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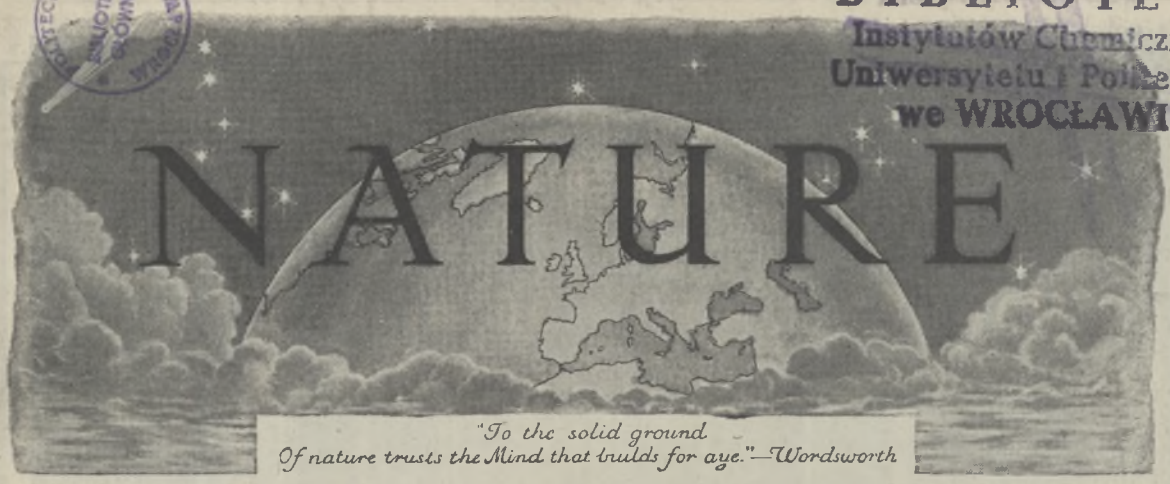

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CARE OF GEOLOGICAL FEATURES IN ENGLAND AND WALES

BRITAIN occupies a peculiarly vital position in geological science. Within its small area are examples of a great range of geological features and of rocks of almost all ages. In the development of geology, British investigators have played an exceedingly important part and have laid the foundations of many branches of study. Many parts of Britain, therefore, contain features of considerable historic interest which will long continue to be of importance to students. In general, it may seem unnecessary to give much attention to the preservation of such geological features, for in many cases they have survived for centuries, and it is not likely that future development will cause them serious harm. The case for their preservation does not always appear to be so urgent as that for the preservation of plants and animals, rare species of which may be exterminated as a result of changes in the utilization of the land. It is desirable, however, at this time, when greater attention is being devoted to the planning of the countryside, that the need for some consideration of geological monuments and sections should not be overlooked, especially as some of the sections are of importance in the progressive development of the science. It is also most essential that arrangements should be made to secure free access to these sites.

These questions have recently been considered in some detail by a Geological Sub-Committee set up by the Nature Reserves Investigation Committee and presided over by Dr. G. F. Herbert Smith. Members of the Sub-Committee included representatives of the Geological Society of London and of the Geological Survey. They have been assisted by more than forty geologists with local knowledge. The report of this Sub-Committee has just been issued*, and it may be hoped that its recommendations will be carefully considered by those concerned with the planning of national parks and nature reserves under the Minister of Town and Country Planning.

The appointment of this special Sub-Committee indicates a recognition that the preservation of geological sections requires different measures from those necessary for the protection of wild life, and the Sub-Committee has worked out its own classification of the types of area and site to which consideration needs to be given. They have defined four separate categories as follows :

(*a*) *Conservation Areas* (*Geological*). Large-scale physiographic features and areas containing many items of geological interest. Working quarries in such areas are to be registered, new quarrying or other works to be undertaken only after approval has been obtained from the appointed authority, advised by a scientific panel.

(*b*) *Geological Monuments*. Small-scale geological features and sections of outstanding interest, to be

* Report by the Geological Sub-Committee of the Nature Reserves Investigation Committee. Memorandum No. 5 : National Geological Reserves in England and Wales. Pp. iv+42. (Society for the Promotion of Nature Reserves, British Museum (Natural History), London, S.W.7.) 1*s*. 6*d*.

permanently protected and kept in a good state of preservation.

(*c*) *Controlled Sections.* Natural sections and artificial sections in a state of disuse, to be subject to control on account of their scientific value, in order to protect them from being obscured by building or the dumping of refuse, or otherwise rendered inaccessible.

(*d*) *Registered Sections.* Sections of exceptional geological importance at present used or worked, to be listed and to be kept under observation by an appointed authority, the owners or lessees being required to give notice of their intention to cease operations, in which event the sections in question would be considered for transference to the previous category, (*c*).

In these four categories the Sub-Committee has listed 390 sites in England and Wales, arranging them under counties for convenience of reference; 331 of these sites are in England, 58 in Wales and one is shared by both countries. Of conservation areas there are 71, of geological monuments 48, of controlled sections 198, and of registered sections 73. These are large numbers; but when the lists of sections given under any county are examined, it is at once recognized that there has been rigorous selection of those sections which are recommended for control or registration, and an even more careful scrutiny has been given to the selection of geological monuments. Many quarries of great scientific importance are not listed. Moreover, the controlled sections include many stretches of sea cliffs which are not likely to be greatly affected by any changes which can be foreseen, but to which it is essential that access should continue to be available; conservation in these cases will not be costly or difficult.

The sites selected are very unevenly distributed over England and Wales, as is to be expected. They fall chiefly in areas where there are harder rocks, for these yield features which may be scenically more attractive and which are more likely to be permanent. It is doubtful, as the Sub-Committee notes, whether much can be gained by preserving a clay pit after its working has ceased. There is thus only one section indicated in Essex and only two in Hampshire, while there are twenty-six in Shropshire and forty-two in Yorkshire. It is a little surprising, however, to find only two each in Cardiganshire and Carmarthenshire. It may be hoped that some sections in the classic areas of Llandeilo and Llandovery in the latter county may be found suitable for conservation.

When the large number of the suggested areas is being considered, several points must be borne in mind. In the first place, many will probably fall within areas which will be utilized as national parks. It may be hoped, therefore, that it will be easier to effect some measure of control. Others will probably overlap with conservation areas chosen on biological grounds, and obviously much is to be gained where the purposes of both biology and geology can be served by the conservation of single areas. Moreover, many of the sites suggested as monuments and as controlled and registered sections fall within the wider conservation areas.

There is clearly a distinction between the problems of registration and control of sections and monuments and the provision of access to them on one hand, and the conservation of large-scale features containing many items of geological interest on the other. In the case of monuments and sections, little supervision is necessary; and provided that access can be secured, little more than periodical inspection is required. It is to be hoped that in such cases a descriptive label (the Sub-Committee suggests in the form of a metal plate) would be set up. There is little doubt that this would have great educational value. Many of the geological monuments listed, such as the Bowder Stone in Borrowdale and Durdle Door, west of Lulworth Cove, are already visited by great numbers of walkers and others. An indication of their significance and of the fact that they are of national interest would do much to stimulate a greater attention to geological phenomena.

The conservation areas suggested by the Geological Sub-Committee involve tracts of country, some of them very small, others covering considerable areas. They include such features as Incombe Hole, Ivinghoe, Bucks, the Lizard Peninsula, four tracts in Derbyshire and six coastal regions in Dorset. It is rather surprising to find that no areas are specified in Cumberland, though it is possibly anticipated that the Lake District will be covered by a proposed national park. Some of the areas included are of physiographical as well as geological interest; and it would be valuable to consider the addition of other physiographic types, such as some areas in the Norfolk Broads or the Fens, and other coastal features such as Chesil Bank, which is conveniently near an area already specified as a controlled section.

The Sub-Committee holds the view that such geological conservation areas should be kept, so far as possible, in their present condition. They do not suggest that quarrying and other industrial activities should cease, for they recognize that the geologist gains greatly from the working of quarries. It is indeed obvious that in many cases more may be gained by continued working of a quarry than by the preservation of a particular section in its present condition. On the other hand, it may be possible to secure the preservation of a column representative of an important section revealed in the course of quarrying operations.

The Sub-Committee indicates that the list which it has provided is not to be regarded as final; and it is engaged in the preparation of a second list of sites and sections of less general interest, some of which it suggests might be preserved by local action. It is desirable that local patriotism should be roused for the protection of many of these features, and that their educational value should be made more widely known.

The conservation of these sites is not only of educational value, however. While it may be hoped that the control of monuments and sections would direct the attention of a wider public to the existence and

interest of most of these features, it must be emphasized also that many of them are of vital importance for scientific research. Moreover, it may be hoped that the conservation of these features will bring enjoyment and stimulus to many who are interested in the countryside but who have no special knowledge of geology. One valuable aspect of the conservation of such features is that it involves no restrictions on the general public. Whereas it may be necessary in the case of some nature reserves to limit access, in the case of geological reserves all that is required in most cases is to secure that access remains available for geologists as well as for other visitors. The protection of many of these features would thus increase and safeguard the general amenities of the countryside for the public as a whole.

It will be noted that the present report refers to England and Wales only. Similar questions are being dealt with separately in relation to Scotland, where it may be hoped that comparable steps will be contemplated.

PLANT LIFE AND SOLAR ENERGY

Photosynthesis and Related Processes

By Eugene I. Rabinowitch. Vol. 1: Chemistry of Photosynthesis, Chemosynthesis and related Processes in Vitro and in Vivo. Pp. xiv+599. (New York: Interscience Publishers, Inc., 1945.) 8.50 dollars.

THIS book is an outstanding contribution to the problem of photosynthesis, and is the first volume of a work which will deal with this fundamental physiological process from the chemical, physical and botanical points of view. The author is a research associate, Solar Energy Conversion Research Project, Massachusetts Institute of Technology, and explains that while this work is not concerned directly with photosynthesis "it has helped to keep alive an interest in the subject, for while experimenting on the conversion of light energy into chemical energy one cannot but turn continuously to plants and wonder how Nature has achieved a result which has not been approached in the laboratory".

This volume is divided into two parts, the first dealing with the chemistry of photosynthesis and related processes, and a second part dealing with the structure and chemistry of the photosynthetic apparatus. These are preceded by two introductory chapters, one concerned with the role of photosynthesis in Nature and the second with the discovery of photosynthesis. Both these chapters might be read with great interest by the general reader. It is strange that although this process is so fundamental to the existence of all life it was not discovered until the eighteenth century. Since then investigations have increased at a great rate in all countries, and at the present time the literature on this subject in scientific journals is immense. It is contained in botanical, chemical, physical, agricultural and physiological journals, so that the preparation of a complete bibliography is a formidable task. Dr. Rabinowitch has gone far in achieving this, and every part of the present volume is well documented and every chapter contains a bibliography; the one following chapter 10, for example, quoting more than 250 references from 1843 until 1940. The great amount of literature brought together and discussed makes this work of great interest both to chemists and to physicists.

Each of the two parts of the present volume is divided into a number of chapters dealing with different phases of the subject. The first part is subdivided into ten chapters and each into many sub-sections. Dr. Rabinowitch first treats of the over-all reaction and the products of photosynthesis and then goes on to consider related processes outside the living cell. Then follow chapters dealing with the photosynthesis and chemosynthesis of bacteria and the metabolism of anærobic bacteria, with a significant section on the role of autotrophic bacteria in Nature. "Green plants reduce carbon dioxide in light by means of water; green and purple sulfur bacteria reduce carbon dioxide also in light by means of hydrogen sulphide; colourless sulfur bacteria reduce carbon dioxide by means of hydrogen sulphide without light. This comparison shows the existence of a hierarchy of autotrophic organisms and encourages speculations as to the genetic relationships between them." This leads on to a discussion of the primary photochemical process of the oxidation of water as the first stage and the reduction of carbon dioxide as the primary process. In a subsequent chapter we have a discussion on the assumption that the reduction of the complex carbon dioxide is a non-photochemical process involving an intermediate reductant and not a photochemical reaction with reduced or excited chlorophyll. Later chapters deal with inhibition of photosynthesis by chemical and physical agents.

In Part 2, which is concerned with the structure and chemistry of the photosynthetic apparatus, one of the most interesting chapters deals with the structure, composition and pigments of the chloroplasts and chromoplasts. The revival of the hypothesis of chlorophyll grana in 1932 and its confirmation by photographs by Doutreligue in 1936 is described. This confirmation showed that the grana are distributed more or less uniformly throughout the chloroplast in distinction to the earlier views that they were concentrated on the surface. Later chapters deal with the chlorophylls *a* and *b* and their ratio; the chlorophylls of the algæ and the concentration of chlorophylls in leaves. The molecular structure and chemical properties of chlorophyll form an important section and the latter part of Part 2 is devoted to the accessory pigments such as the carotinoids, phycobilins, flavones and anthocyanins. Then follow chapters on the photochemistry of pigments *in vitro* and *in vivo* and the last chapter discusses photosynthesis and respiration.

Dr. Rabinowitch raises the question of a possible connexion between the two catalytic mechanisms, and observes that while the nature of the links is as yet quite uncertain they will undoubtedly be subject to closer study in the near future. He follows this up by quoting observations on the effect of light on respiration and observes that "none of the experiments described provides a final proof of the non-existence of true 'photorespiration', the least that can be stated is that no evidence of such a phenomenon has as yet been found (except perhaps in ultra-violet light), and that all definitely established cases of light stimulated respiration were of the 'persistent' type, and could be attributed either to an accumulation of sugars or to an indirect photochemical effect of blue-violet light absorbed by the carotenoids".

This book differs from previous works on the subject by the greater emphasis on physical and physico-chemical theories and methods due to the newer trends in the study of photosynthesis. Photosynthesis in relation to systematic botany or ecology has little place in it. It is essentially written for the research worker and should greatly stimulate work along these lines. The important literature from all sources is brought together and discussed and the book thus forms a very notable addition to the literature in this field. The appearance of Vol. 2 will be awaited with interest. F. J. Lewis.

MEDICINE AND THE HUMANITIES

The Art of Medicine in Relation to the Progress of Thought

A Lecture in the History of Science Course in the University of Cambridge, February 10th, 1945. By A. E. Clark-Kennedy. Pp. 48. (Cambridge : At the University Press, 1945.) 2*s*. net.

THIS lecture, written in simple words and infused by a contemplative charm, is not designed to answer the age-old questions : Have we a soul ? What is mind ? and so forth. It briefly discusses these questions and suggests to us why they cannot be answered and why they probably never will be answered. But the purpose of the lecture is rather to consider how medicine, by bringing science and thought into intimate and personal relationship with humanity, "has resulted in science making a greater contribution to thought than otherwise would have been the case".

In his brief history of the development of medicine and his longer one of the developments of the last hundred years, the author gives, in a short space, a valuable dissertation on his general theme. Prominent in it is the new conception of disease which has arisen, a conception which is an advance upon Sydenham's useful conception of clinical entities, which has, the author thinks, tended to obscure the real nature of disease and to lead to a superficial attitude to problems of medical practice. In a similar way, it might be added, too much emphasis in all fields of inquiry on useful and, indeed, necessary, classification can have a similar effect. The medical man, however, is faced with problems of the mind as well as with those of the body. The body, says the author, has evolved as a physico-chemical machine. Within certain limits it influences and is influenced by the mind. To this the medical man must add the influences of genetic and environmental factors upon the production of disease; and consciousness, as distinguished by the author from the more general and unsatisfactory term 'mind', brings problems of pain, of deliberate thought and free-will and of moral and æsthetic judgment. Man is learning rapidly how to gain health, but is free, as the practising physician knows so well, to make himself as well or ill as he wills. The difficult problems for the medical practitioner which result from this and the repercussions of this view of disease upon politics, social planning, preventive medicine and State control occupy the bulk of this lecture.

On the whole, the author successfully sketches, in the brief space available to him, the main complexities of the modern medical outlook. Only here and there will the reader sit up and blink a little—as, for example, when he reads that, since the studies of Vesalius, Harvey and Malpighi, biology "has limped along behind the mechanical sciences in the part-worn clothes of her elder sister, physics". The author seems to be quite unaware that biology has recently undergone a change not dissimilar from that which he indicates in medicine. The causes, indeed, of the changes in these two related fields of inquiry are, and perhaps must be, essentially the same. Many readers will, however, no doubt agree that the psychologists, even those who labour so earnestly and passionately to heal the disordered mind, have nothing to guide them but an imperfect understanding of the normal mind. It sometimes seems, indeed, that the sick minds studied by the medical psychologist have within them a capacity for self-destruction and for the destruction of society which is analogous to that contained by the unstable isotope of uranium used to make the atomic bomb. But does the psychologist know the stable isotope ? If he does not, upon what does he base the theories of human education and conduct which are put forward for the direction of our youth and our society? The medical psychologist can, of course, not be blamed for this lack of knowledge of the norm ; he is straining every nerve all the time to construct it. The only premature thing is that our future should be subject to any form of directive whatever which is still immature and uncertain of its foundations.

To return, however, to the main theme of this book, its main conclusions are that there is too much specialization in medical education (a point which is already widely recognized), and that the purely scientific education which medical students now receive is not enough for a profession which has to deal with human life and experience as a whole. It is half the art of medicine, says the author, to adopt a reasonable and practical attitude to the unknown. The power of modern medicine to prolong life, to relieve suffering, to influence endocrine secretion, to control birth, to dominate mind and even to modify personality is likely to increase ; it should not be diminished ; but in it there is a real danger. "There always is danger in power."

We live in an age when excessive anxiety over the health of the body has replaced pre-occupation with the welfare of the soul. Many problems, now decided upon ethical grounds, will, in the future, be decided entirely upon grounds of medical expediency and judgment. To meet this situation medicine could and should, the author thinks, be the connecting link which would reconcile the conflicting points of view of the humanities, on one hand, and the sciences on the other. Disease is not entirely genetic or environmental in origin ; behaviour is not all conditioned reflexes and is not entirely due to deliberate thinking. There is a happy mean between too much individual liberty and too little external control ; too great risk and too little security ; too much pain and too little suffering. Medicine has not yet displaced the notion of the soul, and probably it never will. It is not irrelevant to remember that it is one of the privileges of medicine to handle the biological phenomenon of death, "and here we come into closest touch with the spiritual aspects of human life".

There should be few scientific readers who will not, if they look sincerely into their experience, endorse and welcome the main argument of this thoughtful and thought-provoking book.

G. Lapage.

Vegetable and Fruit Growers' Conferences

Edited by Dr. D. H. Robinson. Pp. 64. (Worcester: Littlebury and Co., Ltd., 1945.) 6*s*. net.

THIS little book consists of fourteen short papers read to the Vegetable and Fruit Growers' Conferences held in Worcester in December 1944. The contributors are prominent commercial growers and members of research station and Ministry of Agriculture staffs.

The first paper, by Dr. H. V. Taylor, gives an account of the expansion of vegetable production during the War and probable future requirements. The second, by G. H. Tawell, deals with artificial irrigation of vegetable crops and gives useful guidance on methods, and the application of fertilizers in solution. Prof. T. Wallace contributes the next three pages on the factors determining soil fertility, and a single page by Prof. G. E. Blackman deals with the chemical control of weeds. D. R. Bomford makes a convincing plea for research on horticultural as distinct from agricultural machinery, and suggests specifications of various implements. J. F. Bomford calls for a compulsory marketing and distribution scheme and the education of urban populations in the importance of the industry and its problems. The next four papers, by N. H. Grubb, J. Turnbull, C. P. Norbury and F. J. Masters respectively, give the merits and defects of the main commercial varieties of soft and tree fruits. V. L. S. Charley discusses varieties of apples and pears for cider and perry making and of soft fruits for syrup production. G. A. Nott makes out a case for the production of unfermented apple juice as a means of disposing of low-grade fruit. D. A. Osmond writes on the soil series to be found in Worcestershire and their suitability for various crops, and the book ends with an account by W. L. Moore of his experiences in planting a cherry orchard under grass.

The papers provide stimulating thumb-nail sketches of subjects of current importance to commercial growers, and those on fruit varieties should be particularly useful. There are a few minor typographical errors. W. E. B.

Time, Number and the Atom

By R. Fortescue Pickard. Pp. vii+92 (London: Williams and Norgate, Ltd., 1945.) 8*s*. 6*d*. net.

MR. PICKARD is interested in numbers, particularly primes and perfect squares. He points out that the ratio of the masses of the proton and the electron may be taken as 1849, and this is the sum of the consecutive primes from 3 to 131 inclusive; or as Mr. Pickard prefers to put it, the mass of the whole hydrogen atom is 1850, which is the sum of the first 32 primes, 2 being omitted. In an appendix he gives arguments in favour of omitting 2 from the list of primes. He also points out that $1849 = 43^2$, and 43 is the sum of the terms in the bracket when the Rydberg Series is taken as far as corresponds to the completed series of the Periodic System.

A search for further arithmetical relationships leads him to regard each element as characterized by two integers, its atomic number and its mass number. On account of the existence of isotopes it becomes necessary to choose a "primary" mass number, which is often the rounded atomic weight, or the mass number of the most abundant isotope, but may be that of a rarer isotope, or even of an isotope as yet undiscovered: for example, Li = 6, B = 10, Sc = 44. From this array of numbers Mr. Pickard produces some interesting patterns, though as these mostly involve the sums of the mass numbers of groups of consecutive or otherwise related elements, it is difficult to see what physical significance they can have.

The word "time" in the title refers to certain metaphysical arguments tending to identify the fundamental ideas of time and number.

F. J. GARRICK.

Astronomical Air Navigation

A Comprehensive Handbook embodying the Latest Principles for Practical Navigators, Instructors and Students. By Squadron-Leader Ronald Hadingham. Second edition, revised and enlarged. Pp. xii+152. (Kingston Hill: Technical Press, Ltd., 1945.) 12*s*. net.

THE second edition of Squadron-Leader Hadingham's handbook on astronomical air navigation has been enlarged and revised. A description is included of the Mark IXA bubble sextant, with which the navigator continues his observation for two minutes, during which period the altitude is recorded sixty times and the average value of the observed altitude is automatically indicated; the accuracy of observation during unsteady conditions of flight is thereby considerably increased. A full description is also given of the astrograph and its uses; with this instrument, which was for long on the secret list, the position lines for different altitudes of two stars suitably placed for observation are projected on to the navigator's chart, enabling the position of the aircraft to be obtained quickly and without computation. The chapter dealing with star identification has been enlarged.

The volume is a useful and essentially practical handbook. It is somewhat marred by a number of loose statements, such as that "the value of refraction is always negative and must be subtracted from the observed altitude", and that "this gradual change (i.e. precession) must also produce a change in the positions of the seasons". The statement, on p. 83, that the earth's axis is inclined at $23\frac{1}{2}°$ to the plane of its orbit is so obviously incorrect that it is not likely to be misleading.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1944. Edited by Dr. M. Epstein. Pp. xii+506. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1945.) 42*s*. net.

WITH unfailing regularity, unbroken since 1758, this volume presents a year of the history of the world and a survey of progress in art, literature, science and finance. The usual arrangement is maintained, beginning with a summary of English political history and the course of the War, followed by imperial history; and then the most important movements and events in foreign history, which reveal much that may have been lost sight of in the limited space of current newspapers. The second part includes a chronicle of events, obituaries of the year and retrospects of various aspects of national life. Public documents printed in full include the Bretton Wood agreements, the Franco-Soviet treaty and the Dumbarton Oaks proposals. An excellent index facilitates the use of the volume. No student of current affairs can afford to dispense with this full and objective survey of the world's history.

ACOUSTIC CONTROL IN THE FLIGHT OF BATS

By Prof. H. HARTRIDGE, F.R.S.
St. Bartholomew's Hospital Medical College

NO one interested in wild life or in the science of flight can fail to be curious about bats, which in skill of manœuvre and fearlessness excite our admiration. The facts that their flight is as technically perfect in complete darkness as it is in daylight, that their wings are entirely different in design from those of the birds, and that, unlike most living creatures, they sleep hanging head downwards, add greatly to our interest in them. Small wonder if to the superstitious or the ignorant of bygone days they appeared to be guided, controlled and protected by the Prince of Darkness himself.

The hypothesis which I advanced in 1920[1] to explain their adjustment of speed and direction when flying at night was "that bats during flight emit a short wave-length note and that this sound is reflected from objects in the vicinity. The reflected sound gives the bat information concerning its surroundings. It is possible that if a bat makes use of short-wave-length sound it would be able to estimate the position in space of an object ahead of it with considerable accuracy". There seems to be little room for doubt that this hypothesis is correct, for Galambos and Griffin[2,3] found that bats while in flight emit a discontinuous supersonic note. They can steer clear of obstacles, even thin carpet thread (Hartridge), or thin wire (Hahn[4]), when flying in complete darkness provided they can emit this note and receive its reflexion from surrounding objects by their ears. If, however, they are made mute or deaf they run into such obstacles.

It is the object of this communication to try to elucidate the details of this localizing mechanism, for there are a number of disconnected observations concerning it which can now be fitted into position.

Sounds Produced by Bats

If a physicist were asked to design the vocal apparatus for a bat he would, I think, decide that this should be capable of producing two different kinds of sound: one for the purpose of avoiding obstacles while in flight; the other for sending messages to neighbouring bats, because, as will be seen shortly, no single sound would be suitable for both these purposes.

For localization, an interrupted supersonic tone is required with short wave-length and constant intensity. The interruptions should be made in such a way that the change from emission to silence and vice versa is as sharp as possible. The number of interruptions per second should be variable so as to secure the optimum conditions for localization.

For signalling, on the contrary, a supersonic tone would be quite unsuitable, for a signalling tone should not cast sharp shadows, should be as non-directional as possible, and should have very good carrying power. If possible, it should be capable of alteration in pitch, intensity and quality, for these variations would be useful when one bat wants to inform other bats about such things as the discovery of food or the approach of danger. For such a purpose a tone of medium pitch is indicated.

The bat's vocal apparatus should then be capable of producing these two different kinds of tone, and both would fall with advantage within the range of frequencies for which the bat's cochlea is most sensitive. In man this range is not very large, for it extends over only about four octaves of the whole audible gamut of about 10½ octaves. Assuming that the bat's cochlea, which is histologically very similar to that of the human cochlea, is not very different in performance, then the localizing frequency and the signalling frequency should not be separated by more than about four octaves, that is, the ratio between them should not exceed 16 to 1. In fact, the frequency of the localizing tone in bats is between 45,000 and 60,000 cycles per second and that of the signalling tone is roughly 7,000 cycles per second, so that their ratio is about 7 or 8 to 1—probably well within the efficient range of the bat's cochlea. If this is so, the overtones of the signalling tone would be well heard by the bat, for its first four harmonics would fall within the optimum range of bats' hearing. Other important points are that the production of either localizing or signalling tone, or in emergencies both at the same time, should not interfere at all with flight. Neither should the production of the localizing tone interfere with the collection of food, since a bat's flight is largely, if not predominantly, used for that function. Lastly, the localizing tone should be capable of continuous production, not, for example, having to be stopped during the inspiration of fresh air into the lungs.

Bats produce four different kinds of sound: (1) A buzz. This is not audible unless the observer is quite close to the animal. (2) The signalling tone of about 7,000 cycles per second. This usually lasts for a quarter of a second, and may be repeated over and over again. (3) The supersonic tone. This is seldom less than 30,000 cycles or more than 70,000 cycles per second in the majority of bats. It usually lies between 40,000 and 55,000 cycles. This sound may be emitted both when at rest and in flight. It may be emitted once only, as a single pulse, when it lasts for about 0·01 sec.; or a number of such pulses may be produced. At rest a bat may produce five to ten supersonic cries per second. When it begins to fly, the rate is increased to twenty or thirty per second. When, however, obstacles lie immediately ahead, the number may be raised still further, to as many as sixty per second for short periods. (4) A click which is usually audible anywhere in a small room.

Both the buzz and the click are accompanied by the supersonic tone described above. In the case of the click, there is a single short output of supersonic energy. In the case of the buzz there is a continuous evolution of the interrupted supersonic tone. It should be noted that whereas the click and buzz are always accompanied by supersonics, the signalling tone may either be produced by itself or be accompanied by the supersonic tone.

Structure of the Throat of Bats

The structures in the bat by which the four different types of sounds are probably produced will now be considered. The production of these sounds must not interfere with either breathing or flying. Neither must they make the catching of food difficult, for this is one of the objects of bats' flight. The utilization of energy by the vocal apparatus must be inconsiderable, and the air passages to the lungs must not be obstructed. In addition, it would be advantageous if the vocal apparatus were small in size and light in weight. In all these respects it would be difficult to select a more compact and versatile mechanism

than one on the plan of the mammalian larynx. In man this usually has a range of about two and a half octaves, but may extend to nearly three and a half octaves. Now, apart from the click, the three sounds produced by the bat have frequencies of 12–60 for the buzz ; about 7,000 cycles per second for the signalling tone ; and about 50,000 cycles per second for the supersonic tone. So different are these frequencies that it seems most unlikely that they could all be produced by the vibration of a single vocal mechanism adjusted to different tensions, masses and lengths. That two mechanisms at least are involved is probable from the fact that the buzz and the supersonic tone occur at the same time. If they were both made by the same structure, it would be necessary for the supersonic vibrations to be quenched either by greatly increasing the tension in this structure, or by allowing it to become quite slack, or by forcing its vibrating parts into contact. Each of these changes would cause an alteration in pitch to occur just prior to the beginning of the silence, and again at its cessation. But no such changes are shown in the records obtained by Galambos and Griffin. We are therefore led to the conclusion that the buzz and the supersonic tone are produced by different structures.

It is much more difficult to reach a decision with regard to the origins of supersonic and signalling tones. Since their frequencies are in the ratio of about 7 to 1, that is, within three octaves of one another, they could without difficulty be produced, one at a time, by the same vibrating structure. Some bats have been observed to produce both these tones at the same time ; and it is stated that certain species of bat have two separate vibrating structures in their larynx. If these observations are confirmed, it is possible that one of these structures produces the signalling tone and the other the supersonic tone.

The position may be summarized as follows : The larynx of the bat contains at least two and possibly three vibrating structures. If two only, then one is used for the buzz, the other for both the supersonic and the signalling tones. If there are three, then the buzz and these two tones may be separately produced.

With regard to the position of these structures in relation to one another, they might be arranged either in series or in parallel. But since the buzz is used to modulate the supersonic tone, the series arrangement seems to be preferable. The air from the lungs will therefore pass through the first mechanism and then through the second, setting both of them into vibration.

The laryngeal mechanism for producing either the signalling tone or the supersonic tone might be similar to that of the normal mammalian larynx, except that for the latter greater tensions must be associated with vibrating members of small length and mass, attached at either end to exceptionally rigid supports. This conclusion fits in with the anatomical observations of Robin[5] and Elias[6] on the bat's larynx. They point out that in many places bone has replaced the more usual cartilage. They also emphasize the massiveness of the muscle bellies which set up the tension in the vocal cords. There seems to be little room for doubt that the bat's larynx is generally similar in design to the human larynx, and that it has the same mode of operation, but that it has been greatly modified in detail in order to produce the very high frequency tones required by the bat for its special purposes.

The laryngeal mechanism for producing the buzz may be constructed on similar lines to the above, but its low frequency (12–60 cycles per second) makes an alternative method possible, namely, a rhythmic opening and closing of the orifice, through which the air stream is passing, by direct muscle action.

There is one obvious difficulty in accepting such a suggestion, namely, that mammalian muscles do not as a rule contract rhythmically at such a very high rate as sixty times per second. Thus Ching and I[7] found when flexing and extending the right forearm that eleven up and down movements could be made per second. Fenn[14] obtained values of six to ten movements per second.

It may be pointed out, however, that the wings of insects are moved at very high rates by muscles histologically similar to human striated muscle, the rates of vibration in some cases being hundreds per second. It is therefore possible that certain muscles in a bat may also have a high rate, up to 60 vibrations per second.

If this is the case, it makes possible a linking of two muscle actions, one quenching the supersonic tone, the other rendering the ear insensitive to supersonic sound. This most desirable arrangement will be discussed later.

With regard to the actual structures which produce the buzz, one possible suggestion is the false vocal cords. These are situated in an anterior position to the true cords and are under the control of the will. Normally they are separated ; but they are brought together during swallowing and also when the breath is being held for some violent muscular movement. They are first brought together and then separated for coughing. They might be modified for the production of the buzz by an increase in the rapidity of opening and closing under muscle action. The fourth type of sound made by a bat—the click—may be produced by the same structures, namely, by bringing them together, raising the air pressure in the lungs, separating them suddenly (during this phase the supersonic tone is produced), closing them again, reducing the air pressure in the lungs to its normal value and then separating them once more.

The Supersonic Tone

If a supersonic tone were being selected for purposes of localization, there are two physical factors which would have to be taken into account : the attenuation of sound during transmission through the air, and the resolving power that is required. As with optical instruments, so with devices using sound waves for purposes of localization, the shorter the wave-length the finer the structure the presence of which can be identified. In order to detect the presence of thin wires or threads, wave-lengths approaching the diameters of the wires would be required, the shorter the better. The use of sound of very short wave-length may lead, on the other hand, to much less effective results, owing to the attenuation of sound during its transmission through the air.

The volume of sound reflected back from a small obstacle at first improves with decrease in wave-length, but as attenuation comes into play the improvement ceases and is replaced by a falling off of efficiency.

The resolving power, other things being equal, increases in proportion to frequency, whereas the attenuation increases as the square of the frequency. The following values show how important the effect of attenuation is : at 200 cycles the distance at which the original intensity is reduced to 36·8 per cent is 1,000,000 metres ; at 10,000 cycles the distance is

410 metres ; but at 100,000 cycles the distance is only 4 metres. If, therefore, a bat emitted a note of the latter frequency, only 36·8 per cent of the sound intensity would reach 4 metres, and only 13·5 per cent would be present at 8 metres. Thus a bat 4 metres from an object would receive back from that object only 13·5 per cent of the sound which it emitted, assuming that the whole of the sound emitted reached the object and all of it was reflected back again into the bat's ears. Such, of course, is not the case, for in the first place there is a loss due to the radiation of the sound waves from the source, and in the second place there are the losses which occur when the sound is reflected. The smaller the object, the greater the latter losses become. With reduction of wave-length (increases of frequency) the losses by reflexion become less, but the losses by attenuation become greater. The case is not very different from that of the microscope, in which the shorter the wave-length of the light the greater is the resolving power ; violet rays giving greater resolution than blue rays, and ultra-violet rays greater than violet ones. A limit is, however, soon reached owing to the attenuation of the rays by the optical media of which the lenses of the instrument are constructed. If all the facts concerning the vocal apparatus, the behaviour of the sound waves, and their reception by the ears of the bat were known, it is not unlikely that it would be found that a frequency of about 50,000 cycles per second would give an optimum effect.

Having discussed some of the physical limitations of the use of sound for purposes of localization, we may now consider the successes and failures of the method in practice. It enables the bat to steer clear of carpet thread[1] and wire[4], and to determine the differences between such objects and flying insects, since the bat steers away from wires, but towards insects. It gives the bat precise information regarding the sizes of openings so that it can decide whether a safe passage can be made or not. As would be expected, it fails to identify the presence of a fine mesh net or of a mass of fine material backed by a solid object (hair on a person's head). On the whole, it appears to be a wonderfully successful sixth sense for all conditions which a bat encounters in its natural state.

Interruption of the Supersonic Tone

A problem which deserves consideration concerns the interruption of the supersonic note. How is this interruption produced ? Is it done intentionally or accidentally ? If intentionally, what use is made of it by the bat ?

That the interruptions are intentional is shown by two facts : (1) bats can produce an uninterrupted note (usually of about 7,000 cycles per second) ; and (2) the rate of the interruptions when these are present can be varied, being increased when obstacles are close ahead and reduced again when such obstacles have been safely negotiated. The benefit to be obtained by varying the rate will be considered shortly.

That the interruptions serve a valuable purpose can readily be understood by considering the case of a continuous note, which is reflected without cessation from surrounding objects into the bat's ear. These reflected waves will usually be far weaker than the source itself, particularly when they come from small objects like threads, wires or flying insects. In consequence, while the source itself is sounding, these weak reflected waves may easily fail to be observed. Particularly would such be the case if the source were placed close to the ears in the same animal. By the use of an interrupted source emitting short pulses of sound waves, these difficulties are avoided ; since the reflected waves will reach the ears between the pulses of emitted sound waves, that is, during the silent intervals. Two things are obvious : that the source of the sound must be shut off as sharply as possible, in order not to interfere with the reception of the reflected waves ; and that it is beneficial to increase the rate of the interruptions as an obstacle ahead gets closer and increased accuracy of localization is required. It is probably for this reason that bats increase the rate of the interruptions when critical steering is necessary.

Bat's Hearing

The cochlea of the bat is histologically similar to that of other mammals, but in several important respects it has been adapted for special uses. Thus it is cast at a higher frequency. Whereas the audible limits for man are from about 16 to 16,000–20,000 cycles per second, those for the bat were found by Galambos to be from 30 to 98,000 cycles per second. Further, whereas the hearing of man falls off in acuity with increasing steepness above about 5,000 cycles, the hearing of a bat is still acute at 60,000 cycles.

The middle ear of the bat has a particularly well-developed reflex called by Galambos the intra-aural muscle reflex[8]. This consists of the contraction probably of both the tensor-tympani and stapedius muscles. This reflex has an inhibiting effect on sound transmission through the middle ear. Galambos found that as a bat dies there is, roughly five minutes after respiration has ceased, a marked rise of the cochlea potentials which are produced by intense supersonic tones. A similar change occurs after administering curare. He interprets these facts as follows. That there is a reflex in normal bats reducing the audibility of intense supersonic tones. In consequence, when this reflex is abolished by paralysing the muscles concerned, either by asphyxia or curare, there is a rise in intensity of the sound heard by the animal.

If Galambos' interpretation of his experimental results is correct, this reflex should be a valuable feature in the sound-localizing apparatus as a whole.

One of the difficulties of the process is that the intense supersonic cry produced by a bat may prevent the recognition of the faint sounds which are reflected back from neighbouring objects. The sudden interruption of the supersonic tone as described above will obviously be a valuable aid in this direction ; but this would be even more effective if the bat's ear could be rendered quiescent, or partially quiescent, during the time that the supersonic tone is being produced.

The suggestion has been put forward previously that the supersonic tone may be interrupted by direct muscle action. If the ears of the bat could be rendered less sensitive by muscle action, then these two sets of muscles (those of the larynx and those of the ear) being synchronized, one would have the optimum conditions for sound localization. When the supersonic tone is sounding, the ears would be deaf ; and when the supersonic tone is silent the ears would be returned to full sensitivity. Such an arrangement would be of the utmost benefit to the bat. Further research will obviously be required before such a hypothesis could become acceptable.

A further point which deserves mention concerning the auditory apparatus of bats is the very great development of the pinna, which in most species of bats extends like a large flap from the side of the head, the wide open mouth of the pinna pointing in a forward direction.

There is little doubt that a bat can hear quite well when the pinna has been removed, or when this has been replaced by a short length of glass tubing. At the same time, there seems little doubt that an intact pinna adds greatly to the sensitivity of the ear for the reception of sounds coming to the bat from objects ahead of it.

An important function served by the two ears is to provide stereophonic reception. In man this enables the position of objects which are producing sound to be identified with considerable accuracy. Two methods are employed: with low-pitched tones the time of arrival of the sound waves at the ears is the criterion which is used, the nearer ear receiving the sound first; with high-pitched tones intensity plays the major part, the nearer ear receiving the stronger stimulation. With medium pitched sounds both methods are employed[12].

We do not know how bats use their ears for purposes of localization; it may be by time of arrival, by intensity, by phase, or by change of quality. That the two ears used together play an essential part is shown by the experiments of Galambos and Griffin. "With one ear covered a bat strikes our type of wire barrier almost as frequently as when it is completely deaf." . . . "A few bats refused to fly at all when one ear was covered. Usually such bats land normally on the wall instead of bumping it. They often turned back from the wire or wall, while totally deaf bats practically never did so. This indicates that one ear is sufficient to inform the animal of the general proximity of a large obstacle, but that fine discriminations are almost impossible".

The conclusions that we seem to be justified in reaching as a result of these experiments is that the supersonic beam which a bat emits during flight is reflected (usually in all directions) by external objects. Some of these reflected waves reach the bat's ears and then, by some means at present not known, enable the bat to localize the position of these objects.

Transmission of the Supersonic Note to the Air

Having dealt with the supersonic tone and the probable structures by which it is produced, the following question requires an answer. How is this supersonic tone transmitted to the air? Is it via the nose only, via the mouth only, via either nose or mouth, or via both at the same time?

The facts at our disposal appear to be as follows. Bats have their mouths open during flight. Galambos and Griffin found that if bats are gagged by having a loop of thread tied round their snouts and collodion applied to their lips, the ability to produce the interrupted supersonic note is usually, but not always, seriously impaired, or stopped altogether. When the latter is the case, they fly in a clumsy, hesitant and bewildered manner not noticeably different from that of deafened bats. One bat (No. 37) was an exception, however, for it produced the supersonic note sufficiently well through its nose for it to be recorded electrically, and the flight of this bat was not seriously affected by the gagging[9]. These facts taken together strongly suggest that the supersonic note is usually emitted by the mouth, but may exceptionally be emitted in sufficient strength through the nose.

If this conclusion be correct, it would be expected that breathing would also take place during flight principally via the open mouth and only to a slight extent, if at all, via the nostrils. But there are two facts which make this idea unlikely, or even impossible. (1) Spallanzani[10] found that when the nostrils of bats are plugged they experience acute respiratory embarrassment when in flight, even though their mouths are available for breathing. (2) Most kinds of bat feed on night-flying insects such as mosquitoes, small moths and the like. One object of a bat's flight is therefore to collect food. Since its limbs are being employed for flight, it has to do this with its mouth, which it opens widely for this purpose. The back of the mouth—the fauces—must be kept shut, for otherwise an insect, or part of an insect, might enter the passages by which air gains access to the lungs and cause coughing. If this took place during flight it might have serious consequences, since the supersonic tone would temporarily have to be stopped.

The mouth must not, therefore, be used either for breathing or for the emission of the supersonic tone while it is being used for catching insects. Apart from insects, other foreign bodies float about in the air, for example, parts of plants, and these would be a source of danger to bats if they could pass via the mouth into the air passages. For these reasons the mouth cannot be used for breathing or phonation, and the nose must be used instead for both. This accounts for the finding of Spallanzani that blocking the nostrils caused acute respiratory embarrassment during flight.

How is this conclusion to be reconciled with the experiments of Galambos and Griffin that closing the mouth stops the supersonic tone in most, but not in all, bats?

I think the explanation is as follows. Bat No. 37, which they thought to be the exception, was in fact the rule, and it was the other bats which were the exceptions. This bat could both breathe and phonate, although its mouth was sealed completely with collodion, and in consequence of producing normal phonation its flight was normal. What is the explanation of the behaviour of the other bats which, when their mouths were closed, failed to phonate and therefore failed also to fly without accident? A possible explanation is that they had some nasal defect such as a cold in the head. Such a defect is common in animals kept in captivity, as these bats were.

Assuming that the correct conclusion has been reached about the emission of supersonic sound by the nose, one further point may be mentioned. The snouts of many species of bat are so shaped that they may enable them to produce a kind of beam of supersonic sound energy[13], or at all events may direct the greater part of sound in a forward direction away from the bat's own ears. This would have the effect of improving both the intensity of sound reaching obstacles ahead of the bat, and the sensitivity of the bat's ears.

The Breathing of Bats

Galambos and Griffin have raised an important question when they ask how breathing occurs during the continuous production of the interrupted supersonic tone. That this tone is produced by the vocal apparatus of the throat, and not, for example, by wing vibrations, is shown by their experimental result that bats immersed up to their necks in water can produce the tone, but that bats with their heads momentarily placed under water stop doing so at once.

It seems unlikely that a bat breathes in and out fifty or sixty times per second. How then does it breathe? I think the answer is that it breathes relatively slowly, say two or three times a second, and that it phonates both during inspiration and expiration. In support of this idea the following facts may be noted. A cat can purr both during inspiration and expiration; most men can whistle and a few men can sing and hum during both phases of respiration; a skylark sings continuously without any detectable break, and during the whole time it must be respiring. Probably many other instances could be given. It seems likely that the bat is able to produce its supersonic tone in a similar manner.

Audio-Location and Radar

It is obvious that the basic principles of audio- and radio-location are very similar; in both cases a beam of wave-energy is projected forward, with the object of detecting the presence and position of objects in the vicinity. In the case of the bat this beam consists of supersonic sound waves, while radar makes use of short electromagnetic waves. The frequency of the sound waves is about 0·05 megacycles per sec., that of the electromagnetic waves is about 30,000 megacycles per sec. The velocity of sound in air being $3{\cdot}4 \times 10^2$ metres per second, the wave-length of the supersonic tone is about 0·7 cm. The velocity of electromagnetic waves in air being 3×10^{10} metres per second, the wave-length of the electromagnetic wave is about 1 cm. Since, other things being equal, the resolving power is inversely proportional to the wave-length, the bat has at its disposal a potential resolving power about equal to that of radar equipment. But conditions are actually more favourable to the bat, since the bat by the employment of its two ears can use stereophonic perception.

A man in an aeroplane can determine the distance away of an object by measuring the time taken for the electromagnetic pulse sent out to return again after reflexion. This pulse has a duration of about one millionth of a second, and, as in the case of the bat, the number of pulses emitted per second is variable. In the bat they vary from 12 to 60 pulses per second; while in the aeroplane they vary from 200 to 20,000 pulses per second. In both bat and aeroplane, the pulse frequency is raised as obstacles ahead get closer.

The bat may also determine the distance away of objects by ascertaining the time of the emitted sound after reflexion to stimulate its ears.

In the aeroplane the receiver is made insensitive during the radiation of the supersonic pulse. There are grounds for suspecting that the ears of the bat are similarly made insensitive during the radiation of the supersonic tone by a special reflex called by Galambos the intra-aural reflex.

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THE CONCEPT OF MENTAL MATURITY

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In a recent address under this title[1], Prof. Pear has examined a much-used term. Studying a wide range of examples from modern literature, he has no difficulty in showing that it is employed in very divergent senses, none of them clearly defined. The publication of his lecture is to be welcomed, for it is a delightful addition to his book, "The Maturing Mind"[2]. It is written in the stimulating manner we expect from him, and adds to the hints given in the book as to the rich meaning which he attaches to the term 'maturity'. Above all, it challenges us to endeavour to think more clearly.

In this topic we meet a familiar stumbling-block. Scientific psychology followed upon a long period of popular thinking on psychological matters, and we have consequently inherited a number of words which, though current in general discourse, baffle us when we try to fit them into a scientific framework. We found the word 'attention', which obviously denoted some important mental processes. Years of analysis were needed to discover what they were, and now it appears that we can do without the term. 'Intelligence' has proved even more difficult. Progress would have been more rapid if psychologists had started with a clear field, unhampered by the demand to give scientific precision to non-scientific terms, or to extract clarity from concepts which had been developed for purposes other than ours. We are too socially determined to break away by a single effort. We must accept the situation, and try to bring some order into these untidy ideas. Pear has turned our attention to an important and difficult example of such problems. I would suggest that it would be premature to attempt to give a formal definition or full analysis of 'mental maturity' here and now. A piecemeal process of clearing up is more practicable. Perhaps in the end we shall find that this term is otiose.

I am encouraged to take up the author's implied challenge by his own warm-hearted defence of the second-best[3]. If we lack perfectly clear ideas, may not imperfect ones be better than none? By scientific standards, the concept of mental maturity cannot be regarded as more than second best; but it is reasonable to suppose that people mean something when they speak of it, though they may be unable to say just what they mean, and though they may convince us that they mean quite different things at different times. Pear could easily riddle me with awkward questions if I asserted that he is mentally more mature than a child of ten, but I am sure that my statement would not be nonsense. I am convinced that I should be employing a useful concept, though I were entirely at a loss when invited to put it into consistent words. I have argued elsewhere[3] that operative concepts are not safely to be judged from their verbal expression. Ordinarily the term 'maturity' implies the application of a criterion which is not stated. It would be wrong to conclude that the criterion is absent and the concept worthless. But better things are expected of psychologists.

Maturity is a terminal point on some kind of scale. The position reached by an organism at any moment is judged by the criterion provided by the limit. In

the case of a single function of a simple organism, it is commonly easy to find the criterion. Thus an animal is sexually mature when it is capable of reproduction. The criterion here is the fulfilment of a fundamental biological tendency. Since our biological systems usually take reproduction as the most important single function, it is found convenient to define maturity in relation to it. But this is no final solution, since the simplest organism must have other functions, essential as carriers of sex, which exhibit development. Nor can we regard a boy in a civilized society as mature for paternity at sixteen.

The problems we are considering become urgent as soon as we view the whole organism in its setting. Yet we can learn from the simple case where the difficulties lie. In zoology, reproduction is taken as the cardinal function. Importance is attached to it somewhat arbitrarily on the ground that the species is a more fundamental and permanent scientific object than the individual. The fuller universe is ignored. This is the ordinary scientific abstraction, necessitated and justified by our incapacity to deal with reality as a whole. Yet the individual must remain alive until it has reproduced itself, and this requires the development of functions making for the maintenance of life. Consequently we cannot arrive at a completely adequate definition of maturity until we have analysed out all the functions considered important and decided what is the criterion of maturity of each. The more complex the pattern of the creature's life, the more difficult is it to disentangle the essential threads.

We can, however, now state more definitely the meaning of 'maturity'. An organism is mature when each of its functions is developed to a stage which permits of the achievement of its specific end, and when all the functions are organized to cooperate in attaining that end, which we, for assignable scientific reasons, take as cardinal. It is clear that something arbitrary remains in this definition, and equally clear, I hope, that there is no humiliation in recognizing that we may find a level of complexity such that we cannot at present make decisive statements in terms of it. We may still judge the organism's maturity in respect of this or that function, and permit ourselves now and then to talk vaguely, but not carelessly, of full maturity.

From this point, the word 'maturity' will refer to the mental maturity of the human individual. There is no need to enlarge on the complexity of the life pattern. We do not possess a definitive list of the specific strands of activity or of their ends, and if we did we should probably be unable to work with it as a coherent whole. More urgent is the question, What shall we take as the cardinal end ? Reproduction, or to know God and enjoy Him for ever ? The answer will affect our system building. But psychology is not competent to decide issues on this plane, and there may never be agreement. The quotations adduced by Pear show plainly that the various writers have been influenced by wider values than those of empirical science, and the true outcome of his address, as of his book, is a demand for a philosophy of life. To this psychologists may properly contribute, but they cannot undertake it solely by their own methods. So for the present we must again fall back on second-best thinking. The individual has to react to his environment, of which we may safely take society to be psychologically the most important. Deriving our criterion from this consideration, we may say that an individual is mature if and when he successfully meets the problems set to him by the society in which he lives (if we could agree as to what constitutes success). We thus accept an ethnocentric standard. We can only judge maturity by behaviour, which does not occur *in vacuo*. It would be unreasonable to demand the capacity to complete tasks which in fact will never be set, there having been no opportunity to learn the appropriate responses. Maturity must be judged by reference to the person's social framework, and the Papuan may be as mature as the European if he discharges as competently the duties which life sets before him. An odd consequence of this argument is that maturity must be allowed to children of all ages, if they successfully meet the demands properly laid upon their age. Actually children often appear surprisingly mature, when one meets them on their own plane. They live in two societies, that of their contemporaries and that of adults. They will appear mature or immature according as we view them in one or the other context.

This criterion is easier to state than to apply in the immense complexity of civilized life. There is a present-day tendency to use the term 'culture pattern' in a free-and-easy way which masks the intricacy of the facts which it denotes. At best we have only a formal criterion, and still lack an analytic description. There will be general agreement that integration is important, and we have hopes of being able in the end to describe it in some detail. Then Pear quotes, with well-deserved approval, Allport's views on the mature personality. He summarizes them thus. "In his opinion, the mature personality should have these attributes : richness, congruence, a variety of autonomous interests, extension and objectivation of the self, a unifying philosophy of life which represents to oneself one's place in the scheme of things and gives a long-range perspective"[4]. This should induce modesty in psychologists. What must *we* be to handle all that ? And who can be called fully mature by that standard ? Allport's statement is a limiting conception, highly valuable as such, but less useful when applied to the description of particular cases. Moreover, we can only judge maturity by overt behaviour, which is the end-product of the integrated tendencies; and the more complete the integration the less opportunity is there to judge what lies behind. In short, Allport states an ideal of development rather than a working concept, and ideals take us into other fields. And are we not tending to identify maturity with wisdom ? This may be right, but we should amend our neglect to examine the concept of wisdom before we jump to that conclusion. Prof. Pear would add to our debt if he would undertake the task. He has made a useful start by emphasizing the importance of emotional integration as well as intellectual. Then we remember those very wise and well-integrated persons of moderate intellect and restricted experience. Are they mature ? If so, what is the minimum intellectual development required for maturity ? I do not know the answer to the latter question, but I shall continue to respect the wisdom and maturity of the fisherman and the farm worker.

When we have considered the development of specific innate tendencies, their modification by environmental conditions and their systematic integration, there remains one puzzling factor to work into our scheme, and that perhaps the most distinctively human trait. It is the capacity for growth and variation. No concept of maturity can stand that does not allow for it, and yet it cuts across any

tidy description of a completed personality. This may be an important source of our difficulties. We demand integration and adaptation; but an integration so complete that all responses are psychologically automatic has gone beyond maturity. The person is over-ripe. Variability must be preserved for adequate living. It is as important as intelligence or emotional development, and must somehow be integrated with them in fact and in theory. We must insist that maturity is not only compatible with, but also includes essentially an intellectual restlessness and a striving for the unattained. When the capacity for development is lost, death has set in. It would be easy to construct a plausible description of maturity which equated it with mental death. We are now on the way to answering one of Pear's questions. The truly mature personality, having retained at full strength the capacity for change and adventure, will consequently appear juvenile, and perhaps capricious. When tasks are not pressing upon him he will become sportive and (at least in the eyes of those already mentally dead) rather ridiculous.

My concept of maturity demands that the mature and wise should at times permit themselves to be silly, and those who dislike the word can look up its etymology. When I was interviewed at the outset of my university career, the principal insisted upon my joining him in shooting at a copy of *The Times* with toy bow and arrows. This was not an early example of 'selection procedures'. He just felt like that, and there were many equally surprising moments in the years that followed. Nevertheless, I rank him among the great and wise of his day. The 'sense of humour' is another facet of this trait, implying a capacity to see things in a novel light, to change relations and to respond in an unexpected way. But admittedly a capacity for the unexpected is poor material for science, and perhaps beyond assessment by exact measurement. So by this route also we only reach what Pear might call 'Tudorbethan' thinking—just better than none at all. But we are gaining control of the concepts of development of specific traits, of integration, and of variation of response. Having these, need we continue to employ a term like 'maturity', which inevitably carries an ethical and emotional tinge? We shall be well advised to use it only with the restricted connotation relevant to the immediate context. Even so, let us bear in mind Aristotle's dictum. "We must be content if we can attain to so much precision in our statement as the subject before us admits of: for the same degree of accuracy is no more to be expected in all kinds of reasoning than in all kinds of handicraft"[5]. It may be added that those who desire to study thoroughly and constructively the nature of maturity might well begin with the "Nicomachean Ethics".

Lastly, encouraged by a recent conversation with Prof. Bott, let me suggest a new turn to the discussion. We judge that a particular reaction is mature. We cannot safely judge that the personality is mature. Though the whole personality may have been brought to bear upon the act, it is not limited thereto. A human personality is extended in time as the physical organism is in space and time. One is no more present at a point in time than is the other at the intersection of certain spacial coordinates. It may be convenient to overlook this in rough-and-ready speech. Cross-sections and momentary aspects are indispensable means of knowledge, but they can never give full truth. "Call no man happy until he's dead" is not pessimism but sound science, for the total man has not existed until that moment. So with maturity. The term is applicable to an epoch rather than to an instant. It is a history, not a static quality. We may picture life as an ascent to an undulating plateau followed by a drop to zero, abrupt or gradual as fate decides. '*X* is mature' will be a true statement if the history of a substantial section of the total life of *X* shows the characters which we deem to be significant. One may occasionally be permitted to be less austere, but we shall walk in sticky mud if we insist on applying terms appropriate to the full and continuous temporal extension of personality as adjectives for single moments or assemblies thereof. Indeed, until psychologists deal far more resolutely than they have done with the temporal aspects of mental life, they must be judged to be scientifically immature.

[1] Pear, T. H., "The Concept of Mental Maturity" (Manchester University Press, 1944).
[2] Pear, T. H., "The Maturing Mind", 146.
[3] Wolters, A. W., "On Conceptual Thinking", *Brit. J. Psychol.*, 24.
[4] Pear, T. H., "The Concept of Maturity", 15.
[5] "Nicomachean Ethics", I.3.1.

SCIENCE IN KWEICHOW AND KUANGSI

By Dr. JOSEPH NEEDHAM, F.R.S.
British Scientific Mission in China

AFTER some lapse of time, the opportunity again presents itself of continuing the series of articles on science in China in war-time, of which seven have already appeared in *Nature*. In this and the following article, on China's far south-east, I shall be describing an area which I visited in the summer of 1944, just before the tide of war overwhelmed nearly all of it, wrecking many scientific installations, and forcing many of the scientific workers I met to take to the roads in evacuation or to the mountains in dispersal.

Taking the city of Chungking as the central point of China, this area is China's south-eastern quarter. To enter it the traveller must follow the southern road from the capital, winding over half a dozen passes through the protecting mountains, until he reaches Kweiyang, the capital of the relatively barren and rocky province of Kweichow. A few hundred kilometres south-east of this city is Tushan, the railhead of the uncompleted Kweichow-Kuangsi railway, and here he may entrain for the descent through mountains wreathed in cloud to the fertile plains and rolling hills of Kuangsi around the city of Liuchow. The capital of Kuangsi is, however, farther east, at Kweilin, amidst that extraordinary scenery of 'Karst' limestone pinnacles and sugar-loaf hills rising abruptly out of the plain which justifies to the incredulous foreigner the fidelity of Chinese scroll-paintings. Thence the railway goes on the east, bearing north to Hêngyang and then south to the temporary railhead at Kukong in Kuangtung.

Between Chungking and Kweiyang at a small town called Tsunyi is to be found Chekiang University, one of the best four in China. Housed largely in old and dilapidated temples, there is not enough room for all of it at Tsunyi, so the scientific faculties are situated at a very pretty and very small town, Meitan, some 75 km. away to the east. It is typical of the present transport situation in China that although the University started with three trucks and a car

to maintain its communications, all have long ago broken down and are unrepairable and unreplaceable, so that eminent and aged scholars such as the deans of faculties on their necessary journeys have to perch on the top of loaded army trucks on a trip which may take two days, over a road passing through very few inhabited places.

The president of Chekiang University is Dr. Chu Ko-ching, China's leading meteorologist, who is concurrently head of the Academia Sinica Meteorological Institute. At Meitan one finds a hive of scientific activity. The Biological Department, headed by Dr. Bei Shih-Chang, a pupil of Spemann, Harms, and Hertwig, has been working on induction phenomena in regeneration in cœlenterates, insect hormones, etc. Here also at the time of our visit was the eminent geneticist Dr. Tan Chia-Chen, whose work on the curious colour-pattern inheritance in ladybird beetles is now arousing much interest in the United States, where he has gone for a year's visit. In chemistry there are Dr. Wang Bao-Rjêng (a pupil of J. F. Thorpe's), working on sulpha-drug derivatives (some of which have been found to be active as plant-growth hormones), and Dr. Wang Chin, a specialist on microanalysis and the history of Chinese alchemy. This very active-minded group is completed by Chang Chi-Kai, a German-trained specialist on local anæsthetics, and by Sun Tsung-Pêng, American-trained biochemist.

In physics, work is proceeding mostly on theoretical lines owing to lack of apparatus, in nuclear physics, geometrical optics, etc.; but the level is distinctly high (Drs. Wang Gan-Chang, an Edinburgh man, Ting Hsu-Bao, Ho Tsêng-Lu, a pupil of Millikan's, and the promising Chêng Kai-Djia). There is a special mathematical institute directed by the geometer Dr. Su Bu-Chin.

The Agricultural Research Institute, with a large area of experimental plots, is also doing much work. Dr. Lo Têng-Yi, in biochemistry, has discovered a high vitamin content in the large hips of the local wild rose *Rosa multiflora* (20 mgm. ascorbic acid per gm., and 30 mgm. vitamin P per gm.), and some 35 mgm. per gm. of vitamin P in the Chinese 'date', or 'jujube' as it should be called, *Zizyphus vulgaris*. Dr. Bai Han-Hsi, in the fermentation division, is studying the interesting Kweichow 'barm' used in making the famous 'mao-tai' wine, which, besides its yeast, contains no less than twenty-eight special added drugs, some of which accelerate saccharification while others probably inhibit contaminating micro-organisms. This recipe is an extraordinary example of a procedure with centuries of trial and error work behind it, ensuring good results under country conditions where no sterilization precautions are taken. It even has a war importance, for a certain proportion of the power alcohol used by Allied military trucks upon the roads of China is distilled from spirits prepared in the traditional way by the farmers, and brought to central distilleries. In soil science, under Dr. Pêng Chien, investigations on soil *p*H are in progress, and on trace elements, nickel, zinc, etc., with special reference to tea, legume, and vegetable culture.

In Tsunyi, there is also the All-China Sericultural Research Institute, where very solid work, led by Dr. Tsai Bao, goes on.

At Kweiyang, a larger town than either Tsunyi or Meitan, we found a number of scientific organizations. The largest was the Army's Emergency Medical Service Training School in a beautiful wooded valley among hills called Tuyünkuan; but besides this there were two civilian medical schools, Hsiangya Medical College and Kweiyang Medical College. There was also the Kweichow University, situated some 20 km. to the west of the town in the famous park of Huachi. There was a branch vaccine laboratory of the National Epidemics Prevention Bureau, a branch of the National Agricultural Research Bureau, a number of important industrial enterprises including a low-temperature carbonization plant and a chlorate plant, and several plants of the Ordnance Administration. About 150 km. to the west, at a pretty town called Anshun, there was the regular Army Medical College. Finally, within Kweiyang city, there was the Provincial Science Institute. Among such a wealth of worthwhile institutions, there is space to mention only a few salient points of interest.

The Tuyünkuan College was originally organized by Lieut.-General Robert Lim (Ling Ko-Hsing), the internationally known Edinburgh physiologist. It trains all grades of medical workers for the army, alternating laboratory courses with experience in the field. Dr. Chen Wên-Kuei's model vaccine plant and bacteriological laboratory deserve mention; Dr. Ling Fei-Ching is studying the penicillin production of the indigenous strains of *Penicillium*. An interesting and valuable X-ray apparatus repair station (the only one in China) is directed by her husband, Dr. Rjung Tu-Shan. In teaching chemistry, Dr. Li Kuan-Hua has organized extremely ingenious semi-micro methods which it was a pleasure to see in use by his classes. The reagent sodium tungstate was being manufactured here. The Hsiangya Medical College (Dean Chang Hsiao-Chien, a pupil of Krogh's) had some wretched buildings; but excellent men, such as Dr. Chêng Wên-sse the pharmacologist, studying the Chinese drug 'Yadantze' which has an emetine-like action in dysentery. The Kweiyang Medical College (President Li Tsung-Ên, trained at Glasgow) has the distinguished pathologist Dr. Li Yi, and among her colleagues the American-trained embryologist Dr. Chang Tso-Gan. The psychiatrist Ling Ming-Yo represents a field hitherto little cultivated in China. Both these medical colleges were running up-to-date teaching hospitals.

Two of Zinsser's pupils in Kweiyang, Dr. Wei Hsi, of the National Epidemics Prevention Bureau branch laboratory, and Dr. Liu Pin-Yang of Hsiangya, were engaged upon a very interesting project, namely, the cultivation of typhus Rickettsia bodies in the cœlomic fluid of silkworm larvæ and pupæ (in which good growth is obtained) instead of the yolk-sac of the chick embryo. If this method could be used successfully, it would greatly simplify the preparation of the Cox vaccine under Chinese conditions, where incubators are not available but silkworms are.

The regular Army Medical College at Anshun (director, Lieut.-General Chang Chien) is located outside the town on an airy moorland in a spacious old Ching dynasty barracks, with the various institutes scattered around in scenery like that of the Scottish Highlands. The most important institutes are those of bacteriology, directed by Major-General Li Chen-Pin, and of nutritional science, under Dr. Wan Hsing. Li Chen-Pin, when at the Rockefeller Institute in younger days, carried out classical work with T. M. Rivers. Rivers and Goodpasture were the first to cultivate viruses on the chorio-allantoic membrane of the chick embryo; Rivers and Li were the first to cultivate them (vaccinia and yellow fever) on explanted fibroblasts. Yellow fever vaccine is still

prepared in this way. Unfortunately, lack of equipment prevents much research in these institutes, though manufacture of vaccine goes on. The pharmaceutical institute maintains a model factory in which there is a certain production of drugs, and there is a good pharmaceutical garden and farm under Dr. Kuan Kuang-Ti. The Army is planting in Szechuan hundreds of thousands of saplings of the tree *Dichroa febrifuga*, from which is derived the drug 'changshan', known in the Chinese pharmacopœia at least as far back as the Sung dynasty, and recently found in both London and Chicago to have a parasitocidal action in animal malaria.

One of the best types of institution in the Chinese development of the sciences has been the provincial science institute. Reference has already been made to certain of these seen in other provinces; but the one at Kweiyang, directed by Dr. Ling Shao-Wên from the Emergency Medical Service Training School, was extremely good. For popular education there were really good exhibits of parasitology, highway engineering, war gases, embryology (including man), geology and mineralogy, and nutrition. A splendid room, prepared by Mr. Liu Ting-Wei, a great authority on the subject, demonstrated the life-cycle of the Kweichow wax-insects, allied to aphids. This indigenous industry gives a large annual production of highest-quality wax, and both the insect life-cycle and the industrial methods are very curious. The Provincial Science Institute also manufactured scientific apparatus for schools, and had been planned with spacious centralized laboratories for school practical work; but in war-time it had proved impossible to equip them.

If the exhibitions at the Kweiyang Science Institute were the best I had seen, the apparatus manufactured at the Kuangsi Science Institute was the best of its kind. A good many reading machines, for use with the microfilmed journals sent out by the British Council and the State Department of the United States, have been made here. The Institute, which had an excellent building, adjoined those of Kuangsi University (president, Li Yün-Hua, a chemical engineer) around a sloping patch of grass in the hills, rather resembling an English village green, at Liangfêng, some 25 km. south of Kweilin. Near by, among groves of pine trees, were the wooden buildings of the Academia Sinica Institutes of Geology (under the internationally known Dr. Li Se-Kuang (J. S. Lee), of Physics (under Dr. Ting Hsi-Ling), and of Psychology (under Dr. Tang Yueh).

When I was there, Dr. Li was particularly interested in the distortions produced in stone under glaciation, analogous to the 'bending' of tombstones, etc. Work was proceeding on palæobotany (Sse Hsing-Chien), *Kleintektonik* (Chang Shou-Chang), and mineral ore structure (Wang Yin-Chih). Associated with Dr. Ting was Dr. Parker Chen (Chen Tsung-Chi), the well-known former colleague of Sven Hedin. Away in the hills a very fine terrestrial magnetism station was working; located in a specially built non-magnetic and thermostatic house, it took continuous photographic recordings of all three elements, and possessed excellent apparatus, some of it made in the Institute's own workshops. The smallest of the three Institutes was that of Psychology (really developmental physiology of the nervous system); Dr. Tang was carrying out transplantations on the beautiful transparent tadpoles of *Microhyla ornata*. There was a particularly good library of neurology and experimental morphology, housed in a separate building.

Probably the best scientific department of Kuangsi University was that of chemistry. Here Dr. Amos Pêng (Pêng Kuang-Chin) was working hard with his group on the indigenous plants which contain rubber in their sap. Several useful new sources in Kuangsi have been found, notably the climbing fig *Ficus pumila* and the giant vine *Chonomorpha macrophylla*. Many experimental articles have been made from these rubbers.

The other most outstanding scientific institution in Kuangsi province was probably the Ministry of Agriculture's Experiment Station at Shatang, near Liuchow, covering 7,000 acres and comprising many good laboratories. Directed by Dr. Ma Bao-Chih, the translator of 'Sturtevant and Beadle' and other important books, it was a scene of great activity. Choosing at random from among the divisions, Dr. Huang Liang (economic entomology) demonstrated the bamboo comb designed for use by the farmers to get the caterpillars of the rice skipper, *Parnara guttata*, off the rice plants, and the box coated inside with a sticky mixture of pine resin and teaseed oil, for getting the flea beetle, *Phyllotreta vittata*, off the cabbages. Dr. Chang Hsin-Chêng (a pupil of Waksman) demonstrated the production of inoculum of root-nodule bacteria. Particular attention was being paid to sugar-cane improvement, tung-oil tree (*Aleurites fordii*) culture, rice selection, and storage of citrus fruits. Dr. Huang Rjui-Lun had shown that during the storage of the pomelo or 'yudzo', the ascorbic acid content actually rises, up to a maximum. Attention was being paid to naturally occurring insecticides.

Circumstances have forced me to make considerable use of the past tense in this article. It will be remembered that in last year's campaign, the Japanese, starting from Changsha as a focus on the southern edge of the Japanese-held north-east quarter of China, pushed down to Hêngyang, cutting off the far south-eastern provinces, and then successively down to Kweilin, Liuchow, and Nanning, thus acquiring a corridor with Indo-China. From Liuchow they pushed up the railway to railhead at Tushan and a little beyond, but stopped at the frontier of Kweichow, not however without having caused a partial evacuation of Kweiyang. What happened to the scientific workers ?

It is sad to have to record that the Liangfêng centre was practically destroyed. The Academia Sinica Institutes evacuated their personnel to Chungking, but lost a great deal of apparatus which could ill be spared. The Library of the Institute of Psychology was almost completely lost. Kuangsi University personnel were evacuated into the mountains west of Liuchow and have not been heard of since. Both the Provincial Science Institutes were ruined, that at Liangfêng by the Japanese, and that at Kweiyang, with its laboriously arranged exhibitions, by having Chinese troops quartered in it and being "put in a posture of defence". The Shatang agricultural station was overrun; but it is believed that the records were evacuated in time. It is to be feared that some scientific workers and their families were caught in the congested refugee areas at railhead, where the mortality was appalling. I myself met Mrs. Chou, the wife of the Fukienese physicist Chou Chang-Ning (a Cavendish man), on the station platform at Liuchow just before the fall of Kweilin, and did what I could to assist the onward journey of her and her children. Fortunately, Tsunyi, Meitan, and Anshun were not affected; but Kweichow University was, the students

and professors simply setting out to walk, carrying what books and apparatus they could, as if it were a thousand years ago. This University has now reassembled at Huachi. Hsiangya and Kweiyang Medical Colleges, however, managed to secure some truck transport and moved to Chungking, where they are remaining for the time being.

Western Kuangsi was recaptured early this year from the Japanese, but in a ravaged state. The city of Liuchow, for example, was burnt to the ground. The scientific development of these provinces was just in its opening phase, stimulated by the evacuation from the coastal cities; it has been distressing to see so cruel a frost nip it in the bud.

OBITUARIES

Sir David Milne-Watson, Bt.

A LEADING national industry and a wide circle of friends and admirers will regret the death on October 3 of David Milne-Watson. He was one of those Scotsmen possessed of unbounded energy and enormous capacity for work who, trained as a lawyer, developed great administrative and organizing ability coupled with a facility to understand human nature which made him a great leader of men of all grades of society.

Born in Edinburgh in 1869, he gained two degrees at the University before entering a law office. Something lured him to Balliol College, Oxford, and from there he completed his education at Marburg. He was tempted by politics like many young lawyers of his time and contested the South-Eastern Division of Essex in 1895. Fortunately for the gas industry he was unsuccessful, and though he was called to the Bar in the next year we find him attracted into industry in 1897.

A large statutory company like the Gas Light and Coke controlled by various Acts of Parliament has need from day to day of the best legal assistance: the Company chose Milne-Watson for this work. Once there his administrative abilities developed rapidly; he became general manager in 1903 and managing director in 1916. Two years later he became governor, a position giving him the supreme leadership of the Company. He held this post until April last—a term of forty-eight years with the Company.

This is not the place to trace the development of the Gas Light and Coke Co. under his leadership. It provides a highly efficient service for Greater London north of the river; indeed it stretches from Windsor to the North Sea, and is both the largest and the leading gas company throughout the world.

Milne-Watson became a technician as well as administrator; he appreciated to the full the part that science should play in the gas industry and provided full opportunity both for research and development. He was responsible for the installation of adequately equipped and staffed research laboratories to deal with gas manufacture, tar products and the utilization of gas.

Milne-Watson had the inspiration at an early stage to enlist the co-operation of Sir Harold Hartley, and the edifice created between them has placed the gas industry in the forefront of those industries which by research work in all the sciences are continually giving better service to the public. So far from being effete, as is sometimes suggested, the gas industry is in the very forefront of progress, an achievement which redounds very largely to the credit of Milne-Watson.

Milne-Watson realized also the responsibility which lies on a large firm to promote the education of its employees. Every encouragement and special facilities for study were provided, while Milne-Watson himself served on several important committees dealing with education. As the leader of the gas industry in Britain he could not escape a large share of the co-operative work required by the industry, including the relations with labour; and here again his high qualifications made him a member of many national labour inquiries, committees and conferences, including the International Labour Office at Geneva. Space prevents reference to his many other activities, for he was unsparing of his energies in helping national and public causes.

But it is essential to stress his human qualities. He had the widest possible circle of business friends, to whom he was never too busy to give a word of kindly advice or lend a helping hand. In his own Company he prided himself on being the 'father' of a great family. Though forthright in utterance, he was a very lovable and much respected man. He became a knight in 1927 and a baronet in 1937, and had two sons and a daughter.

E. F. ARMSTRONG.

Dr. A. Lees

DR. ANDREW LEES, of the Projectile Development Establishment (Ministry of Supply) and University College, Swansea, died suddenly, after only a few days illness, on August 29, in his thirty-fourth year.

Dr. Lees was born on November 30, 1911. He had a brilliant career at University College, Nottingham, taking the B.Sc. with first-class honours in mathematics, winning the Lubbock Prize awarded by the University of London, and then taking the M.Sc. with a mark of distinction. His research work in quantum mechanics gained him a scholarship at Trinity College, Cambridge, where he studied under Prof. P. A. M. Dirac, who described him as possessing a quite unusual imagination and power of abstraction. Dr. Lees obtained the Cambridge Ph.D. degree, and was then appointed to the staff of University College, Swansea, but he had only been there about two years when war broke out.

After a short period in the Army, Dr. Lees was transferred to the Projectile Development Establishment at Cardigan. Owing to the requirements of official secrecy, details of his work there cannot be given; but it is allowable to say that as a member of the ballistics group he made several valuable contributions to the theoretical and practical aspects of the external ballistics and fire control of anti-aircraft and other weapons. In his spare time he continued his researches in quantum mechanics and related branches of mathematical physics; at the time of his death he had two papers accepted for publication and he was engaged on a third. His correspondence shows that he had many ideas which he was hoping to develop as soon as he could be released from war duties, and his published work would, in all probability, have been considerably augmented if he had been spared for even a few more years.

We extend our deepest sympathy to his widow and two young daughters. H. T. H. PIAGGIO.

NEWS and VIEWS

Prof. F. E. Weiss, F.R.S.

On November 2, Prof. F. E. Weiss will be guest of honour at a meeting attended by botanists and other men of science in the rooms of the Linnean Society of London to celebrate his eightieth birthday. It is doubtful whether any other man of science in Britain has exerted a greater influence over botanical research and teaching for so long a period as Prof. Weiss has; many botanists and other men of science owe much to his sympathetic guidance and encouragement in their formative years, and, with this in view, the Editors of *Nature* wish to add their contribution to the many messages of esteem which will assuredly greet him on this occasion, for Prof. Weiss has been a contributor to *Nature* over a very long period. But it was at Manchester where Prof. Weiss's main work was carried out: he was George Harrison professor of botany in the University there for thirty-eight years. We cannot do better than quote from the resolution adopted by the University Council on the occasion of his resignation from the chair in 1930: "During his tenure of the Chair he has built up a great School of Botany, which bears a distinguished name both at home and abroad. It is renowned for the researches which have been carried out by the members of the School and for the unusually large number of men and women it has trained who now occupy positions of influence in many spheres of botanical work." At Manchester, Prof. Weiss was also closely concerned with the development of the University itself, especially during 1913–15 when he was vice-chancellor.

On his resignation, Prof. Weiss moved to the south of England—not to rest, but to carry on much useful work with that zeal and understanding which always characterized his work at Manchester. The Linnean Society itself owes much to him—he was president during 1931–34. He has also influenced practical horticulture—he always has been a keen gardener—through his membership of the Council of the Royal Horticultural Society. The British Association owes much to the wise counsel and mature judgment of Prof. Weiss, especially since his release from academic duties at Manchester gave him more time to work for the advancement of science in general. He was joint honorary secretary of the important Committee on Post-War University Education which was constituted by the Association and which issued its report in 1944. It is doubtful if a man of Prof. Weiss's active and alert nature would ever consider resting in spite of a personal history of work for cultural advancement of which any man could be proud: we wish, therefore, to extend our congratulations to him on this occasion, and hope that science and education in general and botany in particular may long continue to have the advantage of his stimulating influence.

Institute of Agricultural Economics, Oxford: Retirement of Dr. C. S. Orwin

Agricultural experts throughout Britain, and indeed over a wider area, will learn with regret that Dr. C. S. Orwin is due to retire at the end of this year from the Institute of Agricultural Economics at Oxford. He was its first director, and from the outset he started it on lines which have since proved very fruitful. He adopted the method of getting right down to the working details of farming by keeping farmers' account books and working out costs of different operations under different conditions, and he published detailed descriptions of the methods of some of the more outstanding farms, especially where new lines have been struck out. In addition, he published an interesting account of the working of the old three-field system, and also of the reclamation of Exmoor. More recently he has devoted his attention to the replanning of British agriculture and village life, and has made some very thoughtful contributions to this important subject. His recent survey of a section of Oxfordshire is a brilliant example of this type of work. In these social and historical investigations he has been ably assisted by his wife, who is herself an expert on these subjects. Not the least of his services has been the training of a staff, some of the members of which have since rendered distinguished service in other institutions. His many friends will wish him long, pleasant and active years of retirement.

Agricultural Engineering Record

The contents of the first number of *Agricultural Engineering Record* provide a good example of the intended scope of this publication, the main purpose of which is to place on record the results of the testing, experimental and research work of the National Institute for Agricultural Engineering, Askham Bryan, York (London: H.M. Stationery Office. Pp. 32. 1*s*.). The subject selected for special review is segmented sugar-beet seed. This process, which originated in the United States, breaks up the seed clusters before sowing by means of a machine, thereby facilitating singling later. Tests carried out on large-scale observation plots in England are described, from which it appears that there was no difference in the yields of beet grown from segmented and natural seed. Another article gives the results of measurements of grain losses with the combine harvester, showing that such losses can easily be of an order which makes the process uneconomical; and it is suggested that attention be paid to improvements in the general design of the cutter-bar, as it is here that the greatest source of loss occurs. Comparative tests with three machines used in sugar-beet harvesting indicated that each was superior to the others in at least one respect, and work is in progress on the production of a composite machine. Grain bin ventilation, a grain flow meter, a coulter for ploughing-in straw and an offset potato-digger form the subjects of the shorter articles, and the number concludes with what is intended to be the chief feature of the publication, namely, summaries of the National Institute's test reports of implements or machines specially imported for research purposes, or experimental prototypes not yet in production.

National Research Council (Canada): Post-War Planning

The twenty-seventh annual report of the National Research Council (Canada), for 1943–44, includes the report of the acting president, Dr. C. J. McKenzie, the financial statement for the year ended March 31, 1944, and reports from the directors of the several divisions, amplifying the information contained in the preliminary review of the work of the Council already issued (see *Nature*, **155**, 737; 1945). Referring to the broader aspects of post-war planning for scientific research, Dr. McKenzie's report states that in a brief review of research programmes in Canada, Great Britain, United States and the U.S.S.R. it was observed that Canada had hitherto been largely a

research importer, and that the Dominion's pre-war *per capita* expenditure of research was far below that of other industrial nations. It is suggested that Canada, through its National Research Council, should maintain in the immediate post-war years a programme of research equal to, or greater than, the present war research effort, which is five times as great as that of the pre-war years. Consideration has been given to a long list of topics suggested as subjects for research in the post-war period, and suitable action indicated. Among many new problems suggested to develop the natural resources of the Dominion or to improve living conditions of the people may be mentioned road research, housing and building research, transport by air, rail, road and water, cold weather and northern latitude problems and the utilization of agricultural crops and products of the forest. Research is recommended on the construction, heating, lighting etc., of small homes, the development of cheap refrigeration units for farm homes, cold-storage locker systems for farms, and farm equipment including plumbing and farm-power units.

It is recognized that the universities must remain the chief centres for training scientific personnel in special fields and should be the chief centres for pure research, although such research must be fostered to a limited extent in the Council's own laboratories. The chief concern of these laboratories should be research on problems expected to yield results for immediate practical application, and provision should be made for this work to be carried to the stage of pilot-plant operation. Provision for the interchange of research workers between the National Research Council, universities, Government departments, and other research organizations in Canada is strongly recommended, as well as the development of research intelligence and the international exchange of research information. The establishment of liaison officers in London and Washington is noted as a policy which might be profitably extended in the post-war period. The value of such co-operation in war research is specially stressed in this report, which notes that it has been possible to plan research with some understanding of the use likely to be made of the results by the Allied Nations, and also it has enabled Canadian workers to discuss their problems at first hand and to establish close relations with other scientific workers investigating similar problems.

New Map of the Moon

Mr. H. Percy Wilkins is a well-known observer of lunar features and has done a considerable amount of very useful work in this particular branch of astronomy. In 1932 he published his 200 in. map of the moon, and now he has brought out a new map which is 25 ft. in diameter and by far the largest map of the moon in existence. It is contained in 107 sheets, each 22 in. by 30 in., bound in three volumes and deposited in the Library of the British Astronomical Association, Burlington House, Piccadilly, London. This map was commenced in 1932 and displays a great amount of care and attention to details—the number of ring-like objects is about 60,000, and many other objects are noted. The number of named objects is 700, including 28 new names; all the names contained in "Who's Who in the Moon" have been included. A large number of new clefts have been inserted as a result of the author's own observations since 1932. Although positions are mainly based on Saunder's list, Mr. Wilkins has made many new measurements with a micrometer, especially of objects near the limb. The large scale—300 in. diameter—is just sufficient to show clearly minute details in the more crowded regions. It is proposed to publish the map on the reduced scale of 100 in. to the moon's diameter, in 25 sections, each 20 in. square, and for the purpose of this reproduction the entire map was re-drawn to this scale, one-third of the diameter of the original sheets. Selenographers will find this map of the moon invaluable for their work.

Trapping Fleas

A. H. Al-Hussaini, of the Department of Zoology, Farouk I University, Alexandria, has described, in a communication to the Editors, a simple trap for catching fleas. A plate of 7–8 mm. depth and not less than 20 cm. diameter is filled with soapy water; a one candle-power petroleum lamp, with a flat supporting base, is put in the middle of the plate. Fleas being thermotropic and thus attracted by the heat of the lamp, they jump towards it and fall into the plate, where they are rapidly 'drowned' in the soapy water. The great majority of fleas caught by this trap are females. Two possible interpretations to this high percentage of females can be offered: (1) the female seeks a hide to lay its eggs, and the hotter the hide the more favourable it is for hatching the eggs; (2) the numbers may indicate the natural ratio between the females and males in the human flea (*Pulex irritans*), which would thus be approximately 25 : 1.

The Venereal Diseases

A recent pamphlet, "People Who Live in Glass Houses", by a "V.D. Orderly" (Harold Thomas) (London: The Central Council for Health Education, 1945. Pp. 80. 9*d*.), gives an accurate account of the common venereal diseases. One would guess that the material was originally used by the author for lectures to young men. As such, and delivered in a breezy 'man to man' style, it was no doubt successful with a certain type of audience; but Mr. Thomas has not achieved the task of translating his message into writing. The lay reader, who is able to accept the style, may not be inspired by the length. There is just too much to be read at a sitting and some of the information, good though it is, is redundant. An orderly in a venereal diseases clinic has a position of great responsibility and is often the friend and counsellor of the patients. Mr. Thomas has obviously made the most of his opportunities for observation of the conduct and mode of life of his patients. We can praise his sincerity and intentions but not his book.

University of Leeds

At a meeting of the Council of the University of Leeds on October 17, Dr. W. T. Astbury, reader in textile physics in the University, was appointed to the newly instituted chair of biomolecular structure which has been established for Dr. Astbury personally as a tribute to his merit as an investigator. The title of emeritus professor was conferred upon Dr. R. W. Whytlaw-Gray, who recently retired from the chair of chemistry. Mr. Wilfred Prest, acting professor in the University of Melbourne, was appointed visiting lecturer in the Department of Economics and Commerce during the second and third terms of the present session.

The Council announced that the following grants to the University had been made: (1) £10,000 over a period of ten years by the Nuffield Trust to establish a readership or senior lectureship in the Dental School for the purpose of encouraging research into problems of dental health. (2) An annual grant of £600 for seven years from Messrs. Turner and Newall for the institution of a research fellowship to promote research in engineering, chemistry, physics, textile industries or any allied science approved by the donors. (3) £1,500 a year for two years from the Bradford Dyers' Association, Ltd., for the institution of two research fellowships: one in dyeing in the Department of Colour Chemistry and Dyeing; and one in Textile Finishing in the Department of Textile Industries; together with a grant of £400 to each of the two Departments for the maintenance and replenishment of their resources; (4) £300 a year from the International Wool Secretariat for the establishment of a Wool Research Scholarship. (5) 6,500 dollars from the Rockefeller Foundation for the purchase of equipment in the United States required in connexion with Prof. Astbury's researches on the analysis of biological tissues, in support of which the Foundation has made a grant of £2,140 a year during the past twelve years. (6) An annual grant of £100 from Williams (Hounslow), Ltd., for equipment for the proposed new lectureship on lakes and pigments in the Colour Chemistry and Dyeing Department. (7) £750 from Messrs. Babcock and Wilcox, Ltd., for equipment to be used in the Coal Gas and Fuel Industries Department in the training of fuel technologists.

German University in Prague

It is announced by *The Times* correspondent in Prague that, by a presidential decree dated October 18, the German University in Prague and the German technical colleges at Prague and Brno will cease to exist on November 17, the day on which the country commemorates the shooting of Czech students and the closing of Czechoslovak universities by the Germans in 1939.

Ministry of Labour and National Service: Technical and Scientific Register

Demobilized men and returned prisoners of war who are scientific workers, professional engineers, architects or surveyors, are invited by the Ministry of Labour and National Service to make use of the service provided by the Technical and Scientific Register of the Appointments Department of the Ministry, at York House, Kingsway, London, W.C.2 (Telephone: Temple Bar 8020). A technical staff, competent to give advice and assistance, has been augmented to meet problems of settlement and reconstruction. A large variety of vacancies, both at home and overseas, is now available for fully qualified men of science, engineers, etc. Inquirers are particularly asked to write or telephone for appointments, stating occupation, qualifications, and the purpose of the proposed visit.

Fiftieth Anniversary of the Discovery of X-Rays

To commemorate the discovery by Röntgen of X-rays on November 8, 1895, a series of meetings has been planned by the Royal Society, Royal Society of Medicine, Royal Photographic Society, Physical Society, Institute of Physics, Institution of Electrical Engineers, British Institute of Radiology, and Society of Radiographers acting together. On November 8, inaugural meetings will be held at the Royal Society and the Royal Society of Medicine, at which Sir Henry Dale and Lord Horder respectively will preside. During the morning of November 9 papers on "Applications of X-Rays to Physics and Chemistry" will be read at the Royal Institution, and there will be a meeting at the Royal Society of Medicine for lectures on "Diagnostic Radiology" and "Radio-Therapy". During the afternoon, at the Central Hall, Westminster, a joint meeting of the participating societies will be held at which Sir Lawrence Bragg will speak on "The Scientific Consequences of Röntgen's Discovery of X-Rays". During the morning of November 10, papers will be read at the Royal Institution on "Applications of X-Rays to Physics and Chemistry". The remainder of the day will be occupied with meetings at the Institution of Electrical Engineers: the Society of Radiographers will hold a medical meeting, and later there will be two general sessions to hear historical reviews covering X-ray equipment, X-ray photographic materials and industrial X-ray analysis.

The Night Sky in November

New moon occurs on Nov. 4d. 23h. 11m. U.T., and full moon on Nov. 19d. 15h. 13m. The following conjunctions with the moon take place: Nov. 2d. 12h., Jupiter 4° S.; Nov. 2d. 20h., Venus 4° S.; Nov. 6d. 17h., Mercury 5° S.; Nov. 23d. 13h., Saturn 2° S.; Nov. 24d. 03h., Mars 0·6° S.; Nov. 30d. 05h., Jupiter 4° S. Occultations of stars not fainter than magnitude 6 are as follows: Nov. 15d. 19h. 33·9m., 24 B. Ceti (*D*); Nov. 21d. 22h. 05·7m., 3 Gemi. *m* (*R*); Nov. 22d. 5h. 53·5m., 36 B. Gemi. (*R*); Nov. 28d. 1h. 58·3 m., ν Virg. (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the times refer to Greenwich. Mercury is unfavourably placed for observation, setting about half an hour after the sun during the month. Venus is conspicuous as a morning star, rising at 4h. 44m., 5h. 30m. and 6h. 19m. at the beginning, middle and end of the month, respectively. Mars, in the constellation of Cancer, can be seen in the late evening hours, rising at 21h. 13m., and 19h. 49m. at the beginning and end of the month. Jupiter, in the constellation of Virgo, is visible in the morning hours. The planet rises at 4h. 37m. on Nov. 1 and at 3h. 14m. on Nov. 30. Saturn, in the constellation of Gemini, rises about the same time as Mars at the beginning of the month and at 19h. 16m. at the end of the month. The planet is stationary on Nov. 6. The Leonid meteors are due on Nov. 13–14 and the Andromedids about Nov. 20–27, but both these showers have been very feeble, or in some cases practically non-existent, for a number of years.

Announcements

Sir John Boyd Orr, M.P., has been elected rector of the University of Glasgow.

Captain Arthur Dyce Duckworth, R.N., has been appointed secretary of the Institution of Naval Architects in succession to the late Mr. G. V. Boys, and will shortly take up his duties at the Institution.

The Conference in Prague on the use of X-ray methods in the metal industry (see *Nature* of October 20, p. 473) has been postponed and will take place during November 28–December 1.

LETTERS TO THE EDITORS

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

Electrical Resistance of Liquid Metals

THE electrical resistance of a metal arises from the scattering of the electron waves passing through it. The fraction of these electron waves scattered in all directions in a unit volume, which will be called the attenuation coefficient, μ, is equal to the reciprocal of the mean free path of the electrons. From this the specific resistance ρ can be calculated from the formula

$$\rho = \frac{h}{n\nu e^2\lambda} \cdot \mu, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where ν is the number of atoms per unit volume, n is the number of conduction electrons per atom, and λ is the wave-length corresponding to the Fermi surface.

In the alkali metals in the solid state, this wave-length is 14 per cent greater than the wave-length that will give the first Bragg reflexion in the backward direction. In a recent paper[1], we have shown that this magnitude for λ is sufficient to make the scattering coefficient *even in the backward direction* conform to the Einstein-Smoluchowski formula

$$\left.\begin{aligned} E_\varphi &= \varepsilon \,.\, \nu\sigma_\varphi, \\ \varepsilon &= \nu kT\beta \end{aligned}\right\} \quad . \quad . \quad . \quad (2)$$

where E_φ is the scattering coefficient in any direction making an angle φ with the direction of motion of the electrons, defined for unit volume and for unit solid angle; β is the isothermal compressibility, and σ_φ is the scattering coefficient for a single isolated atom. (σ_φ will be proportional to the square of the atomic structure factor as usually defined.) T is taken to be sufficiently large in comparison with the Debye temperature for the thermal energy to be regarded as proportional to kT.

The attenuation coefficient will then be given by

$$\mu = \int_0^\pi E_\varphi \,.\, 2\pi \sin\varphi d\varphi \quad . \quad . \quad . \quad . \quad (3)$$

$$= \varepsilon \,.\, \nu\sigma, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where $\sigma = \int_0^\pi \sigma_\varphi \,.\, 2\pi \sin\varphi d\varphi$ is the cross-section of the atom for scattering in all directions.

In the alkali metals in the liquid state also, λ is about 13 per cent longer than λ_0, where λ_0 is the wave-length for which the first diffraction maximum is in the backward direction, $\varphi = \pi$. Though the diffraction halo of the liquid is much more diffuse than the Bragg reflexions in the solid, the above magnitude of λ is still sufficient to exclude all the intense parts of the halo. A portion of its long tail, however, extends into the observable range, $\varphi \ll \pi$. This forms an excess scattering in the neighbourhood of the backward direction over that given by (2), and hence μ will be in excess of the value determined by (4) by a corresponding amount. On calculation, this extra scattering in the liquid is found to account for the observed increase in resistance of about 50 per cent of the alkali metals on melting. (The increase due to changes in β and ν on melting is relatively small, about 10 per cent.)

Since the method adopted for this calculation is general, and is applicable to polyvalent liquid metals also, we will briefly describe the method here. Denoting by x_φ and s_φ the quantities in X-ray scattering analogous to E_φ and σ_φ respectively in electron scattering, we have

$$\frac{x_\varphi}{\nu s_\varphi} = \frac{E_\varphi}{\nu\sigma_\varphi}, \; = R_\varphi \text{ say.} \quad . \quad . \quad . \quad . \quad (5)$$

Now x_φ, s_φ and R_φ involve φ and λ through $\sin\frac{1}{2}\varphi/\lambda$ alone. Hence knowing the intensity distribution in X-ray scattering by the liquid metal, and the X-ray atomic structure factor, for any convenient wave-lengths, we know R_φ. The Fermi electronic wave-length for the metal is also easily calculated; for this purpose we regard *all* the valency electrons as conduction electrons. If now the atomic structure factor for the scattering of electron waves of this particular wave-length is known, the electronic scattering coefficient E_φ for the metal in different directions can be calculated, and thence, using relations (3) and (1) respectively, the attenuation coefficient μ and the specific resistance ρ can be calculated.

We have calculated the electrical resistances of some typical liquid metals by this method, using the known distribution of intensity in the X-ray diffraction pattern of the liquid[2] and the known X-ray atomic structure factors. Data for atomic structure factors for electron scattering for such low-velocity electrons as are involved in conduction are available for the rare gas atoms only[3], and they have been adopted roughly as the appropriate values for the corresponding alkali atoms in the metal. For other atoms, for want of similar data, the electronic scattering coefficient of the atom σ_φ is assumed to be the same in different directions, and equal to $\sigma/(4\pi)$.

Now plotting R_φ against $\sin\frac{1}{2}\varphi/\lambda = \xi$, say, it is found that in all liquid metals there is one prominent maximum for R_φ, the value of this maximum being about 2 or 3. When ξ is increased further, R_φ falls below unity, and after two or three oscillations about the value $R_\varphi = 1$, with progressively diminishing amplitudes, settles down at this value. As we proceed from the prominent maximum to smaller values of ξ, in most liquids R_φ falls quickly to a very low value, which according to the theory must be the Einstein-Smoluchowski value $R_\varphi = \varepsilon \ll 1$, and must remain so at all smaller values of ξ. In a few liquids, for example, zinc and aluminium, R_φ passes through a subsidiary maximum, before falling to ε.

Now the attenuation coefficient, and hence the resistance, of a given liquid metal will depend on how much of the diffraction pattern, the intensity of which is highly concentrated in the neighbourhood of the prominent halo, is included in the range $0 < \varphi \ll \pi$, or $0 < \xi \ll 1/\lambda$, where λ is the Fermi wave-length of the metal. In monovalent metals this range includes little beyond the Einstein-Smoluchowski region; whereas in the other extreme case when the valency is sufficiently high ($n = 5$ or 4), it includes the whole of the diffraction pattern where R_φ deviates significantly from unity. For intermediate valencies ($n = 2$ or 3), the region includes the major portion of the prominent halo, but not the whole of it.

We may mention here one striking result to which we are led by these considerations. Whereas in monovalent liquid metals the attenuation coefficient is of the order of the Einstein-Smoluchowski value, namely, $\mu = \varepsilon \times \nu\sigma$, in polyvalent liquid metals it

approximates to what may be called the Rayleigh value, namely, $\mu = \nu\sigma$, which is much larger. The experimental values for the electrical resistances of liquid alkali and noble metals verify the former value, and those for liquid bismuth, lead and tin the latter, with reasonable values for σ.

The exceptional electric behaviour of mercury is due to the following circumstance. Its prominent diffraction halo, which is very sharp, is much closer to the centre than in other liquids; the spherical zone in phase space the boundary of which corresponds to this maximum can accommodate only 0·9 electrons per atom, whereas in the other liquid metals studied this number varies from 1·2 to 1·7 per atom.

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June 20.

[1] *Proc. Nat. Acad. Sci. India*, in the press. We owe to Frenkel the idea of calculating the coefficient of electronic scattering in a metal in terms of the thermal fluctuations in density.
[2] For collected data, see Gingrich, N. S., *Rev. Mod. Phys.*, 15, 90 (1944).
[3] Ramsauer, C., and Kollath, R., *Ann. Phys.*, 12, 529 (1932).

Stability of the Earth's Atmospheric Oxygen

Among the many ways in which it is scientifically prophesied that the world, as we know it, must come to an end, there is a double 'threat' to the oxygen of the air.

It has been argued (by Goldschmidt originally), and generally accepted, that this oxygen is already much, perhaps a half part, absorbed by iron and ferrous minerals, and must all disappear in the course of time. But those who suggest this neglect the somewhat obvious circumstance that the same gravitational differentiation which separated oxygen from the iron core originally is still in operation, although now as a very slow 'geological' effect; and that, correspondingly, ferric oxide must be dissociated at a certain depth (*c.* 850 miles) provided that oxygen can escape more easily than iron through the molten basalt (as is certain).

Thus, the equivalent volumes of Fe_2O_3 and Fe_2 are 30·5 and 14·3 c.c.; the difference being 16·2 c.c., or at the pressure considered more like 14·6 c.c.; and the heat of formation of Fe_2O_3 (known at 400° C. and not likely to be greatly different, even at 4,000° C., from the specific heat trends, but possibly some 20–60 per cent *less*) is 196,000 cal. ($=8{\cdot}23\times10^{12}$ ergs): from this the dissociation pressure is $8{\cdot}23\times10^{12}\div14{\cdot}6$ dynes cm.$^{-2}$. Now, down to the depth considered, the changes in gravity (some 10 per cent) and magma density are not great and tend to cancel one another; so that, for a surface basalt density of 3·3, the ratio

$$\frac{8{\cdot}23\times10^{12}}{14{\cdot}6\times3{\cdot}3\times981}\rightarrow 1{,}372 \text{ km., or } 857 \text{ miles,}$$

gives a satisfactory estimate. It is very good confirmation of this that a heavier silicate-iron layer has been much supposed to begin at a depth of 1,350 km.

The ruddy aspect of Mars has been cited as evidence of advanced formation of ferric oxide; but appropriate calculation shows that the pressure even at the centre of Mars is considerably less than that required for the dissociation—so that the cases are not analogous.

The other 'bogey' in this matter, though a slender one in its rate of action, is accredited equally or more definitely. It is argued that oxygen escapes kinetically from the 'top' of the atmosphere, at a rate, according to Maxwell's distribution law, of some $10^{-\text{hundreds}}$ gm. sec.$^{-1}$. This is no doubt the case; but what seems to be neglected is that much more oxygen is indrawn gravitationally. Even granting the latter at present, the 'escapists' would argue that it must escape somehow some time into 'infinite space'.

Now infinite space without a corresponding extension of matter is an archaic notion no longer accredited philosophically, or substantiated by observation (so far as it goes); and the gravitational oxygen intake is approximately $\pi\left(\frac{\gamma m}{v^2}\right)^2 . v . \rho_{O_2}$ (assuming the capture radius $\frac{\gamma m}{v^2}$ to be virtually operative although it is only 1/15 of the earth's radius, and that the surrounding oxygen density ρ_{O_2} is 10^{-25}), which amounts to about $1{\cdot}8\times10^{-3}$ gm. sec.$^{-1}$—a quantity unquestionably greater than the kinetic loss. (In the case of the moon, or of Mercury, the kinetic loss is the greater and the earth loses hydrogen to the point observed.)

Lest it should now be argued that too much oxygen in the air would be almost or quite as bad as none, it can be shown that all the oxygen supposed to be in space (ρ_{O_2} near the sun is about 10^{-25}) can never increase the atmospheric content by more than about 23 per cent. For the solar space cell contains about $1{\cdot}13\times10^{31}$ gm. of oxygen; and at a solar velocity of 20 km. sec.$^{-1}$ relative to its surroundings (it is probably less owing to similar movement of gas), the sun takes in gases 4×10^{10} times as fast as the earth, thus leaving only $2{\cdot}8\times10^{20}$ gm. of the oxygen total to accrue to the earth, which at present has $1{\cdot}3\times10^{21}$ gm. (For a solar velocity relative to the gas of 10 km. sec.$^{-1}$ the possible increase would be only 3 per cent.) A similar relation will hold for any other gas, such as nitrogen or argon. Also the earth's iron core may act in a 'buffering' fashion, absorbing most of any excess over the present amount of oxygen.

The theological importance of the question of the future habitability of the earth was the origin of the studies here described—which evidently dispose of all reason for suggesting that the atmosphere is not permanent.

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July 6.

Thermal Decomposition of $HgCl_2$ Vapour

In a recent communication, Gaydon[1] has shown that an absorption spectrum obtained from mercury chloride ($HgCl_2$) in a heated steel tube by Rao[2], and attributed by the latter to diatomic HgCl (not to be confused with calomel (Hg_2Cl_2) which does not exist as a gas), is really due to CuCl (present as an impurity). It is the purpose of this communication to show by thermodynamic calculation that there is no chance at all of obtaining the absorption spectrum of HgCl from thermally decomposed mercuric chloride vapour. The same is true for HgBr and HgI. This may be surprising, because numerous diatomic radicals are known; for example, OH,

NH, CN, CuH, CuCl, CaH, CaF, CaCl, BeF, MgF, MgCl, ZnF, CdF, AlF, AlH, SnF, PbF, PbCl, MnF, FeCl, the presence of which in thermal equilibrium at high temperatures has been ascertained by their absorption spectra. The rather exceptional position of the diatomic halides of mercury is primarily due to their small energy of dissociation, the value of which is 24,000 cal./mol. in the case of HgCl [3] and still lower for HgBr and HgI.

The free energy functions $(G^0-E_0^0)/T$ are accurately known for Hg and for Cl_2 [4]. They can also be calculated with sufficient approximation for HgCl and for $HgCl_2$ vapour by using the molecular data published by me[3] and by Wehrli[5] respectively. These values at $T = 1{,}000°$ and 1,500° K. are given in Table 1.

TABLE 1. VALUES OF $-(G^0-E_0^0)/T$ IN CAL./MOL. DEGREE.

T°K.	$HgCl_2$	HgCl	Cl_2	Hg
1000°	74·06	64·67	55·45	42·83
1500°	79·71	68·16	58·88	44·85

The equilibrium constants K_p given in Table 2, lines 1–3, are then obtained from the equation

$$\log K_p = -\frac{1}{4{\cdot}573}\,\Delta G^0/T, \text{ where } \Delta G^0/T = \Delta E_0^0/T + \Sigma\,(G^0-E_0^0)''/T - (G^0-E_0^0)'/T.$$

(ΔE_0^0 is the heat of reaction of the (ideal) gases at 0° K.; the sum includes the free energy functions of the resultants.)

TABLE 2. DISSOCIATION OF $HgCl_2$ VAPOUR.

No.	Reaction	ΔE_0^0 (cal.)	1000° K. K_p	1000° K. α(%)	1500° K. K_p	1500° K. α(%)
1	$HgCl_2 = HgCl + \frac{1}{2}Cl_2$	+ 51,900	$4{\cdot}59\times10^{-8}$	0	$2{\cdot}22\times10^{-4}$	0·5
2	$HgCl = Hg + \frac{1}{2}Cl_2$	− 4,600	$1{\cdot}96\times10^{2}$	99·7	$1{\cdot}02\times10^{3}$	99·4
3	$HgCl_2 = Hg + Cl_2$	+ 47,300	$9{\cdot}00\times10^{-6}$	0·3	$2{\cdot}26\times10^{-2}$	14·9
4	$HgCl_2 = Hg + Cl_2$ (experimental)[6]		$9{\cdot}23\times10^{-6}$	0·3	$2{\cdot}28\times10^{-2}$	14·9

It is seen from Table 2, lines 1 and 2, that in thermal equilibrium a dissociation of $HgCl_2$ into $HgCl + \frac{1}{2}Cl_2$ does not take place to a measurable degree (α) even at high temperatures, because of the instability of the HgCl radical. On the other hand, the values of K_p calculated for the equilibrium $HgCl_2 = Hg + Cl_2$ (line 3) are in excellent agreement (better than could be expected from an approximate calculation) with the experimental values (line 4) obtained by Braune and Knoke[6] from the thermal decomposition of $HgCl_2$ and represented by the equation $\log K_p = 5{\cdot}141 - 10{,}176/T$. At temperatures above 1,500° K. (not given here) the dissociation of Cl_2 into 2 Cl has to be taken into account.

A more detailed paper including also the calculations for $HgBr_2$ and HgI_2 will appear in *Helv. Chimica Acta*.

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June 5.

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Loss of Antimalarial Properties in Quinine Degradation Products

KELSEY *et al.*[1] have described the preparation and properties of a "quinine degradation product" obtained by incubation of quinine with a suspension of rabbit liver tissue, and Mead and Koepfli[2] have reported on the chemical constitution of the product. These workers have not, however, determined whether or not this product is active against malaria parasites. We have therefore carried out the investigations described below on its action against infections of *Plasmodium gallinaceum* in chicks.

Experiment 1. Quinine was incubated with a suspension of rabbit liver, half the suspension being treated with sodium hydroxide prior to incubation to destroy enzyme activity. The untreated and 'control' materials were then extracted with chloroform, in which both the quinine degradation product and residual quinine were soluble. Suitable volumes of the chloroform extracts were measured into ampoules, the chloroform was evaporated off, and the ampoules containing the dry residue were sealed. Groups of chicks infected with *P. gallinaceum* received twice daily doses of the 'test' and 'control' material dissolved in the requisite volume of dilute hydrochloric acid immediately before administration. The extract from the suspension treated with sodium hydroxide contained 1·7 mgm. of residual quinine per ml.; that from the untreated suspension contained no unchanged quinine.

Experiment 2. Using a larger quantity of liver, a sample of the pure degradation product was prepared by a method similar to that of Kelsey *et al.*[1]; the melting point of the product was within 1° C. of that reported by them. The antimalarial activity of this sample in dilute hydrochloric acid solution was determined in comparison with that of a similar dose of quinine.

The results of the antimalarial tests are tabulated below. Only two birds were used in each group because of the small quantities of metabolic products available.

Expt. 1			Expt. 2		
Mean % red cells parasitized			Mean % red cells parasitized		
Untreated suspension	NaOH-treated suspension	Undosed controls	Quinine degradation product	Quinine	Undosed controls
83	0	71	84	32	88

These results show that the peripheral parasitamia of chicken malaria is not reduced by administration of an extract of liver suspension in which all the added quinine is metabolized (and therefore presumably containing the quinine degradation product), nor is it reduced by doses of the pure degradation product. It may therefore be inferred that after administration of quinine in malaria treatment, a

proportion of the alkaloid is converted by the liver of the host into an inactive metabolite. The amount of alkaloid converted *in vivo* is probably much greater than is converted in liver suspensions.

This metabolizing of quinine, with consequent loss of antimalarial activity, might be borne in mind in designing new derivatives or synthetic products of the cinchona type. We have indications, for example, that, while quinidine is metabolized similarly to quinine, cinchonine and cinchonidine are not metabolized by liver suspensions (chick liver). Mepacrine and plasmoquin also appear to be unchanged by rabbit liver suspensions.

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July 23.

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A Convenient 'Bridge' for Two-Solution Cells

In the setting up of two-solution cells for the measurement of electromotive force, it is not easy to establish a satisfactory junction between the two liquids, so tedious and cumbersome devices, such as the agar jelly bridge, are commonly in use. The difficulty may be overcome, and stable and correct junction potentials obtained within a few seconds, by the simple device of using for the bridge a strip of filter paper, the ends of which dip into the two solutions, which may conveniently be contained in two small beakers resting on a block of paraffin wax.

If the filter paper be used dry, a liquid-liquid junction is immediately set up by capillary rise.

If it is desired to use a third liquid for the bridge, a strip of paper may be soaked in this, and the excess removed before use by pressing between dry filter papers.

If a galvanometer of high sensitivity is in use, a single strand of bleached cotton yarn will form a satisfactory bridge, and the device may be further improved so as to give readings which remain stable indefinitely, by drawing the yarn through a glass U-tube, so as to shield it from evaporation.

S. M. Neale.

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Manchester, 1. July 6.

Chromium Oxide as a Promoter in Catalysts for the Fischer-Tropsch Synthesis

The economics of synthesis of hydrocarbons by the Fischer-Tropsch process may be improved by using (1) cheaper catalytic material, (2) water gas as such in place of enriched synthesis gas ($CO : H_2$ as 1 : 2) and (3) medium pressures instead of atmospheric pressures. A cheap iron-copper catalyst prepared by Ghosh and Sen[1] gave 86 gm. of hydrocarbons per cubic metre of gas and has since been developed by Japanese investigators[2]. The fact that chromium oxide possesses very high adsorption for hydrogen at 200° has been taken advantage of in preparing a catalyst (CO = 34 per cent; Cu = 4 per cent; ThO_2 = 2·3 per cent; Ce_2O_3 = 0·24 per cent; Cr_2O_3 = 4·6 per cent; rest kieselguhr) which has been found to be remarkably steady, and yields with water-gas at a pressure of 5 atmospheres and 205° C., 160 gm. of liquid hydrocarbons per cubic metre with a space velocity of 600 c.c. per hour per c.c. of catalyst.

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S. L. Sastry.

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Feb. 28, 1944.

[*Publication delayed for security reasons.* Editors.]

[1] *J. Indian Chem. Soc.*, **12**, 53 (1935).
[2] Tsunecka, *et al.*, *Sci. Papers Inst. Phys. Chem. Res., Tokyo*, **35**, 330 (1938–39); **38**, 118 (1940); **38**, 184 (1941).

Darkened Violet in Colour Vision

Edridge-Green[1] has directed attention to the shortening of the violet end of the spectrum which he found in some persons. A test of sensitivity to red, orange, yellow, yellow-green, green, blue-green, blue, violet and purple was carried out on 103 men and 104 women, excluding all red-green blind and red or green anomalous subjects. The experiment was performed with a form of colorimeter using the Ilford Monochromatic filters (601–8) and purple (501). Relative brightness was measured as well as sensitivity to hue.

Three women and three men had the violet darkened by more than three times the standard deviation of brightness levels of violet for the remaining subjects, which shows that the darkening was not due to normal variation (or random error). A number had slight darkening of violet and blue, but while there was a correlation of + 0·337 between blue weakness and darkening of blue, the correlation between violet weakness and darkening of violet was not significant. This means that on the whole there was a tendency for blue to be darkened when it was weakened, while violet was as often brighter as darker when there was loss of sensitivity to its hue.

In this test there were about 10 per cent who had marked yellow-blue weaknesses and were not red-green defectives (while the red-green blind are rarely weak in yellow or blue). This confirmed the result of previous tests. The yellow-blue weak subjects were not sufficiently defective to be called blue-yellow blind and they were not consistently detected by tests in general use; but they had sometimes suspected a weakness of colour-sensitivity in themselves. Six of the yellow-blue weak subjects were those with darkened violet. Five of them were weak in yellow as well as in blue, and one in blue rather than in yellow. All were weaker in yellow and/or blue than in violet, but not weaker than the yellow-blue weak in whom violet was normally bright.

Equality of proportion for both sexes suggests that blue-yellow weakness and darkened violet are not sex-linked characters, a conclusion supported by genealogical data. Darkening of violet appears to be about as common in each sex as the familiar darkening of red (as in protanopes) among men. Just as, in my experience with detailed tests on about seventy red-green defectives, the protanopes are not 'red-blind' but are red-green defectives with darkened red as an additional character, so those with darkened violet are not 'blue-blind' but are yellow-blue defectives with violet and blue of diminished brightness.

Thus, although there are, as Walls[2] has predicted, two classes of blue-defectives, namely, those with

and those without darkened violet, they are not, as he suggested, products of a shifting of violet sensitivity towards green (darkened violet), and of green towards violet (not darkened), respectively. They appear to be yellow-blue defectives in whom the violet is exceptionally dark.

R. W. Pickford.

Psychology Department,
University, Glasgow. July 9.

[1] Edridge-Green, F. W., "Colour-Blindness and Colour-Perception", chap. 12 (1891).
[2] Walls, G. L., "The Vertebrate Eye", 99 (1942).

Crystalline Hæmolytic Substance from Normal Blood

The occurrence of a hæmolytic substance in normal blood has been demonstrated by Bergenhem and Fahraeus[1]. This substance was present in the ether precipitate of the alcohol-soluble fraction of serum, and was described by them as a lysolecithin, that is, a derivative of lecithin from which one fatty acid has been split off by the action of lecithinase, an enzyme analogous to that contained in cobra venom. However, the evidence in favour of the existence of lecithinase in serum and of the lysolecithin nature of the lytic substance was indirect, since no attempt at purification or isolation of either the lecithinase or the lytic principle has been reported.

The present work was concerned with the isolation of the hæmolytic substance from human blood plasma. The substance has been purified and finally obtained in a crystalline form. It is free from nitrogen, phosphorus, sulphur and halogen. It is insoluble in water but soluble in ether, and since it is free from nitrogen and phosphorus, it is not a lysolecithin. Molecular weight determination and microanalysis agree reasonably well with the suggested formula $C_{22}H_{42}O_5$; m.p. 45°. 0·1 c.c. of a 5 per cent erythrocyte suspension of human blood in 5 c.c. of isotonic phosphate buffer solution (*p*H 7·2) is completely hæmolysed in about one minute at 37° by 50 μgm. of the crystalline material, that is, in a dilution of 1 : 100,000.

A detailed account of the isolation, purification and chemical constitution of the crystalline material will appear elsewhere.

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[1] Bergenhem, B., and Fahraeus, R., *Z. ges. exp. Med.*, **97**, 555 (1936).

Respiration of Spermatozoa in Egg-Yolk Medium

Of various media used in artificial insemination for the preservation of the semen[1], the egg-yolk phosphate mixture of Phillips and Lardy[2] has given the best results, maintaining the fertilizing capacity of bull semen for several days at 5° C. Egg-yolk phosphate is also a good medium for maintaining oxygen uptake of the semen in respiratory experiments, and Walton and Edwards[3] found a positive correlation between oxygen uptake of semen samples and the fertility of the bulls from which the samples were taken. Experiments have therefore been undertaken to determine the factors present in the egg-yolk affecting the respiratory activity at 37° C., in expectation that the knowledge gained will assist in the discovery of the most favourable conditions of storage.

Semen was obtained from the bull by the artificial vagina[4]; 1 ml. of semen was used for each measurement of oxygen uptake in a Barcroft-Dixon manometer[5].

It was found that neither the cell-free seminal fluid nor the egg-yolk, either separately or in combination, gave any appreciable oxygen uptake. Whole semen (cells plus fluid) in phosphate buffer alone gave relatively good respiration. The addition of egg-yolk, however, greatly increased oxygen uptake, but in about one hour's time there was gradual decline. In order to trace the sources of this increase and of the eventual decline, the egg-yolk has been fractionated by various treatments and each fraction tested separately. The first fractionation was achieved by dialysing the egg-yolk in a 'Cellophane' tube at 1° C. against distilled water. Two fractions were thus obtained; the *non-dialysable portion*, which contained the bulk of the egg-yolk; and the *dialysable portion*, which passed through the membrane into solution. Both fractions were made isotonic, the first by redialysis against phosphate buffer and the second by evaporation at 50 mm. pressure until the volume was equal to the water content of the original yolk. The non-dialysable fraction gave a slightly reduced initial uptake in comparison with the untreated yolk; but the uptake continued at an almost constant rate for the remaining period of the experiment (3 hr.). The addition of the dialysable fraction to the buffered semen caused a slight initial rise, followed by a marked inhibition.

The two outstanding features of these experiments are: (1) that the non-dialysable portion is capable of maintaining a high respiratory rate over a prolonged period; and (2) that dialysis has removed from fresh egg-yolk a substance or substances which give rise to inhibition of respiratory activity, and that these are present in the dialysable portion. In regard to (1), we have further found that by extraction of the non-dialysable portion of the egg-yolk with organic solvents, both the fat-free protein residue and the re-emulsified fat increase the oxygen uptake when added to the semen-buffer system. There is some evidence that the degree of dispersion and the stability of the emulsion may contribute to the activating or preservative action of the fat in the egg-yolk. The unsaponifiable matter of the fat has a slightly inhibitory effect. In regard to (2), we have further investigated the nature of the inhibitory mechanism. An inhibitor itself is not present initially either in the untreated egg-yolk or in the dialysable portion, but is only gradually formed as a result of the oxidative metabolism of the spermatozoa on a substrate which is present in the dialysable portion. The inhibitor is not formed in the absence of oxygen.

Catalase, in relatively large amounts (at least 10 μgm.), completely reverses the inhibition. Peroxidase in smaller amounts has the same effect. Catalase inactivated by heat, cytochrome *C*, hæmatin, and ferrous ion had slight effects only upon the oxygen uptake and did not reverse the inhibition. Although the presence of free hydrogen peroxide could not be detected by the benzidine-peroxidase test, it is possible that the inhibitor is an organic peroxide and that catalase and peroxidase both reverse the inhibition brought about by this peroxide. The mechanism involved bears some re-

semblance to the 'coupled oxidations' of the type described by Keilin and Hartree[6]. The substrate of the inhibitor in the dialysable portion of the egg-yolk is soluble in ethanol but not in ether.

Since the non-dialysable portion of the egg-yolk maintains respiratory activity well, tests have been made of its capacity as a storage medium, and a number of cows have been inseminated with semen stored in it. Results are not yet complete, but so far have been satisfactory.

Our thanks are due to Prof. D. Keilin and Dr. T. Mann, of the Molteno Institute, for much help and advice, and to Mr. Rowson of the Insemination Centre for conducting the fertility tests.

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Arthur Walton.

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June 17.

[1] For a review see Anderson, J., "The Semen of Animals and its Use in Artificial Insemination" (Edinburgh: Imperial Bureau of Animal Genetics, 1945).
[2] Phillips, P. H., and Lardy, H. A., *J. Dairy Sci.*, **23**, 399 (1940).
[3] Walton, A., and Edwards, J., *Proc. Amer. Soc. Anim. Prod.*, 31st Ann. Meet., 254 (1938).
[4] Walton, A., "The Technique of Artificial Insemination" (London: Holborn Surgical Instrument Co., 1945), in the press.
[5] Dixon, M., "Manometric Methods" (2nd edit., Cambridge, 1944), 6.
[6] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **119**, 141 (1936).

Thiourea and the Suprarenal Cortex

Rats fed on diets containing thiourea and thiouracil die after varying periods of time. Some preliminary experiments showed that in the case of rats on 0·5 per cent thiourea, the action of the drug was reversible up to a certain stage; but after this, death occurred whether the animals were put back on to the control diet or not. This indicated that thiourea was exerting more than a simple antithyroid effect. Hughes[1] found similar results with thiouracil. We also observed in rats on both thiourea and thiouracil that in the terminal stages (the last two days) the suprarenals were frequently enlarged and dark reddish brown in colour. Except in the terminal stages, however, our findings confirm those of Williams, Weinglass, Bissell and Peters[2], who reported that in rats treated with thiouracil the suprarenals were smaller than normal although the ratio of gland-weight to body-weight was normal.

To test for possible suprarenal cortex deficiency, a batch of 26 young male rats, which had been on diet containing 0·5 per cent thiourea for 28 days and had remained stationary in weight for 14 days, was divided into four groups. All groups received the diet plus thiourea, one group being supplemented with thyroxine (10 μgm. thyroxine daily injected subcutaneously in alkaline saline), one group having 1 per cent sodium chloride to drink instead of tap water and one receiving 1 per cent sodium chloride to drink in addition to subcutaneous injections thrice daily of 0·1 ml. 'Eucortone' (suprarenal cortex extract). The average weights of these animals are given in the accompanying table.

All the rats receiving thiourea only died in a short time. The rats drinking 1 per cent sodium chloride gained some weight and lived longer than the rats drinking tap water. Those receiving both 1 per cent sodium chloride and injections of 'Eucortone' showed a remarkable recovery, as did also the rats receiving thyroxine. Although these two groups of rats were gaining weight at approximately the same rate, those

Average weight of rats (gm.)

Group	Days on diet			
	30	60	90	120
Control	105	149	202	
Thiourea	52	All dead		
Thiourea + saline		68	All dead	
Thiourea + saline + 'Eucortone'		92	107	147
Thiourea + thyroxine		96	118	140

Thiourea diet supplemented after 30 days by giving saline to drink, saline to drink plus three subcutaneous injections daily of 0·1 ml. 'Eucortone' or 10 μgm. thyroxine subcutaneously daily.

receiving thyroxine were sleek and active whereas those on 'Eucortone' were somewhat lethargic. Neither group caught up with the control group in weight. The thyroids of the thyroxine-treated rats were normal, whereas gross and histological examination of the thyroids of the rats treated with 'Eucortone' showed that these animals were still in a hypothyroid condition. The growth of these animals can presumably be attributed largely to retention of water and increased food intake. One rat treated with thiouracil, which had remained more or less stationary in weight for thirteen weeks, also recovered after injecting 'Eucortone' (0·1 ml. thrice daily). In six weeks, this rat increased in weight from 116 gm. to 164 gm. and was then killed for histological examination.

The results of these preliminary experiments indicate that both thiourea and thiouracil produce suprarenal cortex deficiency in rats. This view is supported by the fact that histological examination of the suprarenals of rats in the terminal stages frequently revealed abnormalities in the cortex including severe congestion, particularly of the zona reticularis, depletion of lipoid (stainable with Scharlach R), hæmorrhages and sometimes areas of necrosis. The glycogen contents of the livers were also considerably reduced.

The exact mode of action of thiourea and thiouracil on the suprarenal cortex has not yet been established.

I am indebted to Dr. C. L. Oakley, who carried out all the histological examinations.

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Langley Court, Beckenham, Kent.
May 16.

[1] Hughes, A. M., *Endocrinol.*, **34**, 69 (1944).
[2] Williams, R. H., Weinglass, A. R., Bissell, G. W., and Peters, J. B., *Endocrinol.*, **34**, 317 (1944).

Palolo Worms

I have been much interested in the communications in *Nature* concerning the palolo worm, sent by Commdr. William Burrows[1] and by Mr. R. A. Leven[2]. I should like to direct attention to the paper published nearly forty years ago by W. McM. Woodworth, in which the distribution, habits, structure and history of the palolo are fully discussed. It was published in 1907 in the *Bulletin of the Museum of Comparative Zoology*, **51**, No. 1, 1–21, pls. 1–3. As it was based largely on Woodworth's own observations, it is of real importance and should not be forgotten or overlooked.

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[1] *Nature*, **155**, 47 (1945).
[2] *Nature*, **156**, 19 (1945).

RESEARCH AND DEVELOPMENT IN THE BRITISH COLONIES

UNDER the title "Colonial Research 1944–45"*, there have now been issued the second annual reports of the Colonial Research Committee and of the Colonial Products Research Council, and the first annual report of the Colonial Social Science Research Council; for convenient record, these reports will in future be published in a single volume. Following on the reports of the Commissions on Higher Education in the Colonies and in West Africa (see *Nature*, Sept. 27, p. 373), they assist materially in appraising the recommendations of those Commissions in regard to Colonial research; and although the Colonial Research Committee's report is not concerned with fundamental principles of policy to quite the same extent as its first report, the present report is of scarcely less general interest.

With the establishment of the specialist research committees, the main work of organization in Britain for Colonial research may be said to be well advanced. The main bodies, including a forthcoming committee for Colonial agricultural, animal health and forestry research, are directly advisory to the Secretary of State, who nevertheless looks to the Colonial Research Committee for advice on general research policy, and the Committee considers that its future work lies rather in certain co-ordinating functions which only a centrally placed body can perform. It has, first, to ensure so far as possible that no important field of inquiry is overlooked because it does not fall well within the scope of one or other of the specialist bodies; and, secondly, to maintain a proper balance in the allocation of effort and funds.

The first function is comparatively simple, and the Committee instances the study of the needs of housing research, for which purpose a Colonial Housing Research Group, with Dr. I. E. Evans of the Building Research Station as chairman, was established. The Committee is also proceeding to a study of the needs of zoological and botanical surveys, in so far as these fall outside the direct scope and interest of agricultural and veterinary research. Other subjects mentioned as worthy of attention are: road research, a study of the power resources of the Colonies of all kinds, potential as well as actual, and the possible application of land utilization survey techniques. In regard to the second function, while the sum of £500,000 made available for research under the Colonial Development and Welfare Act of 1940 has so far been substantially underspent, and with the Act of 1945 that provision becomes £1,000,000 a year, the possibility of any financial limitation of Colonial research effort seems remote, since the Committee proposes to adhere to its policy of supporting only well-conceived schemes for which adequate and suitable personnel are available. Nevertheless, the end of the War will release many research workers, and the proposed research services alone may be expected to cost substantial sums, even if Colonial governments make some contribution. Moreover, plans laid and decisions taken now are likely to have a very important effect on future trends of research policy; and, discussing the choice of the precise means to be adopted, the Committee points out that even the urgent problems do not always yield most readily to a frontal assault. The key to a particular problem, or indeed to a whole complex of problems, may lie in fundamental work in some apparently quite unrelated field. In terms of Colonial needs, it may sometimes be wisest to concentrate effort in the laboratory best equipped to deal with the key problem, wherever that problem may be; and how to discern such key problems is in itself a major problem to the solution of which the Committee proposes now to address itself.

Reviewing the fields of research, the Committee endorses the recommendations of a sub-committee of the Colonial Survey and Geophysical Committee for creating a central organization designed to complete the whole of the geodetic and major framework and half of the outstanding topographical work, making the utmost use of aerial photography. The Royal Air Force is prepared to carry out the air photography on behalf of this survey as part of its peace-time specialist training. The Committee also endorses the recommendations of a Committee on Colonial Geology for a central organization on similar lines, and the two sets of proposals provide an unrivalled opportunity of supplying the Colonies with a thorough and accurate basic knowledge of their most important resources. The Committee has also recommended a capital grant towards the cost of the fisheries research station being installed in Mauritius, as well as the acceptance of the proposals of the Colonial Fisheries Advisory Committee for the formation of a Colonial fisheries service, to be recruited on terms of service analogous to, and interchangeable with, the federated superannuation system for universities.

The Committee considered a full report from an *ad hoc* sub-committee of the Colonial Advisory Council of Agriculture, Animal Health and Forestry, and supports its recommendation for the establishment of a separate committee of specialists to advise on research in these fields and to take over such functions from the Council itself. This recommendation has been accepted by the Secretary of State. A second recommendation, that in the Colonies themselves research should be organized on a regional rather than a territorial basis, has been commended to Colonial Governments, and a third recommendation for the establishment of a separate research service on the lines proposed for the fisheries service has been deferred for consideration by the new Committee. Schemes were also made for continuing the low-temperature research station at the Imperial College of Tropical Agriculture, for research on animal diseases in the Bechuanaland Protectorate, and for a survey of animal diseases in Zanzibar.

No specific schemes for medical research involving substantial expenditure were before the Committee during the year, but schemes were made for continuing studies on the bionomics of *Anopheles gambiæ* in Sierra Leone and Nigeria, and for D.D.T. field trials, for which £4,500 was provided. The latter scheme points the way to what may become a major development in tropical preventive medicine; workers in Africa, advised and guided by Prof. P. A. Buxton, have shown that D.D.T. is toxic to the tsetse fly. Important trials designed to work out effective techniques for its application in the field have been planned. The Committee has also recommended the adoption of an important scheme for research and development work on growing cinchona in the Colonial Empire, based in East Africa; in regard

* Colonial Research 1944-45. 1. Colonial Research Committee, Second Annual Report; 2. Colonial Products Research Council, Second Annual Report; 3. Colonial Social Science Research Council, First Annual Report. (Cmd. 6663.) Pp. 32. (London: H.M. Stationery Office, 1945.) 6*d*. net.

to medical research in general, the Committee considers that, so far as central organization is concerned, the way is now clear for a rapid and systematic attack on the major medical problems of the Colonies. It is pointed out, however, that research cannot be prosecuted effectively in this or in any other field without a regular flow of skilled men of science, and, unless energetic steps are taken, one of the chief shortages is likely to be in the field of entomology.

Other special committees established are the Tsetse Fly and Trypanosomiasis Committee and the Cocoa Research Committee, while with the aid of a grant of £28,000 now made on the recommendation of the Committee, it is intended to place the Anti-Locust Research Centre on a more permanent and satisfactory basis. Under the direction of an advisory scientific committee, the Centre will carry out a development programme covering the collection and dissemination of information (in close collaboration with the Imperial Institute of Entomology), research and technical advice in the conduct of specific campaigns. Proposals for continuing and extending the work of the Discovery Committee, which has done magnificent work on the oceanography and marine biology of the southern seas, were also considered. A list of schemes recommended and finally approved during April 1, 1944–March 31, 1945 is appended.

The report of the Colonial Products Research Council refers to the visit of Sir Robert Robinson and Prof. J. L. Simonsen, the director of research, to the West Indies; they were accompanied on most of their tour by Dr. A. King, head of the British Commonwealth Scientific Office in Washington. Further insight into American methods of industrial development was obtained during visits to Puerto Rico and St. Thomas, and during a visit to Trinidad a detailed programme of research was worked out with Trinidad Leaseholds, Ltd., while it was suggested to the directors of the British West Indies Sugar Association (Inc.) that the formation of an industrial research organization for sugar technology might be of great value. In a visit to British Guiana, it was suggested that difficulties being encountered in schemes for agricultural development owing to the high incidence of malaria in the coastal strip offer an ideal opportunity for an experiment on the use of D.D.T., and according to preliminary reports the experiment has met with a measure of success. Correspondents with the director of research have been appointed in all the Colonies of the Caribbean. A major development during the year was the decision of the Council to open a Microbiological Research Laboratory in Trinidad; Dr. A. C. Thaysen has been seconded to work under the Council and direct the research of this new laboratory, which it is anticipated will provide a centre for fundamental microbiological research in the tropics.

Reviewing research work in progress, the report refers to the investigation of expressed lime oil, which has been shown to contain limettin, *iso*pimpinellin, bergaptol and 5-geranoxy-7-methoxycoumarin, and these crystalline constituents are now being examined as antioxidants. Work on the reactions of eugenol and its derivatives from clove oil has been actively pursued, and at the Chemical Research Laboratory of the Department of Scientific and Industrial Research Dr. L. P. Walls has studied the most suitable methods for determining the ergosterol content of yeasts and for its extraction. Work on the utilization of sucrose has been actively pursued under the direction of Prof. W. N. Haworth and Dr. L. F. Wiggins, attention being directed mainly to lævulinic acid, hydroxymethylfurfuraldehyde, and to the dianhydrides of mannitol and sorbitol. A large number of new substances prepared appear likely to find application as chemotherapeutic agents or in the plastics industry. Work has also been commenced in the starch field, while in that of theobromine some attention has been given to the reaction of chlorotheobromine with diamines as a route to high polymers and to a process for reducing the theobromine content of cocoa meal to about 0·1 per cent by solvent extraction after treatment with ammonia. The utilization of Wallaba wood resin and the study of vegetable oils from Colonial sources have also received attention, and a list of some important plants found in the Colonies which are likely to have medicinal or insecticidal interest is undergoing final revision.

The Colonial Social Science Research Council, which was constituted in June 1944, held eight meetings during the period to March 31, 1945, covered by its first report. The general functions of the Council comprise broadly the review of the organization of research in the social sciences in the Colonies, the scrutiny of research projects submitted to it, the making of recommendations as to the publication of the results of research and the initiation of research in fields not otherwise covered. The Council was constituted to represent the main branches of the social sciences; but economic research is covered by the Research Sub-Committee of the Colonial Economic Advisory Committee, the chairman of that Sub-Committee being a member of the Council.

Attention is directed in the report to the need for certain types of basic data as being fundamental to many of the inquiries with which the Council is concerned, for example, the provision of sound demographic data, including census and vital statistics.

Further, the great bulk of the material required for effective study of the form and operation of political and administrative institutions consists of records in official archives, which at present are not always readily accessible without interfering with administrative work. The Council has also devoted much consideration to the attempt to ascertain what are the main research problems in the various fields, and what order of priority should be attached to them. While a comprehensive research programme has not yet been formulated, several problems have been recognized as major research needs. There is urgent need, for example, for surveys of social and economic conditions in urban and in rural areas; for comparative studies of local government; for studies of the social and economic effects of migratory labour in Africa, of land tenure in relation to agriculture and social structure, of Colonial administrative law, particularly in respect of procedure in native courts, of political development in 'plural' communities; and for sample surveys of literacy in relation to programmes of mass education. A wide range of intensive research on individual languages and cultures of many Colonial peoples is also required.

Attention has also been given to the organization of research. For some time to come, much research in the social sciences in the Colonies must be undertaken by individual workers; but the Council realizes the value of the more integrated organization provided by local or regional institutions specifically adapted for research into social problems, and believes that more institutes such as the Rhodes-Livingstone Institute and the Sociological Department

of the West African Institute of Industries, Arts and Social Sciences will be necessary. The Council has also in mind the need for close integration, first with the practical knowledge and requirements of governments as expressed in development and welfare programmes, and in the work of administrative officers and officers of the specialist services, and secondly, with the research programmes of other organizations in the same field. Reference is made, however, to the present extreme shortage of senior research workers fitted for independent and responsible investigation in these fields; the Council considers that for some time to come it will be necessary to draw most of the workers required from Britain. To enable any comprehensive programme of social research to be undertaken, postgraduate training of research workers on a long-term basis will be necessary, presumably at the universities; but in the present emergency the Council contemplates the provision of short-term training, appropriately planned with the ultimate objectives in mind and financed under the research section of the Colonial Development and Welfare Act. Reference is also made to the real problem which the future career of the research worker may offer, and the scarcity of openings when the investigator has completed his specific project.

Of specific research projects examined by the Council, reference may be made to work on the handbook of African languages, the ethnographic survey in Africa, research work on economic and social aspects of Colonial policy during the war period and Dr. R. R. Kuczynski's "Demographic Survey of the British Colonial Empire".

INDIAN FISHES AND FISHERIES

DR. SUNDER LAL HORA has added much, and is still adding, to our knowledge of the fishes of India. In a series of papers published during 1942 onwards, sometimes in association with other authors, he has dealt with a variety of subjects.

Discussing the respiratory movements of some Homalopterid fishes[1], attention is directed to the close parallelism between the accessory respiratory chambers of these and the bucco-pharyngeal chambers of certain air-breathing fishes. The fishes of Poona[2], with their Hindi names and distribution[3], and the fishes of Mysore and adjoining hill ranges[4] are listed. Notes on fishes in the Indian Museum[5] and descriptions of the large-scaled barbels, already discussed in six previous articles, are continued[4,6,7].

In May 1942, Dr. Hora was appointed to the post of director of fisheries, Bengal. One of his first activities in this capacity was a thorough investigation into the pollution of streams by the effluent of the quinine factory at Mungpo and its effect on the fish. The report[8] deals with many aspects of the problem, the main conclusion being that the effluent leads to the pollution of the streams affected by it (in the sense that the stream waters do not remain natural) not so much through the chemical waste products contained in it, but by the deposition of bark residues in the form of a coloured flocculent matter of very fine consistency, and by the oil contained in the effluent. Although there may be seasonal depopulation of the streams due to pollution, the fish are not permanently injured and their breeding is not affected. The main recommendations for improvement are, so far as practicable, to remove the bark residues by sedimentation in settling tanks and possibly to recover more oil by skimming the tanks. With the construction of these tanks it may be possible to let out the effluent over a longer period, so that only a small quantity passes through the stream at a time.

Dr. Hora is always an advocate for research in all its aspects, and three of his papers[9,10,11] show the great need for biological stations in India and above all urge the plea for the establishment of a fishery research institute. In post-war reconstruction a central organization to deal with the fisheries of the country is the obvious solution.

[1] *J. Roy. Asiatic Soc. Bengal, Science*, **8**, Art. No. 4 (1942).
[2] *J. Bombay Nat. Hist. Soc.*, **43**, No. 1 and No. 2 (April and August, 1942).
[3] *Rec. Ind. Mus.*, **44**, Pt. 2 (1942).
[4] *J. Bombay Nat. Hist. Soc.*, **42**, No. 2 (1942).
[5] *Rec. Ind. Mus.*, **44**, Pt. 1 (1942).
[6] *J. Bombay Nat. Hist. Soc.*, **44**, No. 1 (1943).
[7] *J. Bombay Nat. Hist. Soc.*, **44**, No. 2 (1943).
[8] *Proc. Nat. Inst. Sci. India*, **10**, No. 1 (1944).
[9] *Proc. Nat. Inst. Sci. India*, **10**, No. 1 (1944).
[10] *Proc. Nat. Inst. Sci. India*, **10**, No. 1 (1944).
[11] *Curr. Sci.* (April 1944).

CHEMISTRY IN CHINA

THE four volumes of the *Journal of the Chinese Chemical Society*[1] covering the years 1941–44 contain more than a hundred papers on all branches of the science. Many of the papers deal with problems of nutrition, vitamin content of food, fertilizers and soil types in China, and the analysis of Chinese drugs. There are investigations of the properties of vegetable gasoline made from native materials, cracking of vegetable oils, and the oxidation of natural fats and oils. The indican content of Szechwan indigo, the fixation of Chinese valonia by hide powder, and similar problems have been studied.

A large number of papers are of general chemical interest, as distinguished from those concerned with national requirements, and a very good balance is preserved between the various branches of investigation. In organic chemistry, the papers on amino-acids, the synthesis of products from ethyl alcohol, acetaldehyde from acetylene, ketones, the santonin series, enzymes and sulphanilamide derivates, may be mentioned. Several papers on analytical chemistry, including the use of the polarograph, are of interest. In physical chemistry, the papers are mostly theoretical, dealing with such subjects as ionic volumes, radii and entropies, apparent heat capacities of salts in solution, ionic polarization and refraction, electronegativity and atomic number, viscosity and critical data. Several interesting new equations are proposed relating to these magnitudes. A paper on the temperature of maximum density of heavy water fixes this at 11·21°, in good agreement with other recent investigations. There are some papers on chemical kinetics (iodine monochloride addition and unsaturated acids) and optical rotation.

The standard of the papers is high, and the record of work, some at least of which must have been carried out in difficult circumstances, is impressive. The future contributions of China to chemistry should be of great value if the present rate of progress is continued.

[1] Published by the Society. Annual subscription per volume, 4 U.S. dollars. Inquiries to Dr. F. H. Lee, College of Science, University of Nanking, Chengtu, China.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 29

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Should Engineering Concerns be Managed by Engineers?" (to be opened by the President).

CHEMICAL SOCIETY (joint meeting with the SWANSEA UNIVERSITY COLLEGE CHEMICAL SOCIETY) (in the Chemistry Lecture Theatre, University College, Swansea), at 6 p.m.—Prof. J. Kendall, F.R.S.: "The Separation of Isotopes and Thermal Diffusion".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and SOCIETY OF CHEMICAL INDUSTRY) (in the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. F. P. Dunn: "The Publications of the Three Chartered Bodies".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Brigadier Bernard Fergusson: "Beyond the Chindwin—the Wingate Expeditions into Burma, 1943 and 1944".

Tuesday, October 30

CHADWICK PUBLIC LECTURE (at the Livingstone Hall, London Missionary Society, 42 Broadway, Westminster, London, S.W.1), at 2.30 p.m.—Dr. Walter P. Kennedy: "Health Education, its Problems and Methods".*

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 7 p.m.—Mr A. Muir: "Furnace Automatic Control".

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at the Royal Technical College, George Street, Glasgow, C.1), at 7.30 p.m.—Dr. Paul Vigoureux: "Quartz Oscillators".

Wednesday, October 31

IMPERIAL INSTITUTE (South Kensington, London, S.W.7), at 3 p.m.—Dr. F. Dixey, O.B.E.: "Nigeria, its Geology and Mineral Resources".*

Thursday, November 1

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. L. Hunter: "Mesohydric Tautomerism"; Mr. A. G. Foster: "The Sorption of Condensable Vapours by Porous Solids", Part 3. Multimolecular Adsorption, Part 4. Linear Isothermals and the Langmuir Equation; Mr. A. Campbell and Mr. J. Kenyon: "Retention of Asymmetry during the Beckmann, Lossen and Curtius Changes".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Sir Arthur MacNalty: "The Renaissance, its Influence on English Medicine, Surgery and Public Health" (Thomas Vicary Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "The Anatomy and Functions of the Brain in Lower Vertebrates" (i) "Fishes".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. B. Frost and Mr. E. F. H. Gould: "Practical Aspects of Telephone Interference arising from Power Systems".

INSTITUTE OF WELDING, PORTSMOUTH BRANCH (at the Gas Company Offices, Guildhall Square, Portsmouth), at 7 p.m.—Mr. W. G. John: "Progress in the Application of Welding to Ship-building".

Friday, November 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. A. C. Hartley: "Laying a Pipe-line under the Channel—Operation Pluto".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne), at 6 p.m.—Sir Lawrence Bragg, F.R.S.: "Problems of the Metallic State" (Andrew Laing Lecture).

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, University College, Nottingham), at 7 p.m.—Prof. E. L. Hirst, F.R.S.: "Some Problems in the Chemistry of the Polysaccharides".

INSTITUTE OF WELDING, SOUTH LONDON BRANCH (at the Borough Polytechnic, Borough Road, London, S.E.1), at 7.30 p.m.—Inaugural Meeting. Mr. H. W. G. Hignett: "Some Thoughts on the Weldability of Alloy Steels".

Saturday, November 3

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Meeting of British and Austrian scientists in support of the restoration of Science in Austria.

APPOINTMENTS VACANT

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

PHOTOGRAPHER to take charge of the Photographic Department—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (October 31).

PHYSICIST to assist in work of advisory and employment service for men and women in this profession—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 473, York House, Kingsway, London, W.C.2 (October 31).

DEPUTY CITY ANALYST—The Medical Officer of Health, Department of Public Health, Kenwith Lodge, Westbury Park, Bristol, 6, endorsed 'Deputy City Analyst' (November 3).

ASSISTANT CONSTRUCTIONAL ENGINEERS by an important firm of Engineers and Contractors for service at home and abroad (should be qualified Civil Engineers with experience in Steam, Oil and Hydro Power Stations and Transmission Line Construction)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting E.1968.XA (November 5).

TEACHERS (2) OF MECHANICAL ENGINEERING SUBJECTS, and a TEACHER OF BUILDING SUBJECTS, in the Rotherham College of Technology—The Director of Education, Education Offices, Rotherham (November 5).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING, and an ASSISTANT LECTURER IN TEXTILES preferably with special qualifications and experience in Spinning—The Principal, College of Technology, Belfast (November 7).

LECTURER IN MATHEMATICS in Royal Aircraft Establishment Technical College—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting A.1143.A. (November 8).

LECTURER IN CIVIL AND MECHANICAL ENGINEERING, and a LECTURER IN THE BIOLOGICAL SCIENCES (Botany, Zoology and General Physiology)—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (November 10).

ENGINEERING ASSISTANT in the office of the City Surveyor—The City Engineer and Surveyor, Town Hall, Leicester (November 10).

LECTURER IN CIVIL ENGINEERING—By *Air Mail* to the Registrar, University of the Witwatersrand, Johannesburg, South Africa (November 12—duplicate application should be lodged with the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1).

CHIEF ENGINEERING ASSISTANT—The Chief Engineer, Southend Waterworks Company, 13 Cambridge Road, Southend-on-Sea (November 15).

CHIEF SUPERINTENDING ENGINEER (Ref. No. C.2840.XA), and a MECHANICAL ENGINEER (Ref. No. C.2842.XA), for a Paper Mill in India—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 16).

GEOLOGIST by the Geological Survey of the Sudan Government, for service in the Sudan to carry out general geological surveys and special hydrological and soil erosion studies, also supervision of water development work—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting F.5043.A (November 17).

LECTURER (full-time) IN THE DEPARTMENT OF METALLURGY of the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (November 17).

ASSISTANT LIBRARIAN in the College Library—The Registrar, University College, Leicester (November 19).

SENIOR RESEARCH METALLURGIST to the Tata Iron and Steel Company, Ltd., Jamshedpur—The Ministry of Labour and National Service, Appointments Department, A.9, Room 670, York House, Kingsway, London, W.C.2, quoting F.4979.XA (November 19).

LECTURER IN PATHOLOGY to dental students, and a LECTURER IN PHYSIOLOGY to dental students—The Registrar, King's College, Newcastle-upon-Tyne (November 24).

LECTURER IN PRODUCTION ENGINEERING, and a LECTURER-IN-CHARGE OF COAL MINING DEPARTMENT, of the Technical Education Branch, Department of Public Instruction, New South Wales—The Acting Official Secretary, New South Wales Government Offices, 125 Strand, London, W.C.2 (November 30).

TECHNICAL ASSISTANT IN THE ELECTRICITY DEPARTMENT—The General Manager, Electricity Offices, Ferensway, Kingston-upon-Hull (November 30).

RESEARCH FELLOWSHIP to be held at the Bernard Price Institute of Geophysical Research, University of the Witwatersrand—By *Air Mail* to the Registrar, University of the Witwatersrand, Johannesburg, South Africa (November 30).

LECTURER IN GEOGRAPHY, a LECTURER IN PHYSICS, and a LECTURER IN POLITICAL SCIENCE, in the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.2 (November 30).

CHAIR OF APPLIED MATHEMATICS in the University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (November 30 in Sydney).

ASSISTANT MYCOLOGIST for indexing and editorial work—The Director, Imperial Mycological Institute, Ferry Lane, Kew, Surrey.

GRADUATE ASSISTANT to teach JUNIOR MATHEMATICS in the Technical Day School and SENIOR MATHEMATICS to part-time and evening College students, and a GRADUATE ASSISTANT to teach GEOGRAPHY in the Technical Day School and Technical College, of the West Hartlepool Technical College—The Chief Education Officer, Education Offices, Park Road, West Hartlepool.

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

TEACHER OF CHEMISTRY AND ALLIED SUBJECTS, and a TEACHER OF PHYSICS, ENGINEERING SCIENCE and BUILDING SCIENCE—The Principal, Technical Institute, Tunbridge Wells.

TEACHER for the MECHANICAL ENGINEERING WORKSHOP and for MECHANICAL ENGINEERING SUBJECTS, including Workshop Technology, in the Northampton College of Technology—The Chief Education Officer, Education Office, Springfield, Cliftonville, Northampton.

LIBRARIAN (temporary) in the Department of Agriculture for Scotland—The Regional Appointments Officer, Regional Appointments Office, Ministry of Labour and National Service, 5 Rothesay Terrace, Edinburgh, quoting Ref. No. 352.M.

[*None of the vacancies in these columns relates to a Man between the ages of* 18 *and* 50 *inclusive or a Woman between the ages of* 18 *and* 40 *inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order,* 1945, *or the vacancy is for employment excepted from the provisions of that Order.*]

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars, apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

CIVIL SERVICE COMMISSION DUBLIN

POSITIONS VACANT: METEOROLOGICAL OFFICER CADET, DEPARTMENT OF INDUSTRY AND COMMERCE, DUBLIN

Applications for appointment to the above-named situations are invited from Irish nationals possessing the requisite qualifications. Application forms for and particulars of the posts may be obtained from the Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin. *Salary :* £180 a year, plus bonus of £168 18s. On satisfactorily completing a prescribed course of training extending over not less than two years, Cadets will, on fulfilment of certain conditions, be appointed Meteorological Officers on a salary scale of £200—£20—£500 a year plus bonus. *Maximum Age Limit :* 32 years on November 1, 1945, except in certain circumstances. *Essential Qualifications:* (a) 1st or 2nd class honours University degree with Physics *or* Mathematical Physics *or* Mathematics as a major subject and 1st or 2nd class honours in that subject *or* (b) 1st or 2nd class honours University degree in Mechanical and/or Electrical Engineering *or* (c) University degree in Meteorology *or* (d) a qualification equivalent to any one of the foregoing.

Latest time for accepting completed application forms : 5.15 *p.m. on November* 14, 1945.

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

RESEARCH FELLOWSHIP OF THE BERNARD PRICE INSTITUTE OF GEOPHYSICAL RESEARCH

Applications are invited from men holding the degree of Master of Science or its equivalent for a Research Fellowship to be held at the Bernard Price Institute of Geophysical Research, University of the Witwatersrand, Johannesburg. In the event of there being no suitable applicant of M.Sc. standard, applications from men with a B.Sc. degree will be considered but probably at a lesser salary than mentioned below.

The Fellowship will be tenable from the earliest date which can be arranged, for a maximum period of four years, at a salary of £400 × £25—£500 plus cost of living allowance, less a possible 6 per cent contribution from salary to the University Provident Fund. It will not be renewable beyond four years unless special circumstances arise.

The Fellow will be able to work for a Doctorate degree, but will not be permitted to undertake outside work for the sake of additional income while engaged with the Bernard Price Institute. Electronics will form a large part of the work. It is requested that applications should be sent by Air Mail to reach the Registrar, University of the Witwatersrand, Johannesburg, not later than November 30, 1945.

SUDAN GOVERNMENT

The Geological Survey of the Sudan Government requires a GEOLOGIST for service in the Sudan to carry out general geological surveys and special hydrological and soil erosion studies, also supervision of water development work. Candidates should have an Honours Degree in Geology with some research experience; a knowledge of geophysical methods of locating underground water is desirable. Age 22–45.

Salary £E.600–950 per annum (£E.1 = £1 0s. 6d.), the rate being determined according to age, experience, and qualifications. Short Term Contract (initially for two years) with possibility of extension up to five years. Free passage on appointment. Strict medical examination. At present there is no Income Tax in the Sudan. Separation or Special War Allowance payable when eligible.

Write quoting F5043A to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 17, 1945.

COUNTY BOROUGH OF WEST HAM

WEST HAM MUNICIPAL COLLEGE

Romford Road, Stratford, E.15.

Principal : H. BAKER, M.Sc., Ph.D., A.M.I.C.E., A.M.I.M.E.

Applications are invited for the following full-time post: LECTURER IN THE BIOLOGICAL SCIENCES. Subjects required: Botany, Zoology and general Physiology. Teaching of all subjects is up to Intermediate standard and in some branches to a higher standard. University Degree desired. Teaching duties include both day and evening work.

Salary in accordance with the London Burnham Technical Scale with full allowances for previous teaching and industrial experience.

Form of application and particulars may be obtained from the Principal upon receipt of a stamped addressed envelope, and should be returned so as to reach him not later than Saturday, November 10, 1945.

IRVINE G. JARDINE,
Education Officer.

UNIVERSITY OF BRISTOL

DEPARTMENT OF AGRICULTURE AND HORTICULTURE, LONG ASHTON, BRISTOL

Applications are invited for the post of CHEMIST now vacant in the Soils and Plant Nutrition Section at Long Ashton Research Station.

The appointment will be in the Scientific Officer grade under the Scheme of the Ministry of Agriculture for Research Institutes, with a commencing basic salary in the £400–£650 range according to qualifications and experience, and with bonus added.

Candidates should possess a University Degree and have had previous experience in the Chemistry of Soils and Plants.

Further particulars may be obtained from the undersigned to whom applications, together with copies of three recent testimonials, should be addressed not later than November 10, 1945.

WINIFRED SHAPLAND,
Secretary and Registrar.
The University,
Bristol.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

TRINIDAD, B.W.I.

Applications are invited for the post of Principal of the above College. Salary £1,600—£50—£1,750 with £400 allowances. F.S.S.U. Scheme. Residence and temporary cost of living bonus. Passages including wife's out and home every other year with four months' leave. Candidates should have had considerable academic experience and possess high scientific qualifications, knowledge of tropical conditions preferable. Candidate selected would be required to assume duty about August 1946. Applications should be made to and on forms obtainable from the Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London. Candidates from overseas should apply by air letter giving full particulars and naming three referees.

QUEEN'S UNIVERSITY OF BELFAST

TEMPORARY ASSISTANTSHIP IN MATHEMATICS

Applications are invited for the post of Assistant in Mathematics in the Queen's University of Belfast. The salary will be between £275 and £325 according to experience.

The appointment will be for one year in the first instance, but may then be renewed for a further two years.

Applications, with copies of testimonials and names of not more than three references and a statement when the candidate could begin duties, should reach the undersigned as soon as possible and not later than November 1, 1945.

RICHARD H. HUNTER,
Secretary.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)

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

ASSISTANT LABORATORY TECHNICIAN for the PHYSICS DEPARTMENT required immediately. Experience essential. Initial salary £3 per week. Applications giving particulars of age, qualifications, experience, etc., to be sent to the Warden and Secretary, as soon as possible.

VICTORIA UNIVERSITY COLLEGE

WELLINGTON, NEW ZEALAND

Applications are invited for a LECTURESHIP IN GEOGRAPHY, commencing salary £500 per annum plus recent increase of £75 and plus £13 cost of living bonus. Allowance for travelling expenses. Appointment will be for three years in first instance. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for receipt of applications, November 30, 1945.

VICTORIA UNIVERSITY COLLEGE

WELLINGTON, NEW ZEALAND

Applications are invited for a LECTURESHIP IN PHYSICS, commencing salary £500 per annum plus recent increase of £75 and plus £13 cost of living bonus. Allowance for travelling expenses. Appointment will be for three years in first instance. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for receipt of applications, November 30, 1945.

UNIVERSITY OF SYDNEY

Applications are invited for a LECTURESHIP IN BOTANY. Salary £400 to £600 per annum. Commencing salary being fixed according to the qualifications and experience of the successful candidate. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for receipt of applications (in Sydney) November 30, 1945.

WOOLWICH POLYTECHNIC

The Governing Body invite applications for the post of Head of the Physics, including Telecommunications, Department at the existing basic scale salary of £480—£25—£600, and this scale is subject to revision under the new Burnham scale.

Particulars of the appointment and forms of application may be obtained from the Secretary, to whom they should be returned by November 22, 1945.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER IN MECHANICAL ENGINEERING. Stipend £350 per annum. Duties to commence December 25, 1945. Applications must be sent if possible by November 5, 1945, to the Registrar, the University, Manchester 13, from whom further particulars may be obtained.

Finsbury Borough Council invite applications for the appointment of LABORATORY TECHNICIAN (Public Health Department). A knowledge of Public Health Bacteriology (including milk examinations) and/or Clinical Pathology required. The qualification of the Institute of Medical Technology (or its equivalent) desirable. Salary according to the scale of the Hospital Staffs Joint Committee, commencing at £300 per annum *inclusive* of cost-of-living bonus. Forms of application may be obtained from the Town Clerk, Finsbury Town Hall, Rosebery Avenue, E.C.1, within fourteen days from the date of this advertisement.

Lecturer in Mathematics required in Royal Aircraft Establishment Technical College. Candidates should hold good honours degree and have considerable teaching experience. Required to teach mathematics up to Higher National Certificate in Engineering and the A.F.R. Ae.S. examination. Research or industrial experience an advantage. To take up duties as early as possible.

Salary payable will be in accordance with that of the Burnham (Technical) Scale for responsible assistants with a special responsibility allowance and subject to the Teachers Superannuation Acts.

Write quoting A. 1143 A. to the Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by November 8, 1945.

An Assistant Secretary is required in the offices of a Chartered Scientific Society in the Central London area. Preference will be given to graduates with science degree. Consideration will also be given to applicants awaiting release from H.M. Forces. Salary £300–£350 according to qualifications and experience, with superannuation. Applications in writing should be addressed to Box 426, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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