, indicating that free methyl*iso*butylketone is probably an intermediate in this reaction.

At the moment, insufficient data are available to permit of a decision on the relation between structure of reactants and proportion of normal reaction, reduction reaction and condensation reaction. The *type* of branching at the carbon atom to which the magnesium atom is attached in the Grignard reagent is probably the most important controlling factor.

Further work is in progress on the reactions of ketones and esters with Grignard compounds.

H. J. SHINE
E. E. TURNER

Bedford College,
University of London.
July 2.

[1] *Nature*, **155**, 19 (1945).

Antimalarial Drugs of the Indigenous Materia Medica of China and India

MY attention has been directed to a note on "A New Antimalarial Drug" by I. M. Tonkin and T. S. Work[1]. As a number of workers in China and India are still engaged in the elaboration of newer antimalarials from the rich lore of the indigenous materia medica, the following additional information on *Fraxinus malacophylla* (one of the two remedies referred to by Tonkin and Work) and others of the same species will be of interest.

I also received samples of the active ingredients from *Fraxinus malacophylla*, known in Chinese as 'Fu-Nieh-Ching', through the courtesy of Dr. J. Needham of the British Scientific Office in Chungking via Dr. J. B. Grant, formerly director of the All India Institute of Hygiene, Calcutta. The material was received in three forms : (i) antimalarial pure compound '*A*' in powder ; (ii) pale green, odourless and practically tasteless tablets of 0·013 gm., presumably made from the dried extract of the bark ; and (iii) compound '*B*'—a by-product of the bark extract. The tablets were stated to have been prepared by the Ordnance Administration Centre Research Station at Luhsien, China. All the three compounds were tested for their antimalarial efficacy on simian and human malaria, though emphasis was laid on the 'tablets', which were received in adequate quantities.

Chemical investigation showed absence of any alkaloids in *F. malacophylla*, a finding contrary to Lin *et al.*[2] but confirming the report of Tonkin and Work (*loc. cit.*). Presence of a glycoside, essential oils, etc., was proved, but no effort was made to proceed further with their systematic chemical analysis. Pharmacologically, the oral toxicity was found to be low and administration even to children could be easily recommended.

In simian malaria (*P. knowlesi* infection), the tablets or the compound '*A*' produced no effect on the course of infection. This is different from the observation recorded by Tonkin and Work of "considerable activity against *P. gallinaceum* in chicks".

In human malaria, both malignant tertian and benign tertian, fraxine tablets in dosage varying from three tablets a day to sixteen tablets a day for five days were administered in slide-positive cases hospitalized in the Carmichael Hospital for Tropical Diseases, Calcutta, under Prof. J. C. Gupta. Of five patients treated for 5–7 days (in two instances), only one remained fairly well, though his smear remained positive. He had a relapse within ten days and passed through a typical attack of ague relieved with quinine injections. The other cases gradually passed into a stage when humanitarian considerations demanded urgent treatment with quinine. A peculiar observation was made in two cases, where there was a distinct tendency to a fall in temperature suggesting a 'febrifugal effect' of the drug. In benign tertian cases, four of which were followed up, fraxine tablets did not bring about any alteration in the clinical course of the disease in two ; whereas in the other two, a temporary febrifugal effect associated with disappearance of the parasites was recorded. Both the cases relapsed and had to be treated with intramuscular quinine injections.

Our conclusions with fraxine tablets are, therefore, in essential agreement with the report of Tonkin and Work ; but what we could not account for was the tendency of the drug to produce a febrifugal effect, which in a few cases was actually interpreted at the beginning as a definite antimalarial effect. There was a temporary disappearance of the malaria parasites, but this bears no resemblance to what is produced as a result of quinine administration.

I have examined two other Indian drugs of the indigenous materia medica, namely, *Alstonia scholaris*[3] and *Cæsalpinia bonducella*[4]. The former contains at least one and possibly four alkaloids, but is definitely not anti-plasmodial. The latter contains a glycoside which is also not anti-plasmodial in fowls. In both these, however, the same phenomenon of a febrifugal action was noticed, the degree of which was too pronounced in the case of *A. scholaris* to be ignored. Indian counterparts of *F. malacophylla* (*F. excelsior*, *F. micrantha* and *F. xanthoyloides*) were also examined without any success.

It appears that both in India and China indigenous vegetable drugs have earned reputation as 'malaria cures' primarily from their slight 'febrifugal' properties. Apart from cinchona derivatives, there is no other plant product known to me which can bring about an antiplasmodial effect both in experimental and human malaria.

B. MUKERJI

Biochemical Standardisation Laboratory,
Government of India,
110 Chittaranjan Avenue,
Calcutta.

[1] Tonkin and Work, *Nature*, **156**, 630 (1945).
[2] Lin, Chang, Ch'uan and Tan, *Chinese Med. J.*, **59**, 573 (1941).
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[4] Mukerji, Ghosh and Siddons, *Indian Med. Gaz.*, **78**, 285 (1943).

"Re-dedication of Science in Germany"

IN his interesting and noteworthy article "Re-dedication of Science in Germany" in *Nature* of July 13, p. 66, Prof. Polanyi refers to the Kaiser Wilhelm Institut für Physikalische Chemie in Berlin-Dahlem, and to its former director, Prof. Fritz Haber, and to the celebration in his memory on January 29, 1935.

Certain details concerning this impressive ceremony, illuminating the scientific life in Germany under the Nazis, might be perhaps of general interest and might demonstrate that even in 1935, two years after Hitler came to power, there were in Germany men of integrity. I would like to mention that Prof. Max Planck had arranged this ceremony in spite of the greatest difficulties, and in face of the strongest opposition from the Nazi Government, and it was only due to his reputation in the international scientific world that this gathering could be held. These unbelievable conditions are further illustrated by the fact that Prof. K. F. Bonhoffer, as a member of a German university, that is, as a State official in Germany, was forbidden to attend this celebration, and therefore could not deliver his lecture in honour of Haber. It might be of interest to add that Prof. Hahn read Bonhoffer's lecture in his place. At the last moment it became doubtful whether I should be allowed to attend, owing to the following circumstances. As an industrial chemist, I was a member of the Verein deutscher Chemiker. This society was already under Nazi influence, and the members received a strongly worded circular to the effect that they were not allowed to be present at this celebration. Although I was determined to ignore this order, some of my colleagues in the I.G. Farbenindustrie were in doubt as to what course they should adopt, and asked my advice. Acting against this order might have endangered their career, so I asked Prof. Bosch, chairman of the I.G. Farbenindustrie, who together with Haber developed the process for synthetic ammonia, for his advice. He answered that it was the duty of all chemists of the company who were invited to attend this anniversary. Unfortunately, Prof. Bosch died too early to continue his struggle against the Nazi regime.

This gathering of Haber's friends and admirers was, as Polanyi says, really a noteworthy manifestation of independence in German scientific circles.

One act was significant of the Nazis and of Goebbel's Ministry of Propaganda. Placards fixed on the exit doors of the lecture-room ordered the reporters of the newspapers to gather in a special room. Here they were told that no report whatever concerning Haber's anniversary and the celebration was to be published in German papers. So it came about that the German people did not know that there was a Haber celebration in Germany in 1935 under the chairmanship of Planck, and that at this gathering the representatives of many countries, ambassadors and men of science were present. There were, and there still are German men of science of integrity who, if allowed to start research work, could continue their struggle against Nazi ideas with renewed energy, and could try to build up a new German scientific life in a democratic way.

P. MENDELSSOHN BARTHOLDY

9 Addison Crescent,
Kensington,
London, W.14.
July 15.

[The anniversary celebrations to which Dr. Mendelssohn Bartholdy refers were described and commented on at the time in *Nature* of February 2, p. 176, and February 9, p. 216 (1935).—EDITORS.]

RESEARCH ITEMS

Palæolithic Child from the Teshik-Tash Cave

Franz Weidenreich has published an important note on the alleged Mousterian skull from the Teshik-Tash Cave in southern Uzbekistan (Central Asia) (*Amer. J. Phys. Anthrop.*, N.S., 3, No. 2; 1945). He does not consider that the skull is that of a Neanderthalian of the Mousterian European type. He is not prepared to discuss the geological reasons which have been adduced to suggest this early date, but he does point out that the faunal and cultural indications would not be incompatible with a late Upper Palæolithic one. Weidenreich also mentions certain other Russian finds, more particularly the Podkumok skull. Here again the object does not appear to be of normal Neanderthal facies. Actually, Weidenreich suggests that both the Uzbekistan, the Mount Carmel, and perhaps the Podkumok human remains, are intermediate links between Neanderthal man and *Homo sapiens*; and, as these come from western and central Asia, further important discoveries may be looked for in these regions.

Absorption of Light by Blood Plasma

Under the title "La Absorción Luminosa Del Plasma Sanguineo y La Estabilidad De La Misma Frente A Diversos Agentes", Antonio E. Rodriguez and Jose A. Balseiro have described the results of their investigations of the absorption of light from the red to the ultra-violet by solutions of blood plasma taken from human beings and rabbits (*Pub. Fac. Cien. Fisicomat.*, 3, No. 1; Univ. Nac. De La Plata). A description of the apparatus employed is given and several spectrograms and diagrams show the results obtained. In the visible end of the spectrum there was nothing to indicate that absorption bands could be attributed to absorption by the plasma solutions. In the ultra-violet region it was found that there was a definite absorption band extending from 2570 A. to 2920 A., and this band is shown in solutions of various concentrations. A photomicrograph of one of these reveals that the band is relatively simple. Heating the plasma solutions to 100° C. had no effect on the absorption. The globules were separated by ammonium sulphate with an equal amount of a solution of the plasma, the concentration of the latter being equal to that which exists in the blood, and it was found that the absorption observed was due to the globules. A photograph of the bands from a specimen of plasma and another from the bands of the globules are practically identical, and a photomicrograph shows the similarity of both bands.

Club Root of Brassicas

G. Samuel and S. G. Garrett (*Ann. Appl. Biol.*, 32, 96; 1945) have described a new technique for the investigation of early stages in the attack of cabbage plants by the fungus *Plasmodiophora Brassicæ*. Seedlings are grown for short periods in small quantities of soil in glass tumblers. Roots of young seedlings thus grown are placed in acetocarmine, which stains the zoosporangia of the parasite in infected root hairs. Infection can only take place during the very short period prior to vacuolation when the root hairs are full of protoplasm, and the authors figure the rarely seen stages of zoospore formation and discharge. Heavy applications of lime sometimes fail to control club root, and the explanation probably lies in the initial concentration of spores present in the soil. Tumbler experiments show that seedlings remain clean at *p*H 7·7 with 100,000 spores per ml., but there is marked infection with 10,000,000 spores per ml. At this high spore concentration infection is a little more severe than at *p*H 6·2 with 100,000 spores per ml. A comparison of the action of the hydroxides, carbonates and chlorides of the alkali metals shows that a reduction in infection on application of these compounds was due to their effect on the *p*H of the soil, the chlorides having little effect. Quite apart from the action of hydrogen ions, there is a progressive decrease in disease-rating with increase in concentration of the nutrient fluid. High soil moisture favours the disease, but the lower level at which infection takes place is partly controlled by soil texture. These experiments relate to the initial root hair infection, and do not deal with the subsequent zoospore and zygote infections, or to the development of plasmodia and 'clubs'.

Abrasives and the Transmission of Plant Viruses

The degree of dilution which a virus extract can sustain without loss of infectivity has been regarded as sufficiently standard for diagnostic significance. H. Kalmus and B. Kassanis have recently shown, however (*Ann. App. Biol.*, 32, No. 3, 230; Aug. 1945), that the infective dilution can be increased up to one hundred times by the use of certain abrasives in the practice of inoculation. Celite (diatomaceous silica), animal charcoal and 400-mesh carborundum were all suitable, though some preparations of carborundum and charcoal reduced infectivity. The abrasive can be dusted on the leaf, which is then rubbed by the finger wet with the inoculum, or it can be rubbed on the leaf without inoculum, which is then sprayed upon the surface. Leaves regain their normal resistance to sprayed infection, however, three hours after rubbing. It may be possible, by use of the abrasive method, to standardize the dilution end-point of mechanically transmitted viruses and thus use it for diagnostic purposes with greater certainty.

Nitrogenous Manuring and Eyespot of Wheat

The effect of eyespot (*Cercosporella herpotrichoides*) on wheat receiving dressings of ammonium sulphate has been studied by M. D. Glynne, W. M. Dion and J. W. Weil (*Ann. App. Biol.*, 32, 297; 1945). Two divergent tendencies were observed which explain the variable conclusions of previous workers. High nitrogen dressings promote luxuriant growth, lead to higher humidities within the crops, and consequently to higher rates of culm infection. On the other hand, tiller production is encouraged, which tends to offset any loss in yield. The balance of these two factors is no doubt much influenced by soil, by climate, and by the time of application of nitrogen; but in general, applications of ammonium sulphate are beneficial to affected crops, provided the dressings are not so heavy as to cause lodging.

Petrology of Heard Island

During the British–Australian–New Zealand Antarctic Research Expedition of 1929–31, under the leadership of Sir Douglas Mawson, thirty-five rock specimens were collected from Heard Island. G. W. Tyrrell's account of these has been published (*Rep. B.A.N.Z. Antarctic Research Exped.*, A, 2, Part 3; 1937), copies of which have just become available.

The petrology follows the general plan of oceanic volcanic islands. The commonest rock-type is trachybasalt, accompanied by variations in the ultrabasic direction through olivine-rich trachybasalt and ankaramite to limburgite, and in the other direction through trachyandesite to trachyte and phonolitic trachyte. Five new chemical analyses are provided, bringing the total for the island up to ten. These show that the alkali-lime index for the rock-series is 51, indicating that the series lies on the boundary between the alkalic and alkali-calcic series as defined by Peacock. For the volcanic series of Jan Mayen the value of this index is 51·2. The author directs attention to the remarkable homology in geological structure, regional setting and petrological composition which obtains between Kerguelen and Heard Island on one hand and Iceland and Jan Mayen on the other. Like Iceland, Kerguelen is largely built of basaltic lavas with subordinate lavas resting upon a basement of older basalts. Like Jan Mayen, Heard Island consists of members of the trachybasaltic suite; both series give almost identical variation diagrams. Iceland and Jan Mayen rise from the submarine platform connecting Greenland with the Hebrides, while Kerguelen and Heard Island rise from a submarine plateau that probably connects up with the Antarctic continent. A modern account of the Kerguelen lavas with ten new analyses is given by A. B. Edwards (*Rep. B.A.N.Z. Antarctic Research Exped.*, A, 2, Part 5).

Uplift of the Pir Panjal Range, Kashmir

A FOSSIL leaf of *Woodfordia fruticosa*, a species of tropical shrub, collected from the Lower Pleistocene deposits of the Kashmir slopes of the Pir Panjal Range at 6,000 feet above sea-level, has been described by G. S. Puri (*J. Indian Bot. Soc.*, 22, 125; 1943). At the present time the species is widespread in the tropical parts of Africa and Asia, but is absent from the Kashmir valley and the northern slopes of the Pir Panjal Range, though it is fairly common on the Punjab side of the Range, where the climate is warmer. The author concludes that the Range has been uplifted by at least a few thousand feet since the early Pleistocene. As a result of this uplift the monsoons are unable to reach the Kashmir Valley, from the flora of which, in consequence, tropical elements have been eliminated, while temperate species have found the changed climate congenial. At the joint meeting of the Indian and National Academies of Science in 1943, the author added support to this view by describing fossil leaf fragments of *Litsea lanuginosa* from the same deposits at a height of 10,600 ft. This species now flourishes in the Sub-Himalayas, between 2,000 ft. and 4,000 ft., east of the Sutlej River, but is unrepresented in the Kashmir Valley and on the northern slopes of the Pir Panjal. There is a single record of its occurrence on the south-west slopes of the Range at 4,000 ft.

Magnetic Susceptibilities of Certain Organic Compounds and Glasses

IN the course of an investigation of the change of magnetic susceptibility of certain organic compounds in passing from the solid to the liquid state, M. Mikhail, of the Physics Department, Fouad I University, Cairo, has made a study of the residual magnetism and magnetic time-lag of a Weiss electromagnet. (*Proc. Math. Phys. Soc. Egypt*, 2, No. 2, 55; 1942.) The electromagnet was specially constructed in the laboratory workshop, and the results of the experiments performed on this magnet show that for the same magnetizing current the rate of decay of the magnetic field is greater than the rate of growth but smaller than the rate of reversal. The time taken by the field to become practically constant and for the residual magnetism to reach its limiting value is not more than a few seconds. In a later paper (*Proc. Math. Phys. Soc. Egypt*, 2, No. 3, 7; 1943) a description is given of measurements by the Gouy method of the magnetic susceptibilities of soda, 'Monax', 'Pyrex' and 'Jena' glasses. Both rods and tubes were used. The object was to find which kind of glass had the least susceptibility. The results show that glasses rich in silicon dioxide are distinctly diamagnetic, that 'Monax' has the least susceptibility and that its feeble paramagnetism can be completely destroyed by raising the temperature to about 40° C.

Precision A.C./D.C. Comparator for Power and Voltage Measurements

IN recent years there has been a marked increase in the demand for more accurate commercial A.C. power-measuring instruments. The demand is due largely to changing industrial conditions brought about by legislation, although it existed already for the manufacturer whose A.C. standardizing apparatus was only comparable in sensitivity and accuracy with that of the commercial apparatus he produced. A paper by G. F. Shotter and H. D. Hawkes read in London before the Institution of Electrical Engineers gives a brief review of the sources of error common to dynamometer wattmeters and emphasizes some of the inherent errors which have been less publicized. A new instrument for the measurement of A.C. power and voltage by direct comparison with a standard D.C. potentiometer is described, the principle of operation being a null method based on the balancing of two torques. A summary is given showing the errors inherent in the new instrument and those which have been eliminated by the method of measurement. The stability of accuracy of the new instrument is maintained by self-standardization, and means of checking the accuracy of the associated apparatus are made available.

Drinking Water from Sea Water

THE problem of providing drinking water for airmen and sailors in collapsible dinghies and lifeboats received attention during the War, and one solution was the use of briquettes of a material containing silver zeolite. Two papers describing work carried out in parallel (H. Ingleson, *J. Soc. Chem. Ind.*, 64, 305; 1945. E. I. Akeroyd, E. L. Holmes and A. Klein, *ibid.*, 65, 28; 1946) give particulars of the research and the results. The material consisted of briquettes of reagent containing silver zeolite, barium hydroxide octohydrate, fuller's earth and graphite. It was put into a moulded plastic cylinder with screwed ends, with a changeable filter pad at one end through which the treated water was sucked through a teat. A measured volume of sea water was put into the cylinder with one chemical charge, and after one hour the filtered drinking water was sucked out, an air vent being provided at the other end of the cylinder. The barium was for removing sulphate from the water. The space occupied in a pack by this outfit was one sixth of that taken up by a tin containing the same amount of fresh water as could be provided by the treatment. Full details are given in the papers.

BIOLOGY OF *PATELLA* IN GREAT BRITAIN

By Prof. J. H. ORTON
University of Liverpool

THE recognition of at least three good species of *Patella* in the south of England by Fischer-Piette in 1935[1], with confirmation of two of these in a searching ecological study by Eslick 1940[2] at Port St. Mary, Isle of Man, renders all special observations on *Patella vulgata* prior to Fischer-Piette's work subject to revision.

This note especially reviews new observations on those sex-phenomena in *Patella* noted by Orton in 1928[3].

In occasional visits to Trevone, North Cornwall, during the War it was found that the three species, *vulgata*, *depressa* (= *athletica*) and *intermedia* (their complicated synonymy is given by Eslick[2]), are common in this locality, and that although their major distributions are as described by Fischer-Piette[1], in certain suitable spots at about low-water neaps all three species can be taken in quantity within an area of a few square metres. It was found that while the breeding periods of *depressa* and *intermedia* are somewhat similar, these differ from that of *vulgata*, thus giving the first physiological specific difference. Nevertheless there is an overlap in breeding whence it is possible to carry out cross-fertilizations. Artificial cross-fertilizations of all three species made on the beach with untreated sea-water in jam jars gave high percentages of larvæ, but as the sea-water may have contained naturally spawned sperm of all species, the apparent success can only be regarded as an encouragement to repeat the crosses with sterilized water. A study of the interrelationship of the three species by hybridization may produce interesting results on sex-phenomena as well as general biology.

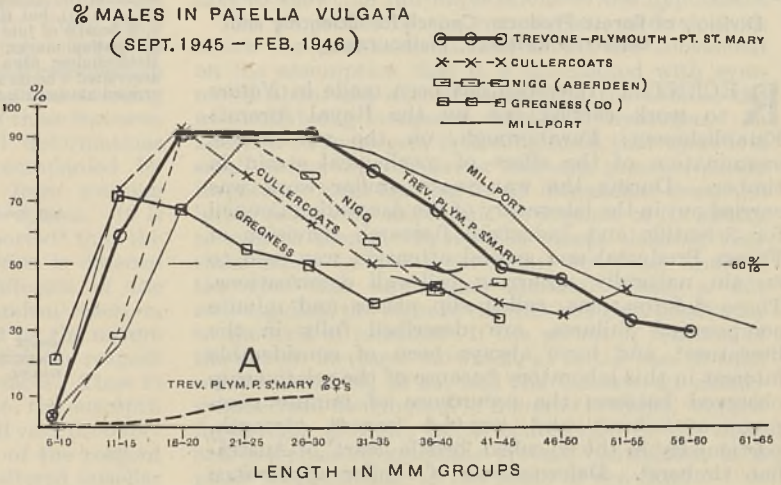
Familiarity with the three species at Trevone made it easy to distinguish the *vulgata* facies from the two other species. In distribution *vulgata* alone is found on bare rock from about half-way between L.W. neaps and ½-tide to H.W. neaps. *P. depressa* and *P. intermedia* are low-water forms, but may occur in such pools as are lined with *Lithothamnion* up to H.W. neaps (Orton)[4]. These distributions have been found to be general in all habitats examined, except that *P. intermedia* has as yet been found only in the south and south-west of England. For this reason the samples of *P. vulgata* examined by Orton[5] for shell-shape must all have been *vulgata* except possibly for occasional specimens of *intermedia* among the low-water samples. Thus apart from the low-water samples, that work can be referred definitely to *P. vulgata* as this species is at present defined: re-examination of low-water samples is necessary to exclude the possibility of contamination with *P. intermedia*.

In a revision of sex-phenomena in *P. vulgata* all radulæ have not yet been examined, but the strict correlation of radular tooth-type found by Eslick[2] with non-opaque-white pallial tentacles and a defined variety of colour in the foot-sole permits these characters along with habitat to be used as a criterion of the *P. vulgata* facies. The foot-sole of *P. vulgata* occasionally approaches in colour to the orange of *depressa* on one hand and the blue-black of *intermedia* on the other, but it is not unreasonable at present to regard these rare occurrences as more likely to be extreme phenotypes rather than genotypes. Nevertheless the degree of variability demonstrated in the genus *Patella* by Fischer-Piette[1] demands caution in dealing with all apparent *vulgata* as one species, and especially on the fringes of the geographical distribution.

With these reservations samples of *P. vulgata*, mostly from the mid-tide barnacle zone, were investigated from six localities ranging from Trevone in Cornwall to Aberdeen and examined for sex-proportions. The results are shown in the accompanying figure. The lengths of shells as tentative criteria of age and size are shown in 5 mm. length-groups ranging from 6 to 65 mm. Each 5-mm. group in each habitat comprises mostly about 100 individuals, with an overall average of 117 per group, and a normal size distribution has been assumed in each group. The sum of individuals for all localities is 8,692 (5,143 male, 1,128 immature). The results for Trevone, Plymouth and Port St. Mary were so concordant that they are here shown in one graph for convenience. The mean group percentage of small females is also given for these combined areas at *A* in the figure.

Except for the Gregness (Aberdeen) locality all graphs show a peak of 90 per cent males at a size of 16–25 mm. The peak is of short duration for Cullercoats but is maintained over a considerable range of size in other localities (excepting Gregness). The percentage of males gradually diminishes towards the maximum size to about 30; it was as low as 23 per cent at Plymouth.

These results are more convincing than those obtained formerly[3], and while providing virtual proof of sex-change from male to female in a section of the male population, point also to the probable occurrence of two types of males in *P. vulgata*. Obvious hermaphroditic forms are rare, due to the apparent exact somatic similarity of males and females and the fact that a long non-breeding period follows a normal complete evacuation of the gonad after spawning in the male. Direct evidence of



successive sex-phases may be obtained by experiment. The results from Gregness (Aberdeen) suggest a difference in type which may be either genotypic or due to environmental conditions markedly different from those on the adjacent ground at Nigg and elsewhere in Great Britain. Although further investigations are being made and may produce more information, it may be noted that as in *Crepidula fornicata*[6], and the oyster[7], there is a possibility that under certain conditions the normal young male phase may be evanescent or even elided, but if so the phase should be demonstrable by experiment.

P. depressa has been found in all the localities mentioned, except Millport (though Mrs. McEwen has kindly sent me this or a related form from the Isle of Eigg), collected from pools or in low water samples. This species has not yet been thoroughly examined, but shows indications of exhibiting the same sex-phenomena as *P. vulgata*. The importance of the biology of the genus *Patella* in the study of evolution recognized by the earlier workers Robson[8] and Orton[9] has been greatly enhanced by Fischer-Piette's work, as recognized by Huxley[10]. A team of workers is co-operating on different aspects of the work, namely, rate of growth, parasitization-rates and mortality, hybridization, sex proportions, environmental effects and general behaviour, all of which are bound up with the subject-matter of this necessarily restricted notice; and full details will be published later. Similar work in the more northerly and southerly latitudes of the distribution of the genus is needed and may produce results of great interest.

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CELL WALL DEFORMATIONS IN WOOD FIBRES

By Dr. H. E. DADSWELL and A. B. WARDROP

Division of Forest Products, Council for Scientific and Industrial Research, Melbourne

RECENTLY[1] reference has been made in *Nature* to work carried out by the Royal Aircraft Establishment, Farnborough, on the microscopic examination of the effect of mechanical strain in timber. During the war years similar work was carried out in the laboratory of the Australian Council for Scientific and Industrial Research (Division of Forest Products) and special attention was paid to certain naturally occurring cell-wall deformations. These deformations, called slip planes and minute compression failures, are described fully in the literature[2] and have always been of considerable interest in this laboratory because of the relationship observed between the occurrence of minute compression failures and lowered impact strength, particularly in the so-called 'brittle heart' of Australian timbers[3]. Deformations of similar appearance to both slip planes and minute compression failures have been recorded for certain textile fibres under the name 'dislocation marks'[4].

All these features can be detected microscopically by examination in polarized light between crossed nicols—they appear bright when the fibre is in the extinction position (see Figs. 1*a* and *b*)—and by the use of stains, for example, iodine and specific lignin stains. Furthermore, they are known to be susceptible to acid attack resulting in the formation of 'broken fibres'[3]. Treatment with dilute alkalis does not have this latter effect. Ambronn[5], on the basis of optical studies, deduced that the dislocation marks of textile fibres were in the form of a fold or crinkle in the cell wall. This explanation has been applied to the optical behaviour of slip planes and minute compression failures, and it has been concluded that the slip plane is a single fold in the cell wall and the minute compression failure a double fold (Fig. 2).

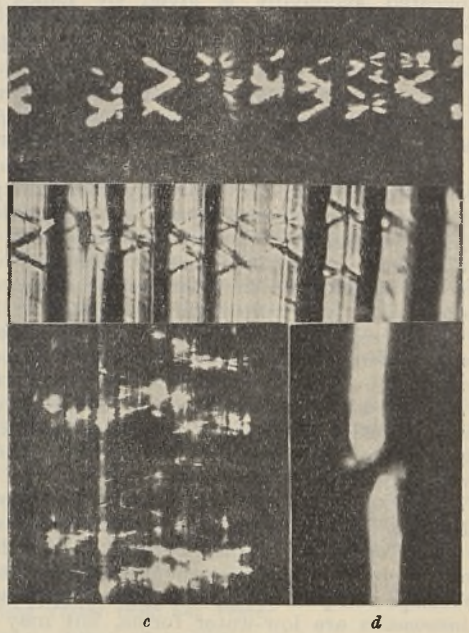

Fig. 1

a, *Eucalyptus regnans* F. v. M. A 5-micron radial longitudinal section viewed between crossed nicols with the fibres in the extinction position. A minute compression failure is seen in the centre of the photograph with some adjacent slip planes. (× 780.) *b*, As in (*a*), but the fibres in the brightness position. (× 780.) *c*, A bundle of jute fibres viewed between crossed nicols, showing dislocation marks. (× 340.) *d*, *Eucalyptus regnans* F. v. M. Holocellulose fibre containing a minute compression failure—acetylated 4 hours and then treated with aniline—viewed between crossed nicols with the fibre in the brightness position. (× 340.)

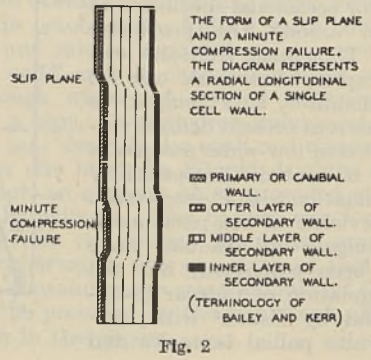

Fig. 2

Thus, if the fibres were in the extinction position the micellar arrangement in the region of both slip planes and minute compression failures would be oriented in a position of relative brightness and vice versa (see Figs. 1*a* and *b*). The angle of the micellar arrangement to the longitudinal fibre axis has been determined in studies of the dichroism of fibre sections stained with Congo Red.

The optical properties of these features have been correlated with their staining reactions and susceptibility to acid attack. Searle[6] attributed the staining reactions and acid susceptibility of dislocation marks to the local depolymerization of the cell-wall carbohydrates. A similar explanation was previously considered in this laboratory in regard to slip planes and minute compression failures. The preferential staining of the two latter features by lignin stains was attributed by Robinson[2] to the rupture of cellulose-lignin interfaces in the cell wall. This has been confirmed by the use of the specific staining method for the detection of lignin developed by Coppick and Fowler[7]. However, iodine stains (for example, Herzberg's) are effective in revealing slip planes and minute compression failures both in untreated and delignified fibres and thin wood sections. Staining with iodine in the presence of potassium iodide is primarily an adsorption effect[8]. In view of the above it has been concluded that the preferential staining effect on slip planes and minute compression failures is primarily physical, resulting from an increased adsorption of iodine. This would suggest increased micellar surfaces in these regions.

The possible influence of cell-wall composition on chemical susceptibility has been investigated by determining the rate of formation of broken fibres on acid hydrolysis. For this purpose holocellulose fibres were prepared from thin wood sections of *Eucalyptus regnans* F.v.M. in which numerous minute compression failures had been observed. These fibres were extracted with various concentrations of dilute alkali so that the material used for acid hydrolysis differed in composition from holocellulose to Cross and Bevan cellulose. Within the limits of the experiment, no increase was observed in the rate of formation of broken fibres. The chemical susceptibility of slip planes, minute compression failures and dislocation marks has been further demonstrated by the acetylation of fibres containing these features and the subsequent treatment of the acetylated fibres with cellulose acetate solvents which were found to dissolve the fibre in the region of the failures because of the preferential acetylation (Fig. 1*d*). From these observations and the work on staining referred to earlier it has been concluded that cell-wall composition is not the dominant factor governing the staining reactions and chemical susceptibility of these features.

It is suggested that the cell-wall deformations revealed by optical studies are accompanied by increased micellar surface (evidence from staining reaction) and increased inter-micellar spaces. It is of interest to note that Sisson has reported[9] that the kinetics of cellulose derivative formation is determined rather by the velocity of diffusion of the reagent than by the speed of the chemical reaction, that is, initially the rate is determined by the nature of the inter-micellar spaces through which the reagent becomes accessible to the micellar surfaces. Thus in the acetylation experiments referred to, the susceptibility of the deformations in the cell wall very probably results from an initial rapid diffusion of the reagent through the fibre wall because of the altered micellar arrangement and the increased inter-micellar spaces. In addition, the reaction would proceed more rapidly because of increased micellar surface. Dilute acids are also known to react on the micellar surface[10], and the formation of broken fibres using these reagents can thus be explained. Broken fibres are not formed when dilute alkalis are used because such reagents would be of insufficient concentration to attack the cell-wall carbohydrates or to produce a degree of hydrolysis comparable with that of the acid.

It has been concluded that the slip planes and minute compression failures of wood are morphologically similar to the dislocation marks of textile fibres, and that the conception presented in the diagram is consistent with the optical and mechanical behaviour of these cell-wall features as well as with their staining and known chemical susceptibility. A more detailed account of the investigations reported here, together with possible explanations for the formation of slip planes and minute compression failures in timber, will be published elsewhere.

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STRUCTURE OF THE EXTRA-GALACTIC NEBULÆ

UNDER the title "On the Structure of Disk-shaped Extragalactic Nebulæ", F. Hoyle has published four papers (*Mon. Not. Roy. Ast. Soc.*, **105**, 5, 287; and 6, 363; 1945) in which the investigation of the structure of the extragalactic nebulæ is based on the view that the combined mass of the stars in a nebula is only a small fraction of the total mass of the diffuse material existing between the stars. This is not a mere *ad hoc* assumption, nor is it an entirely new view; it has been advocated by others, but Hoyle is the first to show the full implications of the hypothesis.

The properties of the interstellar material, from which the gravitational field arises, are considered on the assumption that it is distributed with symmetry about the axis of rotation of the nebula, the material being composed mostly of hydrogen. In addition to hydrogen, it is considered that there is a small proportion of heavier elements present, partly in gaseous form and partly as interstellar dust, the latter being very important on account of its ability to radiate energy. In nebulæ, except those of very small mass—of the order about 10^8 times that of the sun—this interstellar material forms a flat rotating disk, the plane of the disk being perpendicular to the axis of rotation. If the period of rotation of the nebula increases outwards, as in the case of such nebulæ as *M* 33, *M* 31, and the Galaxy, an axially symmetrical distribution of material is stable. Centrifugal force prevents radial contraction of the disk, and gas-pressure gradients prevent contraction in a plane perpendicular to the plane of the disk.

On the view that hydrogen is the chief constituent of the interstellar material, it is shown that the temperature must be less than 20,000° : if it exceeded this, the hydrogen would radiate energy at a rate which exceeds the luminosity of the nebula, which is of the order — 17. Knowing the mass per unit area of the disk of the nebula, that is, the mass contained in an infinite cylinder of unit cross-section with generators perpendicular to the plane of the disk, and also the temperature, it is possible to calculate the thickness of the disk. This is found to be small in comparison with the observed radii of the nebulæ, and in the case of such nebulæ as *M* 33 and *M* 31 the ratio is about 10^{-2}.

Certain astronomical problems directly connected with the condensation of stars are discussed in the second paper under the heading "On the Condensation of Stars, The Luminosity Function, and the Distribution of Bright Stars". A statistical study of stars in our Galaxy shows that if $N(M)dM$ represents the number of stars with masses lying between M and $M+dM$, then $N(M)$ decreases rapidly with increasing M. This is true down to values of M of about one fifth that of the sun ; adequate statistical evidence is difficult to obtain for stars of smaller masses owing to their faintness. If we adopt the short time-scale of about 10^{10} years for the age of the universe, a star of mass less than that of the sun could not have exhausted by nuclear transformation any large fraction of the hydrogen that it originally possessed at the time of its condensation from diffuse gaseous material, and hence the short time-scale requires the form of the function $N(M)$ to be a property of the condensation process. On the long time-scale, however, it is possible to interpret the luminosity function in terms of stellar evolution, and in this case it might be argued that stars of half the sun's mass are more numerous than stars of the sun's mass because more of the latter type have burnt themselves out. As this explanation does not seem possible, it must be assumed that the condensation process involves certain features which prevent the formation of stars of large masses.

It is shown that if the angular momentum of a condensation is calculated from the average observed value of dV/dr, the stellar rotational velocities are of the order 10^9 cm./sec. ; these velocities are so high that rotationally stable stars cannot be formed unless one of two conditions is fulfilled : (1) the star condenses at some special distance r_0, where $dV/dr = 0$; (2) some further process intervenes to prevent the occurrence of rotational instability.

The only process that can account for the rotationally stable stars is the accretion of diffuse material before rotational instability commences. But the question arises : "Can accretion be sufficiently rapid to slow down the rotation of the star so as to prevent rotational instability ?" To answer this question we must possess some knowledge of the time required for the contraction of the condensation to the stellar state, and it is found that for a condensation of fixed mass M the time is approximately proportional to M^{-4}. For a condensation of mass twice that of the sun the time is of the order 10^7 years, but for a star of mass one fifth that of the sun it is of the order 10^{11} years. It appears, therefore, that there is ample time for accretion to play an important part in slowing down the rotation of small stars ; but in the case of the more massive stars—those exceeding twice the mass of the sun—the time is much too short for accretion to have any important effect. For this reason it is suggested that the only condensations which can form stable stars are those of small mass. The rotationally unstable stars of large mass throw off to infinity a large proportion of their mass, the nucleus which remains being of small mass and rotationally stable. The third paper, "On the Formation of Multiple Systems", confirms the view that stable stars are formed only from condensations of small mass.

Bright stars of large mass must belong to one of two groups : (1) those which condense at r_0, where $dV/dr = 0$; (2) those that are of small mass at the time of condensation, but increase in mass by the rapid accretion of diffuse material. The first type forms a concentration of bright stars in a ring of radius r_0, and this should occur in the outer regions of the nebula, because in those regions $dV/dr = 0$. Observational evidence confirms the existence of such a bright ring.

The second type has special interest in relation to the problem of spiral arms, a subject dealt with in the fourth paper of the series. In Section 1 of this paper it is shown that under certain conditions stars of a large rate of accretion are confined at a particular time to two opposite diameters of the nebula, and the subsequent distribution of such stars depends on $P(r)$, the period of rotation. If this increases outwards, the stars are distributed along two spiral arms which gradually wind themselves up. This implies that the arms trail behind the nucleus in all spiral nebulæ, which is different from the conclusion reached on the theory of rotational instability ; in the latter case the arms must be advanced.

Hoyle has supported his theory by a most careful consideration of all the conditions, and if it is accepted, drastic alterations in the subject of galactic dynamics and nebular structure must be expected. It remains to be seen whether observational evidence will confirm the theory advocated.

TRIFOLIUM SUBTERRANEUM LINN. IN AUSTRALIA: AN AUTECOLOGICAL STUDY

SINCE Turesson demonstrated the existence of ecotypes arising from the selective action of environmental factors upon the genotype, well-conducted investigations have been made into the biotypes of many wild plants. With notable exceptions, there has not been the same activity in relation to naturally occurring plants of economic value which have been brought into cultivation and, although the agricultural possibilities of varieties are assessed, their origins are not examined so often. Yvonne Aitken and F. R. Drake have examined the subterranean clover in Australia (*Proc. Roy. Soc. Victoria*, **53** (N.S.), 342 ; 1941), and the organisation of their investigation is worthy of notice.

First the type variety in Australia, "Mt. Barker", is described and genotypical variations listed from material collected from different parts of the country. The origin of these 'varieties' is considered next by direct comparison of the Australian material with European samples and, less satisfactorily, with European floras. A similar range is demonstrated in both regions, and it is considered that there is no evidence whatever of any hereditable response to the altered environment encountered by the species upon

introduction to Australia ; only in the distribution of anthocyanin is any noted mutation considered to have occurred. The varietal distribution seems to be a chance one, with environment preventing the persistence of late-maturing types in short-season districts, while a heavier setting of seed favours the late types in long-season districts.

The responses of the varieties to time of sowing, day-length and relatively high temperature (which inhibits flowering and, therefore, gives a longer grazing-period) have been studied in detail. By means of trials conducted at several stations, the effect of latitude and season on time of flowering of autumn-sown plants has been investigated and, finally, observations were made upon production according to variety and environment, using both spaced plants and those grown in swards.

INDIAN RESEARCH FUND ASSOCIATION

THE technical report of the Scientific Advisory Board of the Indian Research Fund Association* for the year 1944 includes an account of researches carried out during the year together with reports of the advisory committees on cholera, malaria, nutrition, plague, and anti-smallpox vaccination in British India, with a note on the *Indian Journal of Medical Research* and *Indian Medical Research Memoirs* and a list of miscellaneous papers issued under the auspices of the Indian Research Fund Association.

The cholera treatment inquiry, under the director of the School of Tropical Medicine, Calcutta, describes the results of investigations on the treatment of cholera cases with sulphaguanidine and with sulphasuxidine. Important conclusions have been drawn from an inquiry on the statistical evaluation of anti-cholera inoculation in the Madras Presidency. Under the Malaria Research Institute of India, investigations on insecticides and on repellants and protective clothing are reported, including trials with dimethyl phthalate and with D.D.T., and a statistical inquiry into methods of forecasting epidemic malaria. Nutrition researches under Dr. W. R. Aykroyd at the Nutrition Research Laboratories, Coonoor, covered the analysis of foods ; animal experiments on vitamin P and vitamin C, on experimental fluorosis, clinical and field investigations, etc., while an ascorbic acid inquiry under Dr. D. N. Ghosh at the University College of Science and Technology, Calcutta, related to the biosynthesis of ascorbic acid under the influence of narcotics. An inquiry on the formation, functions and variations of plasma proteins in health and disease, under Mr. N. C. Dappa at the Grant Medical College, Bombay, has confirmed the relations of hypoproteinæmia and œdema and of hyperproteinæmia and hyperglobulinæmia. Mr. M. N. Rudra has continued an investigation into the role of manganese in the biological synthesis of ascorbic acid at the Prince of Wales Medical College, Patna. Other nutrition inquiries have covered the factors affecting normal calcium metabolism in certain areas of the Punjab, protein metabolism by human feeding experiments, the deterioration of vitamin A in liver oils, concentrates and other preparations and the relation between the vitamin B complex and tumour growths, as well as tests on the biological value of soya bean protein, growth tests with soya bean and human experiments with soya bean. The estimation of vitamin A activity in plant foods has been investigated at the Punjab University Institute of Chemistry, Lahore, the role of nutritional factors in hepatic cirrhosis at the Haffkine Institute, Bombay, and the chemical nature and nutritional availability of food iron, under Dr. D. N. Ghosh, at the University College of Science and Technology, Calcutta.

Leprosy investigations at the School of Tropical Medicine, Calcutta, and the Lady Wellington Leprosy Sanatorium, Chingleput, Madras, are also reported, as well as plague researches under the director of the Haffkine Institute, Bombay, and a plague inquiry in the Salem district under the Director of Public Health, Madras. Pharmacological investigations have included an indigenous drugs inquiry under Dr. J. C. Gupta at the School of Tropical Medicine, Calcutta, and under Sir Ran Nath Chopra at the Drug Research Laboratories, Jammu, Kashmir, and a pharmacological inquiry on synthetic anti-malarial drugs under Dr. B. B. Dikshit at the Haffkine Institute, Bombay.

Other researches noted in the report include Dr. D. N. Ghosh's investigation into medical mycology at the School of Tropical Medicine, Calcutta, Dr. Sundar Rao's investigation on filariasis at the School of Tropical Medicine, Calcutta, and an investigation of filterable viruses at the King Institute, Guindy, Madras, and a kala-azar investigation under the director of the Pasteur Institute, Shillong. Methods for the manufacture of solid blood plasma and other related problems have been investigated under the director of the All India Institute of Hygiene and Public Health, Calcutta.

* Indian Research Fund Association. Report of the Scientific Advisory Board for the Year 1st January to 31st December, 1944. Pp. vii+188. (New Delhi : Indian Research Fund Association, 1945.) 1 rupee.

FORTHCOMING EVENTS

Wednesday, August 7—Thursday, August 8

BRITISH SOCIETY OF ANIMAL PRODUCTION.—Summer Meeting.

Wednesday, August 7

At 10.15 a.m. (at the West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2).—Discussion on "The Collection, Interpretation and Use of Milk and Butterfat Records" (to be opened by Mr. J. Edwards and Mr. A. H. Ward).

APPOINTMENTS VACANT

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

LECTURER IN AERODYNAMICS AND FLUID MOTION (with subsidiary subjects Mathematics and Airframe Design or Aero Engine Design), and a LECTURER IN CHEMISTRY, at the Kingston-upon-Hull Municipal Technical College—The Director of Education, Guildhall, Kingston-upon-Hull (August 10).

TEACHERS OF CHEMISTRY, MECHANICAL ENGINEERING, AND PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (August 10).

ASSISTANT PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The House Governor and Secretary, Royal South Hants and Southampton Hospital, Southampton (August 17).

RESEARCH ASSISTANT IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds (August 17).

PSYCHOLOGIST (part-time)—The House Governor, St. George's Hospital, Hyde Park Corner, London, S.W.1 (August 17).

PRINCIPAL OF THE TAUNTON TECHNICAL INSTITUTE—The Chief Education Officer, County Hall, Taunton (August 19).

RESEARCH OFFICER IN MASS SPECTROSCOPY, DIVISION OF INDUSTRIAL CHEMISTRY, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, MELBOURNE—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2 (August 24).

UNIVERSITY LECTURERS (2) and a part-time LECTURER IN MATHEMATICS—The Secretary of the Appointments Committee, Pembroke College, Cambridge (August 24).

DIRECTOR OF RESEARCH—The Medical Superintendent, Cardiff City Mental Hospital, Whitchurch, Cardiff (August 25).

PRINCIPAL, a VICE-PRINCIPAL and LECTURER IN AGRICULTURE, and a HEAD OF THE HORTICULTURE DEPARTMENT—The Principal, Cheshire School of Agriculture, Reaseheath, Nantwich (August 26).

ASSISTANT LECTURERS IN BOTANY AND ENGINEERING, and RESEARCH DEMONSTRATORS (part-time) IN PHYSICS, CHEMISTRY AND METALLURGY—The Registrar, University College, Singleton Park, Swansea (August 26).

LECTURERS (2) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Manchester 13 (August 31).

CHAIR OF MATHEMATICS—The Registrar, University College, Southampton (August 31).

JUNIOR LECTURER IN PHYSICS, and an ASSISTANT TO THE PROFESSOR OF CHEMISTRY—The Registrar, Trinity College, Dublin (September 1).

ARCHÆOLOGY OFFICER IN THE MINISTRY OF AGRICULTURE AND FISHERIES ORDNANCE SURVEY DEPARTMENT—The Director of Establishment and Finance, Ordnance Survey Office, Leatherhead Road, Chessington, Surrey (September 2).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (September 6).

PRINCIPAL SCIENTIFIC OFFICERS at the Chemical Defence Experimental Station, Porton, under the Ministry of Supply, for work in connexion with specialized aspects of research in pathology, pharmacology, biochemistry and animal breeding—The Civil Service Commission, 6 Burlington Gardens, London, W.1 (September 14).

LECTURER IN PHYSIOLOGY—The Registrar, University of Otago, Dunedin, New Zealand (September 16).

DIRECTOR OF RESEARCH—The Secretary, British Baking Industries Research Association, 8 Bolton Street, London, W.1 (September 30).

SENIOR LECTURER IN ORGANIC CHEMISTRY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.569 (September 30).

CHAIR OF PSYCHOLOGY—The Registrar, The University, Liverpool (October 12).

CHAIR OF PSYCHOLOGICAL MEDICINE tenable in the Medical School, King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (December 31).

LECTURERS IN THE DEPARTMENTS OF CIVIL AND MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, APPLIED CHEMISTRY, AND PHYSICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN CIVIL ENGINEERING—The Director of Education, The Polytechnic, Regent Street, London, W.1.

LECTURER IN BIOLOGY at the Crumlin Mining and Technical College—The Director of Education, Education Department, County Hall, Newport, Mon.

LECTURER (Graduate) to teach mainly PHYSICS up to and including B.Sc. standard, and some Mathematics, at the Norwich City College and Art School—The Director of Education, City Hall, Norwich.

LECTURER IN PHYSICS AND/OR CHEMISTRY at the Southend Municipal College—The Chief Education Officer, Education Offices, Warrior Square, Southend-on-Sea.

LECTURER (full-time) IN METALLURGY IN THE SCHOOL OF CHEMISTRY—The Principal, Leicester College of Technology and Commerce, Leicester.

ASSISTANTS (2) to carry out computing work as members of the X-Ray Crystallography Research team at Welwyn Garden City—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

PRINCIPAL RESEARCH OFFICER by the Government of Ceylon for the Department of Commerce and Industries—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.16727.

SOIL CHEMIST to the Research Division, Sudan Department of Agriculture and Forests—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Soil Chemist'.

SENIOR CHEMIST, a CHEMIST, and a MARINE BIOLOGIST, for fisheries research posts—The Director, Newfoundland Government Laboratory, St. John's, Newfoundland.

RESEARCH ASSISTANT (Honours graduate in Chemistry) in the Inoculation Department for work on Antibiotics—The Secretary, St. Mary's Hospital, Paddington, London, W.2.

EXPERIENCED LABORATORY ASSISTANTS IN CHEMISTRY AND BIOLOGY—The Senior Science Master, Malvern College, Great Malvern.

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING—The Principal, County Technical College, Stoke Park, Guildford, Surrey.

DIRECTOR OF RESEARCH—The Secretary, Institute of Brewing, Goring Hotel, Grosvenor Gardens, London, S.W.1.

PRINCIPAL SCIENTIFIC OFFICER—The Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Society for Psychical Research: What it is, What it has accomplished, Why its Work is Important. Pp. 20. (London: Society for Psychical Research, 1945.) 3*d*. [112

An Exhibition of German Aeronautical Developments. Contributed and arranged by the Ministry of Aircraft Production at the Science Museum by kind permission of the Ministry of Education. Pp. ii+70. (London: Science Museum, 1946.) 6*d*. [122

Bleached Lac. (British Standard 1284: 1946.) Pp. 14. (London: British Standards Institution, 1946.) 2*s*. net. [142

South-Eastern Naturalist and Antiquary: being the Fiftieth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Fiftieth Annual Congress held at Harpenden, 1945. Vol. 50. Edited by Capt. T. Dannreuther. Pp. 1 + 50. (London: South-Eastern Union of Scientific Societies, 71 Rectory Place, S.E.18, 1946.) 5*s*. net. [142

Carnegie Trust for the Universities of Scotland. Forty-fourth Annual Report (for the Year 1944–45) submitted by the Executive Committee to the Trustees on 11th February 1946. Pp. iv + [illegible]. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1946.) [142

Civil Engineering as a Career. Pp. 56. (London: Institution of Civil Engineers, 1946.) 1*s*. [182

Sheffield Metallurgical Association. Report for 1945 and List of Members. Pp. 22. (Sheffield: Sheffield Metallurgical Association, 1946.) [182

Central Statistical Office. Monthly Digest of Statistics. No. 1, January 1946. Pp. ii+95. (London: H.M. Stationery Office, 1946.) 2*s*. 6*d*. net. [182

Colonial Office. Further Education and Vocational Training. Pp. 8. (London: Colonial Office, 1946.) [252

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 16, No. 1, June 1944. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Keuneman. Pp. iv+74. (London: H.M. Stationery Office, 1945.) 4*s*. 6*d*. net. [252

Scottish Marine Biological Association. Annual Report, 1944–45. Pp. 29. (Glasgow: Scottish Marine Biological Association, 1946.) [252

University of Leeds. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1944–45. Pp. 32. (Leeds: The University, 1945.) [252

Other Countries

U.S. Department of the Interior: Geological Survey. Professional Paper 200: Geology and Ore Deposits of the Magdalena Mining District, New Mexico. By G. F. Loughlin and A. H. Koschmann. Pp. vii + 168 + 38 plates. 2 dollars. Professional Paper 201: Geology and Ore Deposits of the Cottonwood—American Fork Area, Utah. By F. C. Calkins and B. S. Butler; with Sections on History and Production, by V. C. Heikes. Pp. x + 152 + 51 plates. 1.75 dollars. Professional Paper 203: Stratigraphy and Fauna of the Louisiana Limestone of Missouri. By James Steele Williams. Pp. iv + 134 + 9 plates. 50 cents. Professional Paper 204: Geology of the Hanover–York District, Pennsylvania. By Anna Jonas Stose and George W. Stose. Pp. vii + 84 + 18 plates. 1.75 dollars. Professional Paper 205–A: Relative Abundance of Nickel in the Earth's Crust. By Roger Clark Wells. (Shorter Contributions to General Geology, 1943.) Pp. ii + 22. 10 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 866–B: Geology of Dam Sites on the Upper Tributaries of the Columbia River in Idaho and Montana, Part 2: Hungry Horse Dam and Reservoir Site, South Fork Flathead River, Flathead County, Montana. By C. E. Erdmann; with a Section on Geophysical Investigations, by B. E. Jones. Pp. x + 37–116 + plates 8–11. 40 cents. Water-Supply Paper 888: Stream-Gaging Procedure; a Manual describing Methods and Practices of the Geological Survey. By Don M. Corbett and others. Pp. xvi + 245 + 33 plates. 65 cents. Water-Supply Paper 889–E: Chemical Character of Surface Waters of Georgia. By William L. Lamar. Pp. iv + 317–380. 15 cents. Water-Supply Paper 908: Water Levels and Artesian Pressure in Observation Wells in the United States in 1940, Part 3: North-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 288. 30 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 938: Water Levels and Artesian Pressure in Observation Wells in the United States in 1941, Part 3: North-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 232. n.p. Water-Supply Paper 940: Water Levels and Artesian Pressure in Observation Wells in the United States in 1941, Part 5: North-western States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iii + 172. 25 cents. Water-Supply Paper 945: Water Levels and Artesian Pressure in Observation Wells in the United States in 1942, Part 2: South-eastern States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 162. 25 cents. Water-Supply Paper 960: Surface Water Supply of the United States, 1942. Part 10: The Great Basin. Pp. iv + 124 + 1 plate. n.p. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

Sveriges Geologiska Undersökning. Årsberättelse för år 1939. Pp. 8. 0.50 kr. Årsberättelse för år 1940. Pp. 8. 0.50 kr. Årsberättelse för år 1941. Pp. 8. 0.50 kr. Årsberättelse för år 1942. Pp. 8. 0.50 kr. Årsberättelse för år 1943. Pp. 6. 0.50 kr. Årsberättelse för år 1944. Pp. 6. 0.50 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1945.) [151

Sveriges Geologiska Undersökning. Ser. Aa, No. 182: Beskrivning till kartbladet Lidköping. Av S. Johansson, N. Sundius och A. H. Westergård. Pp. 197. 4 kr. Ser. Aa, No. 183: Beskrivning till kartbladen Visby och Lummelunda. Av G. Lundquist, J. Ernhold Hede och N. Sundius. Pp. 167. 4 kr. Ser. Aa, No. 184: Beskrivning till kartbladet Hedemora. Av G. Lundquist och S. Hjelmquist. Pp. 146. 4 kr. Ser. Aa, No. 185: Beskrivning till kartbladet Horndal. Av R. Sandegren och B. Asklund. Pp. 106. 4 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1943.) [151

Sveriges Geologiska Undersökning. Ser. C, No. 435: Flintrännans och Trindelrännans geologi (Öresund). Av Fritz Brotzen. Pp. 33 + 1 plate. 1 kr. Ser. C, No. 437: Nya djuphorrningar genom aldsta ordovicium och kambrium i Östergotland och Närke. Av A. H. Westergård. Pp. 72. 2 kr. Ser. C, No. 438: Geology and Ores of the Boliden Deposit, Sweden. By Olof H. Ödman. Pp. 190 + 48 plates. 8 kr. Ser. C, No. 439: Nyare undersökningar inom Remdalens malmtrakt och dess omgivningar. Av Torsten Du Rietz. Pp. 85 + 4 plates. 3 kr. Ser. C, No. 440: Jordskalv i Sverige 1936–40. Av K. E. Sahlström. Pp. 23 + 1 plate. 0.50 kr. Ser. C, No. 441: Oljeskiffrar och skifferolje-industri. Av N. Sundius. Pp. 45. 3 kr. Ser. C, No. 442: Skifferborrningarna i Yxhultstrakten i Närke 1940. Av A. H. Westergård. Pp. 20 + 3 plates. 2 kr. Ser. C, No. 443: Relations between Ore Deposition and Structure in the Skellefte District. By Sven Gavelin. Pp. 16. 0.50 kr. Ser. C, No. 444: Copper Ores of the 'Red Beds' Type from Visingsö, Sweden. By Olof H. Ödman. Pp. 26. 1 kr. Ser. C, No. 445: Grunddragen av fjällkedjeranden's bergbyggnad inom Västerbottens län. Av Oskar Kulling. Pp. 320+1 plate. 6 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1945.) [151

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

CHEMICAL ENGINEERS—SPECIAL COURSES

Modern industrial development is demanding trained chemical engineers in increasing numbers. Men who have graduated in engineering, physics or chemistry and who have completed their National Service are invited to take advantage of the special one-year, full-time courses in chemical engineering arranged by the Ministry of Education at certain Technical Colleges. Applicants may be eligible for an award under the Further Education and Training Scheme.

For further details, apply for leaflet P.L.216 at the Ministry of Labour and National Service, Technical and Scientific Register, York House, Kingsway, London, W.C.2.

BRITISH RUBBER PRODUCERS' RESEARCH ASSOCIATION

Vacancies exist for two assistants to carry out computing work as members of the X-ray Crystallography Research team in the Association's Laboratories in Welwyn Garden City. Applications are invited from candidates of either sex having H.S.C. in mathematics or with similar qualifications. Commencing salary £4 per week. Facilities will be offered to enable successful applicants to qualify for a degree. Applications to be addressed to The Secretary, The British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

The British Welding Research Association invites applications for a position of Senior Principal Scientific Officer. The minimum salary will be of the order of £1,250 per year; actual salary on appointment will depend upon the qualifications and experience of the applicant. Superannuation is provided for under the F.S.S.U. Scheme. Applicants should be under 45 years of age and experienced in metallurgy and/or engineering, and preferably in research and industrial practice. Applications should be addressed to the Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

Chemist required in London Food Laboratory. Some experience in food chemistry an advantage. Reply, stating age, qualifications, experience and salary required to Box No. H1403, Bensons, Kingsway Hall, London.

University of Bristol.—Applications are invited for the post of Biochemist in the Department of Preventive Medicine for research and routine work to be carried out at Ham Green Isolation Hospital. The appointment will be for one year subject to renewal. Salary £225 with full residential emoluments; a non-resident post could be arranged at £400 a year. Qualifications required are Ph.D. or B.Sc. with some experience in Biochemistry not necessarily medical. Applications together with the names and addresses of three referees should be sent not later than August 15, 1946, to the undersigned.

WINIFRED SHAPLAND,
Secretary and Registrar.

The University,
Bristol, 8.

University of Cape Town. Applications are invited for a senior lectureship in Organic Chemistry. The post is vacant from 1947. Salary scale £675×£25–£775 per annum, plus a temporary cost of living allowance. Applications from candidates who have been on military or other national service will be given special consideration. Applicants are advised to give particulars of such service.

Applications should be made (in duplicate, together with copies of testimonials) stating age, qualifications and experience, and giving the names of three referees to whom the University may refer, to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.569, for application forms which must be returned completed by September 30, 1946.

Vacuum Physics Laboratory in large concern situated in S.W. London area have vacancies for graduates; Honours Degree in Physics, Physical Chemistry or Electrical Engineering and several years research experience required. Salary £600 per annum, upwards, according to age, qualifications and experience. Good conditions of employment and opportunity to publish original work.

Assistants to above also required, and these men should have Honours Degree in Physics. Mathematical ability will be regarded as an asset. Salary £300 per annum, upwards, according to qualifications and experience. Apply in writing in the first instance to the Works Personnel Officer, Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey, quoting reference 6"K.".

Ph.D. required by the Editors of Elsevier's Encyclopaedia of Organic Chemistry, Amsterdam, Holland. Organic Chemist, experienced in different ranges of organic chemistry, able to read French and German and be acquainted with physical chemistry in such a way as to describe exactly all kinds of measuring organic compounds. Applications in own handwriting, stating salary required, to be sent to: Elsevier Publishing Co., Ltd., 2a, Southampton Row, London, W.C.1.

Bacteriological Technician required for Veterinary Research Laboratory. Applicants should be fully trained in all branches of bacteriological work, especially on the research side. Salary £400. Housing accommodation available. Applications to be sent not later than August 15 to Veterinary Science Division, Research Department, Boots Pure Drug Co., Ltd., Thurgarton, Notts.

Assistant Chemist required by well-known chocolate and confectionery manufacturers. Graduate; main subject biochemistry, with either qualifications or strong interest in biology, particularly entomology. Salary according to qualifications. Applications, stating age, qualifications and experience (if any) to Box 654, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Glassblower required for Research Laboratory, West London. Good all-round knowledge of hard and soft glass technique, including lathe work. Wages according to experience. Write, stating age, experience, and full particulars to Box 655, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Junior Laboratory Assistants. Two wanted, one for work in a chemistry, the other in a physics, laboratory, under Chief Steward. Write, stating previous experience and salary required, The Bursar, Marlborough College, Wilts, marking envelope "Laboratory Assistant."

Chemist (man or woman) interested in administrative and intelligence work of Research Department wanted by firm of Pharmaceutical Manufacturers. Shorthand and typing essential: knowledge of German and French desirable. Reply, giving details of previous experience, to Box 656, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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