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CONTROL OF SCIENCE IN GERMANY

ON two successive days, May 29 and 30, Lord Cherwell was called upon in the House of Lords to reply on behalf of the Government to inquiries dealing with the control of scientific development in Germany, with special reference to applications in warfare. Such inquiries are evidence of the keen interest which is being taken in this topic, and should be welcomed since they made it possible to give authoritative assurances and also dispose of some of the more alarming apprehensions of which we have heard so much in the past few months.

The first inquiry, general in character, came from Lord Vansittart. He said that unless strict control be maintained over scientific developments in Germany, there will inevitably be developed even more potent 'secret' weapons than those from which we suffered in recent months. Provision should also be made to guard against other countries, whether Allied or neutral, granting Germany permission to use devices developed by them which were potentially dangerous. He therefore advocated the control of all German laboratories, university and industrial, through an extensive and intensive intelligence service provided from the United Nations. In addition, Lord Vansittart suggested the formation of a civil inspectorate, which might in time become a world inspectorate on the watch for the development or over-development of secret devices likely to be turned against mankind. Without some such safeguard, he predicted that nations would quickly become involved in a secret armaments race more terrifying than any previous such race. Lord Vansittart therefore asked the Government to take the initiative in proposing the inclusion in the terms to be imposed on Germany of an article providing for an inter-Allied committee of scientific men to examine and control, and if necessary prohibit, the use by Germany of any scientific invention or discovery considered likely to be dangerous to the safety of mankind.

Lord Strabolgi supported this view, and suggested that similar action should be taken against Japan. Incidentally, he suggested that Lord Vansittart gave the impression that it was the discovery of new weapons which makes wars. This would put the responsibility for war on scientific men and inventors; this, as Lord Strabolgi commented, is incorrect. The worst that can be said of men of science in this connexion is that they are coerced or persuaded or bribed into helping the real war-mongers.

The second inquiry, more specific in character, came from Lord Brabazon, who discussed particularly the so-called directed missiles, the flying bomb and the rocket. The engine of the flying bomb, he said, developed 350 h.p. and cost about £15, while the rocket is capable of immense development —"the physicist's dream or nightmare". He believes that the policing of Germany will be relatively easy for ten years, after which troubles will begin to arise. The technique of rocket propulsion is bound to develop, and he drew a vivid picture of a future power secreting long-range rocket weapons, with new

explosives and new powers of control, and unleashing them swiftly against the great cities of its enemy with terrible effect before armies could be assembled. He therefore suggested the constitution, as a part of the peace organization, of an international committee of inspection with power to enter works anywhere in the world. There are, he said, only two alternatives : to push on vigorously, in combination with the United States, the development of this technique in order to obtain a lead over the rest of the world ; or to invent such machinery of inspection as may be necessary to prevent development.

The story was taken up by the Earl of Darnley, who painted a gruesome picture of the war of the future, in which the fighters would be bands of troglodytic alchemists dealing out death to millions. He also referred to the atomic bomb, which he said was almost ready at the end of the War. Any future war might last only a few minutes, and might end before survivors knew what had happened. The development of such engines of war would lead to the extermination of the human race. Lord Darnley's address reminded one of H. G. Wells' "War in the Air", revised and with a modern setting.

Lord Cherwell's replies set out the Government's policy and also provided a survey in general terms of the problem of secret weapons and related topics. He said that the Government appointed a committee of scientific men a year ago to consider the whole question of the future of scientific research in Germany, and that a report of its preliminary conclusions will shortly be ready ; "the Government," he said, "will certainly give the greatest weight to them." Any proposals, however, must be discussed with our Allies, and a concerted policy agreed upon. A scientific and technical staff has been attached to Supreme Headquarters of the Allied Expeditionary Forces for some time, the duties of which have been the examination and control of German activity in these fields. All German activities, including scientific work, will come under the Control Commission. It would be premature, in the Government's opinion, to make specific proposals for inclusion in any eventual peace treaty. He assured the House, however, that the Government intends to see that scientific men will continue to play their part both in disarming Germany and securing the future against the use of scientific developments by that country for war-like purposes.

In discussing the general problem of secret weapons, Lord Cherwell gave a well-balanced account of the approach from a scientific point of view. The problem is a grave one, as he admitted, but spectacular or unexpected results must not be allowed to outweigh the conclusions of careful investigation. In the first place, Lord Cherwell said that a distinction should be drawn between pure science and its applications ; in the former, the Germans are definitely behind the leading Allied nations ; in the latter, they have maintained a high reputation, due largely to their methods of training. But the new German weapons of war, while they were well-executed pieces of engineering designed for a particular purpose, did not involve any new scientific principle. Radiolocation is an application of the experimental fact, known for the past fifty years, that a metal object scatters electromagnetic waves ; and many nations, including the Germans, applied themselves to its development as a means of detecting aircraft at night. German engineers produced a workable method, but it was not so efficient as that developed in Great Britain.

Dealing with Lord Vansittart's suggestion for an international scientific committee for the investigation of developments in German laboratories, Lord Cherwell pointed out the difficulty of deciding at what stage a scientific discovery might be considered as likely to be potentially dangerous in unscrupulous hands. Thus, in the investigation of electromagnetic radiation, supposing such a committee had been in existence when their existence was predicted by Clerk-Maxwell, would it have been able to act immediately ? Or would it have deferred action until Hertz detected the radiation a few years later, or when Marconi demonstrated its commercial use, or when broadcasting was in its infancy ? Another example quoted by Lord Cherwell to emphasize his contention was the discovery by Elster and Geitel that a negatively-charged plate of zinc loses its charge when ultra-violet light impinges on it. This effect is the basis not only of the talking film, but also of modern instruments for measuring the velocities of shells and bullets. Indeed, it is a truism to say that no one can foresee all the possibilities of a scientific discovery, and Lord Cherwell clearly does not believe that an international committee of investigation would be of much value. Nevertheless, as has been said above, he stated that the Government intends to pay adequate attention to scientific aspects of control.

Lord Cherwell re-affirmed this point in his reply to Lord Brabazon, before passing on to deal specifically with the question of long-range weapons. He pointed out that range is not the only consideration in warfare. The R.A.F. produced a pilotless aircraft some years ago, he said, but development was stopped because it was found that the weapon was not accurate enough to hit the kind of targets with which we were likely to be concerned. London is a unique target with about 700 square miles of built-up area and within a hundred miles of a foreign coast-line ; and the Germans considered it worth while to attempt the kind of random bombardment which the use of such weapons involves. The only guided missile described during the War was the wireless-controlled glider bomb used by the Germans against shipping.

Some interesting figures were given by Lord Cherwell about the cost of production of long-range weapons. He equated one bomber to a hundred 'flying bombs', and bearing in mind that the range of the latter was about 140 miles and its accuracy less than a tenth of that of a bomber, it was clearly an uneconomic weapon. The rocket, *V*2, is believed to be even more uneconomic, for Lord Cherwell said that it probably cost twenty times the number of man-hours to produce. Granting that the bombardment with flying bombs and rockets caused much

suffering, they can only be used against a target area of large dimensions, and the cost of production in man-hours can generally be spent to more effect on the manufacture of bombers. The total weight of the war-heads of flying bombs which crossed the English coast during three months was less than 6,000 tons, and about half of these bombs reached the London area ; in seven months of bombardment by rockets, about 1,000 tons of war-heads reached England, and again about a half reached London. Against such figures can be put the facts that the R.A.F. was able to drop nearly 5,000 tons in a single attack, in many cases with half of the bombs within a mile of the target ; and that the attack could be launched on any city in Germany.

If, however, the anti-aircraft defences of a country should be developed to the point when it became exceedingly dangerous for bombers to fly over it, then there would be a case for long-range weapons. But the very length of range militated against their accuracy. The only means known at present of guiding such missiles to their targets is radio, and very elaborate anti-jamming devices would be essential. Moreover, the greater the distance from the firing point, the greater the efficiency of jamming ; half-way along its trajectory, the guiding transmitter and the jamming devices might have equal power, but at three-quarters of the distance or range, the jamming might have a ninefold superiority, and so on.

Lord Cherwell also referred to the possibility of utilizing atomic energy. He stated that there has never been an instance of the experimental disintegration of an atom without a collision of one of the bombarding particles and the nucleus of an atom ; and there is no reason to think that the disintegration would extend to ordinary matter, thus bringing about the explosion of the whole earth.

Nevertheless, Lord Cherwell said that unless the nations could agree on some form of limitation of weapons, their range and lethality would undoubtedly increase, and we in Great Britain have the most to lose by this. He therefore insisted that, until an international organization can guarantee our safety, we must keep ahead in all scientific and technical devices of warfare, and the Government would spare no effort to do so.

Lord Cherwell's statements will be widely welcomed. They dealt with the question of the 'terror' weapons used by Germany against the background of warfare in general and bombing by piloted aircraft, demonstrating effectively the relative superiority of the latter for large-scale effects. Nevertheless he conceded the possibilities of development, to guard against which intense scientific effort will be necessary. This will apparently take two forms : the strict control of German laboratories, and increased activity in our own. But the first step will be consideration of the report of the scientific committee discussing scientific research in Germany. It is to be hoped that the general conclusions of this committee, if not the whole report, will be made available for discussion, for it will be a document of the greatest interest to scientific workers.

MEDIEVAL ORNITHOLOGY

The Art of Falconry

Being the "De Arte Venandi cum Avibus" of Frederick II of Hohenstaufen. Translated and edited by Casey A. Wood and F. Marjorie Fyfe. Pp. cx+637 (186 plates). (Stanford University, Calif. : Stanford University Press ; London : Oxford University Press, 1943.) 60*s*. net.

IT will scarcely be questioned that this work of the great Roman Emperor, the founder of the University of Naples in 1224, is one of the most remarkable scientific documents which have come down to us from the Middle Ages. Having said this, it is astonishing to have to add that the present edition is the first appearance of the complete work in print in any language. We owe this tardy recognition to the devotion and learning of the senior translator, Dr. Casey Wood, the founder of the Wood Library of Ornithology at the McGill University, Montreal. The fact that there is a widespread revival of interest in Frederick's researches in ornithology is the achievement of another distinguished American scholar—the late Prof. C. H. Haskins. What is needed now is the publication of a standardized Latin text collated from all the known manuscripts ; but the task would be long, arduous and costly.

The first printed version of 1596 in Latin is by Marcus Velser and is based on the incomplete Vatican manuscript. It includes only Book 1 and the first thirty chapters of Book 2, and also lacks nine chapters of Book 1. These missing chapters, however, are to be found in the thirteenth-century Bologna manuscript, which is the earliest version of all six books, and was therefore (in conjunction with the Vatican manuscript) employed as the chief source of the present translation. The second Velser edition of 1788–89, by the zoologist J. G. Schneider, is particularly valuable on account of the commentary and notes of its distinguished editor. Both these Latin texts are exceedingly rare, especially the latter. The only other printed editions are two German translations of Velser's text.

It is generally agreed that Frederick is the author of the original work, and he may even have been its scribe and illustrator. It was written after some thirty years of preparation between 1244 and 1250, and it terminates abruptly at Chapter 34 of Book 6. He mentions his intention of writing a section on the diseases of birds, which, if written, has not survived, and as he himself died in 1250 it seems certain that the work was never completed.

The present volume includes an annotated, illustrated English translation of the complete Latin text, based on a comparison of the twelve available manuscripts in European libraries, a chapter by the English zoologist Cresswell Shearer on the castles and hunting lodges of the Emperor, appendixes on various topics of practical and historical importance to falconers, an annotated list of the birds mentioned and figured by Frederick, and an admirable critical bibliography of ancient and modern falconry, together with a glossary and index. The book is lavishly illustrated, and the Stanford University Press has demonstrated that typography of the highest class is still possible in America in war-time.

The Emperor stands out from his contemporaries as an original thinker and observer. The methods of the scholastics, which at that time were coming into dangerous prominence, were rejected, and he saw

that science could advance only by research. Shearer rightly claims that the "De arte venandi" is the "first zoological treatise written in the critical spirit of modern science". Thus, for example, the barnacle goose myth is methodically investigated by Frederick, and dismissed as a superstition based on ignorance of the real nesting places and fledglings of this bird, but none the less the superstition survived until the eighteenth century*. Nor does the Emperor confine his studies to the falcons used in hunting. He is interested in birds generally, and his work must be regarded as the first generalized treatise based on original investigation of the species, habits and structure of birds. His philosophical outlook is that of the teleologist, who interprets adaptations as evidence of an ordered and designed world into which the peculiarities of avian structure must, and can, be fitted in.

The part of Frederick's work relevant to the interests of this journal is Book 1, which deals with the biology and anatomy of birds, especially, but by no means entirely, of the species employed in hunting. Particular attention is devoted to external characters, habits of feeding, reproduction, and locomotion in all its forms. A comprehensive account is given of plumage, how and when it is moulted and the different types of feather, with their distribution over the body and their functions in the general economy of the bird. The ala spuria, with its four plumæ pollicis, is described. He mentions, and evidently saw, a single bone only in the ala, but the present translators render this passage in the plural, which is correct as a statement of fact but is not what the Emperor wrote. Frederick's views on the function of this part are fanciful and strange even for his own time.

The Emperor's discussion of his researches on the problems of bird migration is admirable and detailed, although he could not be expected to have deduced or guessed the historical setting of avian migration. He distinguishes several geographical and climatic types of the phenomenon, and he also perceives that the colder of the two climates inhabited by a migratory bird, namely, that in which it nests, must be regarded as its original home. His anatomical notes, if somewhat scanty, include some interesting and acute observations. He describes the nictitating membrane of the eye—previously, however, known to Aristotle—and appears to have seen parts of the osseous labyrinth of the ear. His account and interpretation of the skeleton of the wing is on the whole sound, but his *tour de force* is a comparison of the skeleton of wing and leg. Here, basing his conclusions on the limb skeletons of various birds, he correctly homologizes, and for the first time, the bones of the leg, and avoids the pitfall of regarding the tarso-metatarsus as the shin bone. Other features in the anatomy of birds known to Frederick are the muscles of flight, the distinction between the stomachs of carnivorous and graminivorous birds, the uropygial gland, the sinus rhomboidalis of the spinal cord and ventricles of the brain, the hyobranchial apparatus, the absence of an epiglottis, the aperture of the Eustachian tubes, the absence of the gall bladder in some birds and of the urinary bladder in all, and the fact, known to Aristotle, that the rectum and urogenital ducts open into a common chamber or cloaca. The Emperor also describes the looping of the trachea in the sternum of the crane, which he associates with the production of the deep call of this bird, and he noted that the pairs of spinal nerves emerged from the backbone between contiguous vertebræ.

We have checked the translation against Velser's printed text only in those cases where the rendering was obviously open to question. Even this, however, could not always be done, owing to imperfections in the Vatican manuscript which was the version transcribed by Velser. The statements that "sterile eggs . . . lack the activating male spermatozoa", and that impulses are carried to all parts of the body by "motor and sensory nerves" scarcely suggest an original written in the thirteenth century. The "viæ deferentes" are obviously the ureters, and not the uriniferous tubules, which Frederick could not possibly have known. In Chapter 44 the translators imply that the Emperor described a pair of ovaries in birds, whereas he distinguishes between the sexes by using the plural in his account of the male, and the singular in that of the female. It is clear that he was familiar only with the functional left ovary and oviduct present in most birds.

Dr. Casey Wood did not live to handle the beautiful volume he had wrought so hard, and for so long, to perfect; but the work itself remains as a lasting monument to his memory. F. J. COLE.

* In his fascinating book on the barnacle goose, Heron-Allen states that Frederick does not mention the myth, but this is an error traceable to the printed text which lacks the chapter in question.

MEDICINE IN THE TROPICS

Tropical Medicine

By Sir Leonard Rogers and Sir John W. D. Megaw. (Churchill's Empire Series.) Fifth edition. Pp. x+518. (London: J. and A. Churchill, 1944.) 21*s*.

A GOOD indication of the value of this book is the fact that five editions of it have appeared since 1930 and that two editions have been required since the third edition in 1939. Originally the book was written for the general practitioner in the tropics, rather than for the specialist with up-to-date laboratory facilities at his disposal. The aim of the authors was to provide a small and handy book which would give a broad survey of the field of tropical medicine and yet would deal adequately with the diagnosis and management of diseases commonly encountered in the tropics and subtropics, with such methods of microscopical study and laboratory diagnosis as the general practitioner could carry out by himself. Such a book could only be written satisfactorily by authors with wide experience of the practice of medicine in the tropics who also had the power of communicating their experience to others and the judgment necessary for the wise selection of the essentials.

It would be difficult to find anyone who possesses these qualities in greater degree than do Sir Leonard Rogers and Sir John Megaw. They have produced a volume which is both a general introduction to this fascinating subject and a practical guide of great value. It is likely to have greater value in the future; for the wide dissemination of Allied troops in tropical countries during this War carries with it a risk of the spread of tropical diseases both to areas within the tropics and sub-tropics and to non-tropical countries. The control of this risk has already required the creation of a considerable organization, and in this control the general practitioner must play an essential part. As the authors of this book point out, successful treatment of tropical diseases—and indeed of all

diseases—depends upon early diagnosis ; and prevention of them is no less dependent on this. The general practitioner therefore mans the front-line observation post upon which the artillery of preventive medicine relies. He will find in this compact and authoritative volume an invaluable source of the accurate information which he must have.

In this fifth edition no change has been made in the plan and scope of the book ; its size has not been increased ; it is, in fact, a few pages smaller ; but many pages have been entirely rewritten, especially the chapters on malaria, kala-azar, trypanosomiasis, the fevers of the typhus group, leprosy and the dietetic diseases. Although the results of much modern work have been included, the book evidently went to press just too early for the inclusion of any reference to the remarkable success of D.D.T. for the control of the lice which transmit epidemic typhus fever (cf. *Nature*, 154, 600 ; 1944). Possibly much more information than can at present be released about the uses of D.D.T. will be available for a post-war edition in which it will, we may hope, be possible to include also valuable data obtained during the War which is not yet available for general publication. The possible value of penicillin for the treatment of typhus fever and other Rickettsial diseases is mentioned in the addendum on the treatment of louse typhus at the end of the book. Incidentally, the chapter on the febrile diseases caused by Rickettsia bodies is one of the most clearly stated short accounts that we possess of the essential differences between epidemic and endemic, louse-borne typhus (including Brill's disease) on one hand and, on the other, the non-epidemic, zootic typhus fevers (murine endemic flea-borne typhus, tick-borne Rocky Mountain spotted fever, the mite-borne Japanese river fever which is also called tsutsugamushi or scrub-typhus and the other types of tick-borne and mite-borne fevers which resemble typhus).

The section on dietetic diseases is introduced by a chapter on dietetic errors in the tropics which should be read by all who contemplate going there. These chapters on the dietetic diseases and the chapter on the effects of such climatic factors as sunlight and heat, with the wise advice given on the methods of combating the tropical climate by means of clothing, modern methods of cooling and so on, should enable visitors to the tropics to avoid lowering their resistance to tropical disease or becoming victims of the direct action of climatic factors themselves. Only those who have lived in the tropics can appreciate the importance of this kind of personal and general hygiene. Another valuable chapter, by Sir Leonard Rogers, compares the incidence in Calcutta and London of general diseases which are encountered all over the world, so that the reader can form an idea of what he is to expect apart from tropical diseases themselves. The importance in the tropics of these non-tropical diseases is often underestimated. The extreme importance of the problem of tuberculosis in India, for example, has been only recently realized. Sir John Megaw adds a section which amplifies the conclusions drawn by Sir Leonard Rogers. He discusses beriberi, pellagra, and nutritional anæmias, epidemic dropsy and other conditions due to faulty nutrition. One small paragraph in this section reveals the need for vigorous action for the betterment of the nutrition of tropical peoples. Dietetic malnutrition, Sir John considers, is the most important of all the tropical diseases. It causes lifelong disablement of hundreds of millions of people, and is indirectly responsible for millions of deaths every year. It is so common in some parts of the tropics that it is regarded as the normal condition of the people. The extensive planning of world civilization in the future which is now going on should make sure of the removal of this kind of underlying cause of disease. It is, as the careful rationing system in Britain during this War has shown, by no means confined to the tropics.

Many general practitioners will find useful the final chapters on the use of the microscope and on diagnosis. If they add to this book the study, suggested by its authors, of the *Tropical Diseases Bulletin*, they should be well supplied with up-to-date information. For the abstracts of world literature printed in the *Tropical Diseases Bulletin* are unique in that they are the critical work of experts, among whom are the authors of this book, so that they form a supplementary text-book which is continually being brought up to date.

G. LAPAGE.

CHEMISTRY OF MILK AND MILK PRODUCTS

A Textbook of Dairy Chemistry

By Edgar R. Ling. Second and revised edition. Vol. 1 : Theoretical. Pp. vii+196. (London : Chapman and Hall, Ltd., 1944.) 13*s*. 6*d*. net.

JUNIOR students of dairy science are at present ill-provided with competent, up-to-date text-books. The War has doubtless been responsible for the lag in getting the results of the considerable advances of recent years into a form useful for the younger student.

In dairy chemistry the situation is now much easier than in dairy physiology or dairy husbandry. We have the thorough revision (1942) of Richmond's "Dairy Chemistry" by Elsdon and Walker, a valuable text with a strong analytical flavour, and now the volume under review, written by one of our most experienced teachers of agricultural chemistry. The present edition is a fairly complete revision of the theoretical part of his 1930 volume.

It is a straightforward, sensible handbook for students of intermediate grade, is well documented and demands no more than a fair elementary acquaintance with chemistry. Careful thought has clearly been given to providing a simple yet accurate, readable and up-to-date presentation.

Nevertheless, in one or two places revision has faltered. The table on p. 55 purporting to show the vitamin content of various types of milk and dairy products certainly requires overhaul. Instead of indicating vitamin content by vague adjectives such as 'good', 'fair', 'slight', etc., use should be made of the range of quantitative data now available (in μ gm. or in international units) for most, though not yet all, dairy products. One could also have wished that the paragraph on the effect of heat on milk had been brought closer to date and that recent sources had been quoted, though the author does in fact reach the right conclusion in his final sentence (p. 109). These small blemishes are perhaps the more evident since the background is generally so well informed.

The book can confidently be recommended to dairy diploma students and to those engaged in the dairy industry who require a sane and dependable chemistry text-book.

H. D. KAY.

Catalogue of Lewis's Medical, Scientific and Technical Lending Library

Part 1: Authors and Titles; Part 2: Classified Index of Subjects, with Names of Authors who have written upon them. New edition, revised to the end of 1943. Pp. xiii+928. (London: H. K. Lewis and Co., Ltd., 1944.) To Subscribers, 12*s*. 6*d*. net; to non-Subscribers, 25*s*. net.

THE difficult task of cataloguing the great variety of scientific books in this remarkable library has been well done. Probably the most difficult part of it was the compilation of the subject index (Part 2). This section indicates the wide range of the library, for the headings in it extend from chemistry (9½ pages) to travel, and from sugar to suicide. It covers, in fact, practically the whole range of science. Together with the alphabetical list of subject headings, it forms a valuable reference list of the authors of important works on the various branches of science up to the end of 1943. Subscribers receive, each month in normal times and quarterly at present, lists of new books and editions added to the library, which keep them in touch with new publications.

It is not surprising that "Lewis's" is used by scientific workers of very varied interests and by book clubs, medical and scientific societies and by the research departments of many industrial organizations. The preface to this catalogue suggests that we owe the foundation of "Lewis's" to Carlyle, whose complaints about the loss of time involved in waiting for books at the British Museum gave us the London Library as well; so "Lewis's", originally mainly medical, came into being and now provides a unique general science library service which has features no other scientific libraries possess. The subscriber will not, however, be able to borrow scientific books in foreign languages, unless these have been translated. Many subscribers have hoped, and still hope, that it will eventually be possible to remove this restriction.

It is never easy to assess in a few words any library service. So much depends upon atmosphere, the spirit of service and the willing co-operation of the borrower in seeing that the necessary rules are obeyed. But the long experience and wise management of "Lewis's" have surmounted the potential causes of complaint and failure. This catalogue is, incidentally, a tribute to their quality as publishers. It is yet another example of the high degree of attractiveness, utility and good printing which can be attained under the authorized economy standards of war-time book production.

The Natural Order

Essays in the Return to Husbandry. By Edmund Blunden, H. J. Massingham, B. D. Knowles, Philip Mairet, Philip Oyler, L. F. Easterbrook, C. Howard Jones, J. E. Hosking, Lord Northbourne, Michael Graham, Rolf Gardiner, Adrian Bell, C. Henry Warren, the Earl of Portsmouth. Edited, with an Introduction and Notes, by H. J. Massingham. Pp. vi+178. (London: J. M. Dent and Sons, Ltd., 1945.) 7*s*. 6*d*. net.

THIS volume, containing some fourteen essays, has been written by lovers of the country, its agriculture, rural tradition, and way of life. No doubt it will be read with pleasure and approbation by those of kindred mind: it *should* be read seriously by a much wider section of the community, in particular by those who, by political action, mould the national way of life. It may be argued, of course, that there is a sense in which everything that man does is part of the natural order. But the meaning intended is made quite clear in the introduction and in the integrated series of essays presented. The basic plea is for a return to good husbandry, for a personal understanding of the land, and a knowledge of how it should be used so that its fertility may be conserved and used to best advantage; it is a plea for good work performed for its own sake and because it is part of a good way of life; it is a plea for the retention of a civilization that is rapidly being submerged in the modern mechanized, urbanized development; above all, it is a plea for the fair treatment of the land (and those who work on it) on which so much that is good in our national life depends. The theme is fully explored in essays contributed by authors each with particular experience of his own subject. Here and there, no doubt, there are evident overstatements, and occasional pseudo-scientific assertions which would have been better omitted. But these can well be overlooked in a book that is so unmistakably sincere. More is the pity that so much that could be ideal in life is unlikely to be realized.

The British Journal Photographic Almanac and Photographer's Daily Companion

With which is incorporated the Year Book of Photography and Amateurs' Guide and the Photographic Annual, 1945. Edited by Arthur J. Dalladay. Pp. 388+31 plates. (London: Henry Greenwood and Co., Ltd., 1945.) Paper, 3*s*. 6*d*. net; cloth, 5*s*. net.

THE "British Journal Photographic Almanac" is one of those books that few photographers can afford to be without. This applies to all those who handle cameras or photographic materials, whether they be amateurs or professionals, interested in pictorial photographs or research involving the use of light-sensitive materials. The volume is published annually and, while much of the contents is little changed from year to year, a series of up-to-date articles forms an important feature of each issue. This year there is an editorial which deals with the development of photography from the days when all photographers started by serving an apprenticeship to learn the technique, until to-day when photography is being used more and more for scientific purposes where a knowledge of the behaviour of photographic materials is a necessary preliminary. The plea is for the professional photographer of the future to learn more of the science of photography and rely less on rule of thumb methods. Is it not even more important that the would-be research worker should be taught more of the science of photography so that he can, should the need arise, use photography intelligently as a tool to assist his research?

Other articles of interest are "Photographic Dermatitis" in which the requirements of preventive ointments are considered and formulæ given for various preparations; "Colour Photography Practice" deals with the pre-war, war and post-war periods in the principal countries, mainly from the point of view of the commercial and advertising trade; "*p*H Measurement by Indicators" is written for photographers and deals with the subject from the point of view of photographic solutions. The remainder of the volume is taken up by formulæ, general information, advertisements and illustrations, etc., so well known to those familiar with previous issues of the almanac.

ISOLATION OF THE MAMMALIAN COLOUR RECEPTORS WITH MICRO-ELECTRODES

By PROF. RAGNAR GRANIT

Nobel Institute for Neurophysiology, Karolinska Institutet, Stockholm

IN 1943 I gave a summary[1] in *Nature* of my analysis of the retinal colour receptors isolated with micro-electrodes on the optic nerve reached from the inside of the opened bulbs of various light-adapted animals, anæsthetized or decerebrated. Two types of responses were found to be represented by single fibres : narrow bands of sensitivity located in three preferential regions of the spectrum, 0·600–0·580 μ (red-yellow), 0·500–0·540 μ (green) and 0·460 μ (blue). These were called *modulators*. In addition, there was a broad band, called the *dominator*, with maximum at 0·560 μ, and a distribution of sensitivity corresponding to the human photopic luminosity curve. The dominator was held to mediate the sensation of white. The modulators were located by a 'chance method' of surveying a large number of light-adapted retinæ. It seemed desirable to check these results by devising a method for removing this element of chance, and at the same time to find out whether the dominator could be regarded as the sum of a number of modulators. To this end a method of selective adaptation was employed. The new results obtained will now be briefly summarized. They represent my general solution of the problem and have confirmed and extended the earlier results.

Decerebrated cats were used as experimental animals. A special colorimeter, designed by Dr. W. D. Wright of the Imperial Institute of Science and Technology, on the principles of his own well-known instrument[2], and constructed by Mr. G. C. Newton, was used for stimulation. In such experiments the micro-electrode records the impulses from a convergence unit of the type shown to the right of Fig. 1. There are connected to the same optic nerve fibre receptors which contain merely visual purple and receptors containing other colour-sensitive substances. The number of receptors is probably very much larger than in the diagram and the proportion of the two types is unknown and variable. In the dark-adapted state the highly sensitive visual purple completely dominates the results and gives the curve P (Fig. 1), based on some 1,320 readings, averaged into 179 values, again averaged to give the large circles around the curve. The small black points are Lythgoe's[3] corrected curve for visual purple absorption, which is a little too low in the violet, as shown by Schneider, Goodeve and Lythgoe[4]. A slight effect of the dominator makes my curve a little too high in the yellow-red region.

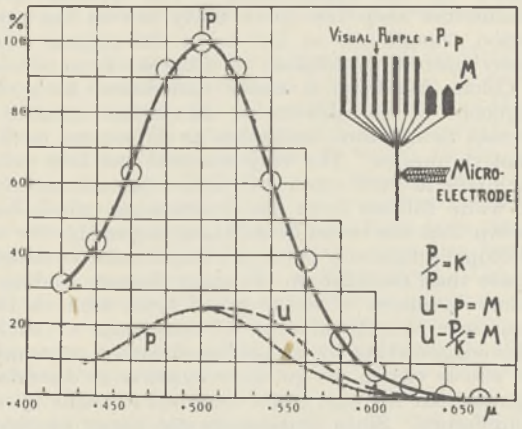

Fig. 1. MICRO-ELECTRODE RESULTS FOR DARK-ADAPTED CAT. Large circles, averages for spectral sensitivity of dark-adapted cat's retina. Small black circles, Lythgoe's[3] corrected curve for visual purple absorption. For significance of symbols and p- and U-curves, see text. Spectrum of equal quantum intensity. Diagram to the right illustrates convergence element picked up by micro-electrode on the optic nerve.

If the eye be adapted to red, blue or green light, the curve P is reduced to p, by proportionate ordinates at all wave-lengths, since P represents a homogeneous substance. Hence

$$P/p = k \quad . \quad . \quad . \quad . \quad . \quad (1)$$

But if there are any other colour-sensitive substances (M), *preformed* or produced by visual purple, curve P does not drop to p but to some other curve U (Fig. 1). The modulators M are given by the difference between U and p, as evident from the diagram, or

$$M = U - p \quad . \quad . \quad . \quad . \quad (2)$$

In this case p is unknown, but the equation can be solved by giving it the form

$$M = U - P/k. \quad . \quad . \quad . \quad (3)$$

P is obtained *before*, U *after*, selective adaptation, and k can be obtained from (1) by finding the spectral region in which selective adaptation has caused the largest drop of sensitivity, since in this region there was no substance other than visual purple to resist adaptation. This region will generally be found in the place where the letter p is inserted in the diagram (Fig. 1). All quantities of (3) are now known and the argument can be tested by experiment.

Equation (3) was solved in thirty-four experiments on the basis of some four thousand observations collected in 601 points on U-curves. Some 60 per cent of the U-series referred to isolated fibres, the rest to restricted activity. In 29 per cent the equation came out zero ($U = p$) and hence the micro-electrode had struck a unit with pure visual purple receptors. In the rest of the series the characteristic narrow modulator bands of sensitivity were obtained. Red adaptation gave green and blue modulators (the red ones wholly suppressed), blue adaptation merely red modulators, green adaptation gave red, blue and green modulators.

The averaged modulators are shown in Fig. 2, in which the outer contours indicate the dispersion. The narrow red modulators were of two types with maxima at 0·600 μ (red) and 0·580 μ (yellow) respectively, the former type more common. Most green modulators overlapped and had maxima at 0·540 μ, some at 0·520 μ, and two of them were of the type previously described as narrow visual-purple curves. These may be lacking in pure cone eyes. All these modulators have been seen before in different types of retinæ, analysed by the earlier 'chance' method[1]. Most blue modulators had their maxima at 0·460 μ (blue), one at 0·440 μ (violet). They were very narrow bands. Errors of measurement increase from red to the blue end. On account of the steepness of the modulator curves the maxima are fairly well definable.

The averaged modulators of Fig. 2 are too narrow to add up to a cat dominator. It is clear that impulses also must be delivered up the optic nerve by modulators with 'legs' outside the averages. The

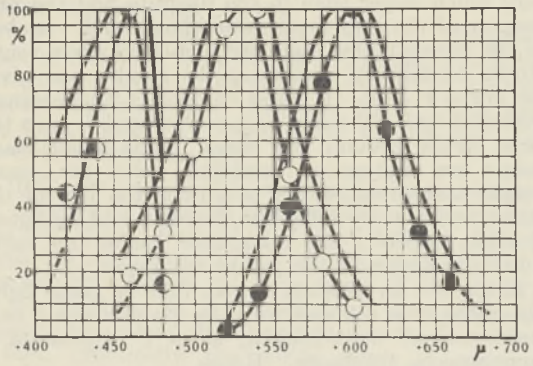

Fig. 2. AVERAGES OF INDIVIDUAL MODULATORS IN THE THREE PREFERENTIAL REGIONS.
Outer contours indicate dispersion. Spectrum of equal energy.

greater the number of modulators added, the greater has to be the spectral area allotted to each preferential region. In Fig. 3, I have synthesized the cat's dominator, as obtained experimentally with single fibres some years ago[5]. This has a hump at 0·600 μ. The circles refer to the readings, the thick line to the theoretical curve obtained by adding the *R* and *G* curves. It is a remarkable fact, demonstrated by Wright[6], that if the human photopic luminosity curve be determined with a sufficiently small stimulus, imitating the micro-electrode recording, it too has a hump around 0·600 μ, and, in fact, fits my synthesized curve for the cat almost exactly.

In Fig. 4, I have synthesized the human photopic luminosity curve with three 'fundamental sensation curves' for *R*, *G* and *B*, and indicated the red and yellow modulators adding up to the *R* curve. These fundamental sensation curves correspond fairly well to those recently obtained by Walters' on the human eye. In his work will be found a summary of the earlier attempts to define the fundamental sensation curves.

Now these fundamental sensation curves do not exist, except as mathematical entities. Nature uses a six- or seven-colour mechanism made up of narrow modulators, two red, two blue, two or three green. In addition, many of these modulators form fixed groups responding as *functional units* with the dominator distribution of sensitivity. Despite considerable

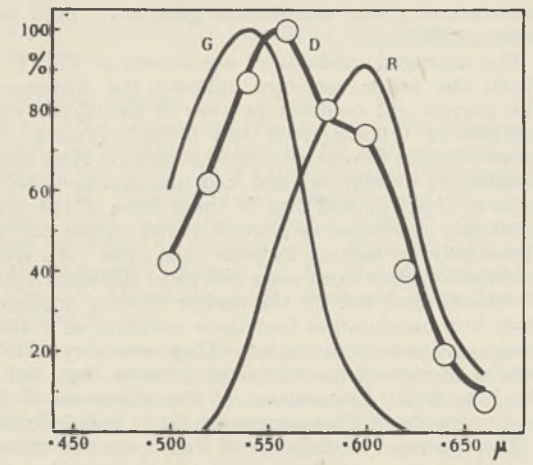

Fig. 3. CIRCLES, AVERAGES OF FOUR PHOTOPIC DOMINATORS OF CAT. Curve *D*, synthesis of cat dominator by adding grouped modulators in the red (*R*) and the green (*G*) and plotting their sum in per cent of maximum. Spectrum of equal energy.

experience in recording from single fibres, I have never seen three 'fundamental sensation curves', but merely dominators and the narrow modulators localized at the three preferential regions. The trichromatic theory is therefore to be regarded as a convenient first approximation expressing the spectral areas covered by the three groups of modulators in terms of gross averages.

The existence of families of modulators, located in three preferential spectral regions, makes the extraordinary capacity of the eye to discriminate colours intelligible. In Fig. 5, Wright and Pitt's[8] measurements of colour discrimination are found. These show maxima of discrimination (minima in the curves) at 0·580–0·600 μ, where the red and yellow modulators overlap and intersect with the green ones, at 0·480–0·510 μ, where the red, green and blue modulators intersect and rise, as well as at 0·450–0·440 μ, suggesting that two blue modulators, the blue proper and the violet one, overlap in this region, as also

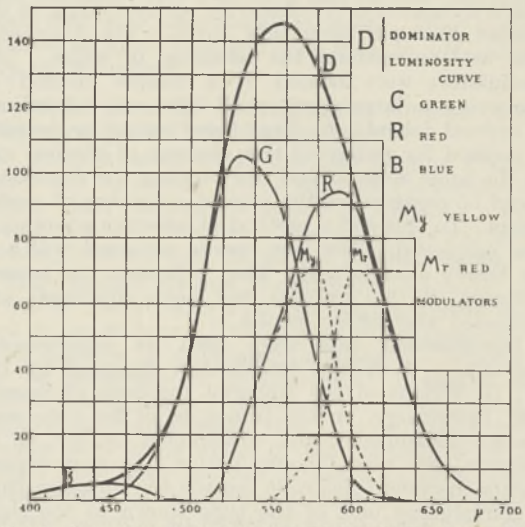

Fig. 4. SYNTHESIS OF HUMAN PHOTOPIC LUMINOSITY CURVE (*D*), AS DETERMINED BY COBLENTZ AND EMERSON[9] ON 125 OBSERVERS. *D* is the sum of three fundamental sensation curves, *R*, *G* and *B*, which are summed modulators as indicated for the *R*-curve by M_r and M_y. Spectrum of equal energy.

shown by the experiments. The broader green modulators keep the curve fairly low in the green region, though not as low as in the regions where many narrow modulators of different type overlap.

Colour blindness is easily understood as a consequence of the absence or diminished number of certain modulators, anomalies as differences in their relative number. The very essential fact that colour blindness in most cases goes with retained sensations of white follows from the experiments, which have shown that the broad dominators responsible for the photopic luminosity curve are much easier to demonstrate than modulators. In most diseases leading to colour blindness of the acquired type, white is likewise seen despite absence of sensations of colour. This suggests that the isolated modulators, responsible for colour vision, are far more sensitive to disturbing agents than the aggregates assumed to make up the dominators. Since dominators are easier to obtain and hence probably commoner than the modulators, it seems natural that a slight reduction of the number of isolated modulators will suffice to cause colour blindness, but that for white-blindness nearly all structures must be affected.

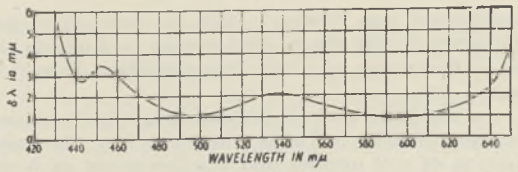

Fig. 5. HUMAN COLOUR DISCRIMINATION ACCORDING TO WRIGHT AND PITT[8].

There are also minor differences in the location of the photopic luminosity curves between protanopic and deuteranopic colour blindness. These are best explained as differences in the proportions of the modulators making up their aggregate dominators.

Since the modulators, which are the *physiological units of colour reception*, represent a finer mechanism of colour reception than the one envisaged by the trichromatic theory, it is perhaps for this reason that colour matches with three primaries never are perfect in saturation. Nature uses a greater number of primaries, at least six or seven modulators, and, possibly, a still greater number of narrow sensitivity bands within the three preferential regions of the spectrum.

A full account of this work will be published in *J. Neurophysiol.*, vol. 8, 1945.

[1] Granit, *Nature*, **151**, 11 (1943).
[2] Wright, *Proc. Roy. Soc.*, B, **115**, 49 (1934).
[3] Lythgoe, *J. Physiol.*, **89**, 331 (1937).
[4] Schneider, Goodeve and Lythgoe, *Proc. Roy. Soc.*, A, **170**, 102 (1939).
[5] Granit, *Acta physiol. Scand.* **5**, 219 (1943).
[6] Wright, *Nature*, **151**, 72[6] (1943).
[7] Walters, *Proc. Roy. Soc.*, B, **131**, 27 (1942).
[8] Wright and Pitt, *Proc. Phys. Soc.*, **46**, 459 (1934).
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THE FUTURE OF X-RAY ANALYSIS*

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I HAVE been out of contact with X-ray analysis for the last six years; this is both an advantage and a disadvantage. Because I know little of its present state, I shall not fail to see the wood for the trees; I can follow the trends, but I am certain to be wrong in detail.

The predictable future is the rational projection of the past and the present, so I shall begin by tracing the major stages of X-ray analysis in the last thirty-three years. The first stage, the Bragg period, as it may well be called, was that in which all the basic structures were worked out. The first edition of "X-Rays and Crystal Structure" contained a specimen of every basic type. It could not have been realized at the time, but every structure since has been an elaboration of one or other of these types. The same is true of methods; all were then known in embryo. The next period was one of rapid development; the silicates were elucidated, then the alloy structures, and a beginning was made in organic compounds with long-chain compounds, aromatics and fibre structures. The number of papers on crystal structure rose rapidly until 1933, then fluctuated about a mean. This date may be taken as the end of the heroic age of X-ray analysis. It was then realized that the new structures would be essentially like the old ones, and interest was directed towards new and more complex phenomena. From then until the outbreak of war, activity centred round such matters as order-disorder transformations, isomorphous replacement, equilibrium diagrams and biological molecules. During the War there has been an almost complete cessation of academic crystallography; but X-ray analysis has given valuable assistance to other branches of science and industry.

What will happen when it is possible to resume a rational programme of research after the War? The only guarantee of the progress of applied science lies in keeping a proper balance between it and pure science. I believe that 'pure' X-ray analysis will find new fields, more and more complex structures, and show a great development of analytic methods, while 'applied' X-ray analysis will become as essential a tool for other fields of research as the microscope and the spectroscope have been in the past.

Substances to be Investigated

In inorganic chemistry not even the simpler fields have been completely covered, but enough has been done to consider the rest as 'mopping-up' operations. There are still, however, a few groups of compounds not well understood. The first is that of the compounds of boron and carbon with other light elements. These have homopolar bonding, are very hard, and have high melting points. They may contain interstitial metal atoms, and their electrical properties are interesting. Diamond is the only one that has been worked out properly. Another group that will claim attention is the sulphides and the sulpho-salts—compounds of sulphur, arsenic and antimony with metals. They are of major interest to the geochemist, and may throw light on the genesis of metallic ores. There is also work to be done on the oxy-acids, and on the types of Wernerian complexes, the variety of which verges on the organic.

In the field of organic chemistry, there is no future in attempting to find the structures of all crystalline compounds. The basic elucidations of some types—aromatics and sterols—have given keys to organic structure determination, and interest will centre on the nature of the bonds between atoms in the molecules and those between neighbouring molecules. Chemists outnumber crystallographers by about fifty to one, so that crystallographers must make the best use of their time; they must tackle things with soluble structures, but things the chemical nature of which is unknown. One of the triumphs of crystallography during this War has been the complete determination of the structure of one extremely important compound before the chemists had unravelled its structural formula. Many substances of great chemical difficulty will be tackled in the same way.

Beyond the ordinary compounds of organic chemistry there lies the wide range of complicated biological molecules of which the proteins are the best known but by no means the only type. Intense work will undoubtedly continue both on the crystalline and fibrous states of these compounds. The structure of the proteins, fundamental to the understanding of living processes, will not yield to X-ray analysis alone; the attack must be combined with biochemical, centrifical, electrophoretic, electron microscope and other methods, but there is no doubt that X-rays will play a crucial part in verifying all

* Substance of an evening lecture to the 1945 Conference of the X-Ray Analysis Group of the Institute of Physics, delivered at the Royal Institution on April 12.

hypothetical structures put forward on any other basis.

Physics

In the field of X-ray physics, interest will be concentrated on the secondary phenomena of diffraction : thermal spots, side-bands, Preston streaks, the effect of temperature on the 'micellar' structure of real crystals. There will be the development of such things as Guinier's central-spot methods, photography at high and low temperatures, high-intensity sources. X-ray tubes in current use are still at the Röntgen level, and a revolution in camera- and tube-design may be expected very soon. Goldstaub and Guinier have already shown how the electron beam can be controlled as in an electron microscope and focused to a tiny spot, so that a current of 0·1 mA. will do as much as 50 mA. now. There is a trend toward the use of smaller cameras ; and with better tubes time-exposures will become snapshots. Filters are anachronisms, and crystal-reflected, monochromatized radiation will be the rule.

There must be great development of analytic methods and means of calculation. We are only at the beginning of the development of mechanical and optical methods, and their improvement is very necessary as calculations are becoming a bottle-neck. There is no use in being able to take photographs in a few seconds if the calculations take months.

Applications

So far, I have spoken only of straight structural analysis. There is another side to the story : the applications of X-ray analysis to other problems. This will form a larger and larger part of X-ray work. The difficulty has been that the X-ray tube and camera were considered a mysterious and dangerous instrument. People have had three hundred years to get used to the optical microscope, but only thirty to get used to X-rays. The result is that X-rays are not utilized to anything like the extent that they should be. Only the crust has been broken in their industrial application.

I see two fields of organized effort. First there will be highly concentrated specialist X-ray laboratories in universities and big firms. There will be comparatively few of these, not more than one per university or institute. Secondly, there will be standardized equipment available in every laboratory that can usefully employ it. X-ray tubes will be as universal as spectroscopes, and powder cameras as microscopes. The field of X-ray analysis ranges from well-established techniques, as in the metal industry, to the almost unexplored problem of humus formation.

In the metal industry many standard techniques are in use, such as those for the identification of materials, measurement of strain, measurement of grain size. There is considerable use of X-rays in the refractory, ceramic and glass industries—as a rough generalization one might say that the closer an industry is to metallurgy, the more satisfactory is the situation. In cement manufacture, X-rays are used chiefly for quality control, and the industry would benefit greatly from an extension of their use to the examination of raw materials and of the setting process of cement. In the chemical industry a start has been made, but it is only a start, even in the heavy chemical field. Light chemicals have scarcely been touched, and the food industry offers a great opportunity. It is true that the substances to be investigated are 'messy', and do not give good photographs, but there is no reason to suppose that the mathematics of their interpretation cannot be worked out.

In agriculture a small beginning has been made in the identification of soil minerals, but the whole question of soil profiles and the formation of humus remains to be examined. Nagelschmidt's and Mathieu's work in this field marks the beginning of the physical understanding of soils, and its development will lead to the replacement of the present 'mysticism' by knowledge. In geology, geophysics and geochemistry X-ray analysis will have a great part to play. Goldschmidt's study of minerals has led to modern geochemistry. Study of stresses in strata and similar problems will lead to a rational development of geophysics. Though it sounds a contradiction in terms, what is needed is an Institute of Experimental Geology, where geological processes can be reproduced and studied in detail.

The Task of Crystallographers

It would be futile to consider these prospects without discussing the means for their realization. We have a great task before us if our opportunities are not to be missed. First, we must ensure that there are enough trained people. I hope that, after the War, X-ray analysis will have a larger part in university curricula. A little of it is taught somewhere, usually in chemical or geological departments in most universities, but the only full-scale course is at Cambridge. It is up to the universities to provide greater facilities for both graduate and undergraduate instruction. The Cambridge summer schools in industrial crystallography have made a good start and should be a regular, but probably not a permanent, feature. When crystallography has found its proper place in the normal curriculum, such schools will be needed for whatever is the new subject at that time.

Secondly, there is need for improvement and standardization of apparatus. We know how difficult it is to get apparatus made to our own specifications, since the numbers required are not large enough to make commercial production profitable. We may hope that standardization will remedy this, and that it will no longer be necessary to put up with home-made apparatus. We must first, however, develop reasonable and practicable designs for all necessary apparatus. Our laboratory workshops will still be necessary, but they will be free to work on new equipment instead of spending most of their time making copies of old apparatus. An interesting thing I have noticed is the slowness of the diffusion of material techniques from one laboratory to another, even in the same country. When refitting after the War, we must make the best use of ideas that have been developed in countries other than our own. It is interesting to find that the X-Ray Analysis Group of the Institute of Physics is working on a new method of agreed specifications.

Thirdly, there is the question of publications. Before the War, crystallographic papers appeared in fifty-seven different journals, and of these only the *Zeitschrift für Krystallographie* was devoted wholly to crystallographic work. We must work for some sort of centralization. One big task is the tidying up of existing knowledge. No one has time to read everything published. A good deal of early work may be wrong, and in any event the detailed measurements

are inexact. We need some sort of a permanent up-to-date loose-leaf 'Strukturbericht'—an X-ray analogue of Groth's "Chemische Krystallographie". In pre-war days Germany was the major stronghold of such systematizing activity; but it is unlikely to be so again, at any rate for some time after this War, so we must share it out. The "X-Ray Index" is a small beginning. Crystallographers in the past have been good at co-operative international activity; the "International Tables" are one outstanding example. We may confidently expect similar success in the future.

International Aspects

Soon it will be possible to resume international contacts. In Great Britain we do not realize how much X-ray analysis has been a British subject. It has struck no deep roots in other countries, but we shall all be the gainers if others work as intensely as we. I look forward to a spread of crystallographic activity all over the world, with increasing benefits to mankind.

ANOMALOUS INACTIVATION OF HEAVY METAL ANTIFOULING PAINTS*

By Dr. G. H. YOUNG and G. W. SEAGREN
Mellon Institute, Pittsburgh, Pa.

THAT ordinarily effective antifouling paints occasionally show very poor performance, or suddenly begin to foul severely after a period of satisfactory functioning, is an observation familiar to every user of marine paints. In the case of compositions carrying metallic copper, such failures have been almost universally attributed to 'galvanic coupling' with the steel hull—the implication being strong that such paints can and do act in a manner entirely analogous to a gross sheet of copper. In an effort, therefore, to establish the real truth of this matter, the phenomenon of inactivation with both metallic copper and cuprous oxide paints has been under study by us for some time. We have already shown that accidental or deliberate contact of the steel hull with either type of copper-bearing paint can lead to serious pitting at the contact point and to accelerated corrosion attack at adjacent bare areas or 'holidays'[1,2]. An equally if not more serious result of failure to separate properly the antifouling paint from the steel hull by adequate barrier coats is a decreased effectiveness or even complete inactivation of the antifouling coat[1].

While certain of our experiments are still uncompleted, we have already established that contact-inactivation can happen with cuprous oxide paints as readily as with metallic copper paints[1]. The antifouling efficiency of both types is rapidly lost if they are applied over bare steel; within three months of immersion they are as badly fouled as are control panels carrying no antifouling paint. As many of these formulations have demonstrated satisfactory antifouling action if applied in the conventional manner over the usual primer and anticorrosive coats, or if applied to wood, it seems established that their immediate proximity to corroding steel is responsible for the inactivation. It is important to note that this inactivation seldom manifests itself in the first month of exposure; this fact alone throws doubt on simple 'coupling' as the causative factor, because all fouling exposures involving unpainted copper-steel couples show immediate fouling of the 'cathodically protected' copper.

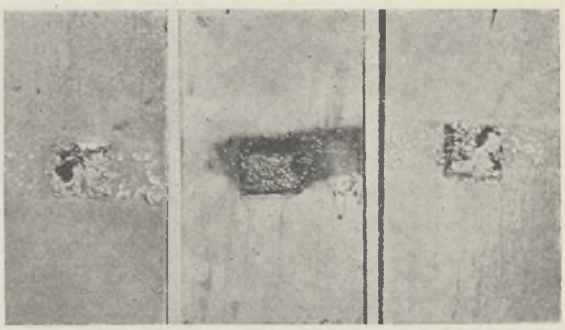

Fig. 1. CHARACTERISTIC BANDED FOULING ADJACENT TO BREAK IN PAINT FILM.

The observation—first made by us in 1942 in connexion with a series of immersed painted steel panels racked on 'Micarta' strips which in turn were bolted to plain iron angles—that 'run-down' of iron corrosion products over an antifouling paint inactivates the latter has undoubtedly been made by others, although we find no reference to it in any published reports. It is our belief that many cases of anomalous inactivation may be better attributed to this effect than to 'coupling'.

Selective Fouling

The occurrence of fouling in 'bands', either horizontal or vertical, near gross breaks in antifouling paint film on test panels where corrosion is actively going on has been the subject of much speculation[3]. Several of our test series show this phenomenon markedly.

The North Florida Test Station exposure site at Daytona Beach, Florida, is located near the mouth of an inlet; the tidal action is such that a maximum velocity 'up-stream' approximating to 4 m.p.h. when the tide is coming in is attained; this is followed by a period of relative quiescence, then the current flow reverses, reaching a 4 m.p.h. velocity 'down-stream' at low tide. Thus, tidal action is such that a semi-stratified layer of water sweeps across the face of the test panels except when excessive wind and wave action produces turbulence and counter-currents. Accordingly, corrosion products originating at bare areas or mechanical breaks in the film may be swept out and across the surface of intact paint, in a horizontal band roughly the width of the corroding spot. Photographs of several test panels demonstrating the phenomenon are presented in Fig. 1.

Similar observations have been made at Kure Beach, Wilmington, N.C., where, however, the current flow is continuous, and in one direction only; here the area 'down-stream' of a corroding spot is always rust-stained and tends to foul well in advance of the 'up-stream' area.

We have observed the phenomenon taking place in substantially a vertical line with another series of panels bolted to, but insulated from, an unpainted steel overhead member. When fouling began, it was always the area immediately adjacent to the support at the top which fouled first, the fouling band being

* Contribution from the Stoner-Mudge, Inc., Multiple Industrial Fellowship on Protective Coatings at Mellon Institute.

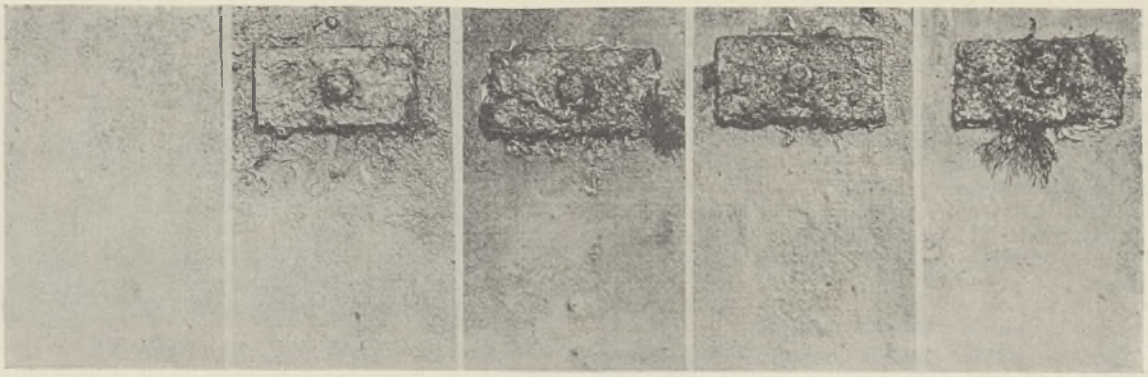

Fig. 2. BRONZE ANTI-FOULING PAINT.

as much as two or three inches wide across the top of the panel. Fouling tends to run vertically on panels exposed at mean tide-level, where the air-water interface actually moves up and down as the tide shifts. We have occasionally seen manifestations of the phenomenon on ships' hulls, where rusting and corrosion 'top-side' at a bilge port cause run-down and staining of the antifouling coat at the boot-topping zone; fouling on the stained areas usually precedes that on 'clean' paint.

Reaction with Iron Corrosion Products

There is admittedly some question as to the solubility of iron corrosion products in sea water. Wesley and Lindsley[4] have determined the equilibrium solubilities of ferric iron in a synthetic sea water and concluded that only a fraction of a part per million could exist in solution at *p*H 8–8·3, normal for sea water. Despite this finding, there appears to be good evidence that iron in soluble form can and does exist in natural sea waters at concentration levels many orders of magnitude higher than predicted by Wesley's calculations. Thus, ZoBell[5] has shown that up to 1,000 p.p.m. of ferric iron can be held in natural sea water nutrient solutions in the form of organic complexes.

Wesley himself states that, in the *p*H range of 7–8, 60–6,000 p.p.m. of dissolved ferrous iron is theoretically possible. This fact is important, for the *slime film*, which blankets all submerged surfaces in a matter of hours, or at most days, is characterized by a *p*H of only 6·3–7·6, and even lower values have been recorded. Thus ferrous iron, at least, could be concentrated in organic detritus or slime film to values in the range of 1,000 p.p.m. This is, of course, an oxygen-deficient zone by virtue of the organic matter present; there is thus no reason to predict instantaneous and complete conversion of ferrous to ferric iron in the slime film region. ZoBell says both ferrous and ferric iron are found in natural sea water, and makes the important observation that "iron, like aluminium compounds, precipitates from solution and thus inactivates toxic agents such as silver or copper . . ."[5].

As we see it, the stream of soluble iron complex is washed along and through the slimy interface region (faster in the direction of current flow), where it reacts with and precipitates the dissolved copper; the result is an 'inactivation' of the antifouling paint. With highly gelatinous, permeable paint films, copper precipitation can take place in the body of the film itself[6], and even at the steel-paint interface in the absence of a barrier film.

Effect of Accidental Contact with Corroding Steel

We have also attempted to determine the possible effect of accidental contact of steel bolts, anchor chain or the like against an antifouling coat on a wood hull. For this purpose we employed seasoned panels, 8 in. × 12 in. × $\frac{5}{8}$ in., coated with three coats of the two selected test paints. To these panels were attached cleaned and weighed medium carbon steel tablets, 2 in. × 4 in. × $\frac{1}{8}$ in. drilled with a $\frac{7}{16}$ in. hole at the centre, in the following several manners:

(1) directly in contact with the paint face, attached with steel bolts and nuts;

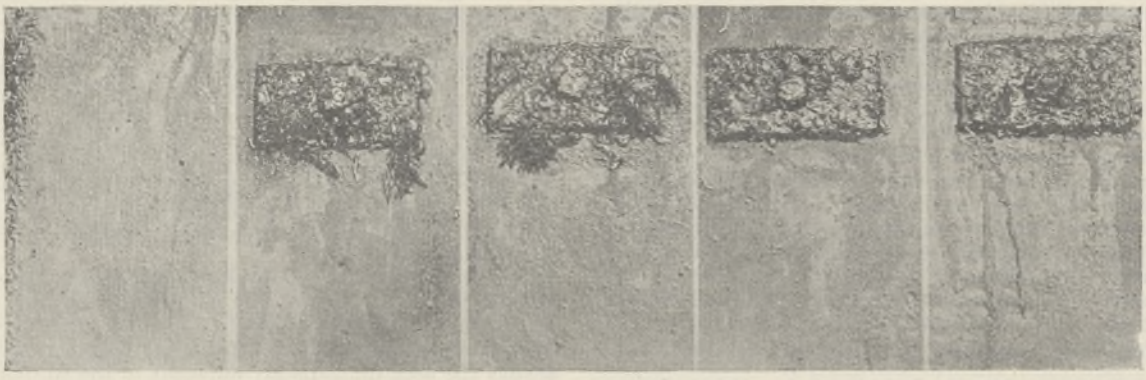

Fig. 3. CUPROUS OXIDE PAINT.

RESULTS OF FOUR-MONTH IMMERSION OF PAINTED WOOD PANELS WITH ATTACHED STEEL TABLETS

Panel No.	Paint system	Tablets attached	Fouling observations	Wt. loss (gm.) of duplicate steel tablets
1	Metallic copper paint	None	No fouling	
2		Method 1	Fouled over an area about 2 in. around the tablets	9·3–10·0
3		Method 2	Slight fouling immediately adjacent to tablet	6·6–6·7
4		Method 3	Same as panel 3	4·9–5·0
5		Method 4	Same as panel 3	4·6–4·5
6	Navy Formula 16	None	No fouling	
7		Method 1	Fouled over an area about ½ in. around the tablets	5·1–4·9
8		Method 2	Same as panel 3	6·1–6·1
9		Method 3	Very slight fouling not associated with tablets	6·0–6 1
10		Method 4	Same as panel 9	6·8–5·3

(2) separated from the paint face by 2 in. × 4 in. × ⅛ in. 'Formica' spacers, both attached with steel bolts and nuts;

(3) separated as in (2), with 2 in. × 4 in. × ⅛ in. 'Vinylite' spacers, both attached with steel bolts and nuts;

(4) separated as in (2) with 2 in. × 4 in. × ⅛ in. 'Formica' spacers, both attached with bolts machined from cellulose acetate rods and steel nuts. (This arrangement positively guarantees that no accidental contact of paint to steel can take place.)

As test paints we employed a formula containing approximately 4·8 lb. per gallon of metallic copper, with which we have had considerable experience[1,2], and Navy Formula No. 16, which is based on cuprous oxide as the toxic agent[7]. Several panels carrying no attached steel tablets were included as controls.

The panels were immersed at Daytona Beach, Florida, during the period March 10–July 10, 1944, after which they were removed, photographed, and returned for dis-assembly and study. Their appearance after the four months' exposure is shown in Figs. 2 and 3. Weight loss data on the tablets are summarized in the accompanying table (above).

Conclusions

The following observations appear to us to be significant:

(1) Only in the case of non-insulated contact direct to the face of the metallic copper formula was there an appreciable inactivation for finite distances from the bare steel; this distance was of the order of 2 in. only.

(2) The general antifouling characteristics of the remaining panels were roughly the same, and probably not significantly different from the controls. As the steel tablets were ⅛ in. removed from the paint-water interface, it would appear that diffusion of iron corrosion products into the interface zone, from even this short distance outside it, was insignificant.

(3) The weight loss of the tablets attached directly to the metallic copper paint was significantly greater than for the remainder. This fact almost certainly indicates that here a contact-couple effect was operative; the phenomenon has been discussed elsewhere[2].

(4) The average loss of weight of all the remaining tablets was approximately 5–6 gm., and the figures were in excellent agreement. This finding gives a calculated rate of corrosion of 100 mgm. per sq. dcm. per day. Previous studies[3] on the corrosion-rate of medium carbon steel in sea water at Kure Beach, N.C., where no antifouling paints were in the immediate neighbourhood, gave a value of 22 mgm. per sq. dcm. per day. *It thus appears that all our tablets corroded at a rate about five times the normal rate*

The conclusion seems obvious that copper, migrating out of the interface region, was deposited on the steel, from which severe local-couple acceleration resulted. It is important that this phenomenon took place without any direct contact to the paint films. It is completely predictable on the hypothesis of mutual interaction of soluble iron and copper, which we advanced earlier.

As a practical matter, it would thus appear that accidental contact of chain, rudder posts and similar ironware with the antifouling paint on a wood hull would have very little deteriorating effect on antifouling efficiency unless the contact area be large. Certainly, the likelihood of overall inactivation is extremely remote.

[1] Young, G. H., and co-workers, *Ind. Eng. Chem.*, 36, 341 (1944).
[2] Young, G. H., and co-workers, *Ind. Eng. Chem.* (in the press).
[3] LaQue, F. L., private communications based on unpublished observations.
[4] Wesley, W. A., *et al.*, *Metals and Alloys*, 8, No. 12, 335 (1937).
[5] ZoBell, C. E., *J. Marine Research*, 4, 42 (1941).
[6] Moor, W. A., *Science*, 100, 494 (1944).
[7] U.S. Navy Department, "Instructions for Painting and Cementing Vessels", 1939 Ed., Appendix 6.

NATIONAL FLOUR (80 PER CENT EXTRACTION) AND BREAD IN BRITAIN

Seventh Report from the Scientific Adviser's Division, Ministry of Food

THE extraction of national flour was reduced from 82½ per cent to 80 per cent on January 1, 1945. A survey of this 80 per cent flour has been carried out on similar lines to that of the 82½ per cent national flour survey[1]. Samples received from controlled mills were examined weekly for colour index and granularity and at frequent intervals for vitamin B_1, fibre, ash, calcium, iron, riboflavin and nicotinic acid, as described in the sixth report[1], with the exception that fibre was determined only on samples sent by Ministry of Food inspectors and calcium was determined only once in four weeks. In addition, about forty loaves were baked each week from different flour samples.

By February 12, the quality of the new flour was approaching something like constancy (although it can still be improved considerably) and the present report describes the results obtained in the period of twelve weeks from this date to May 5. During this time, 2,943 samples of flour were examined.

Composition of the Grist

The average composition of the grist used for milling the flour, calculated fortnightly during the period from data supplied by the millers and accompanying every sample, was as follows (Table 1):

TABLE 1.

Fortnight beginning	Average composition of grist (capacity basis) of samples analysed			
	Manitoba wheat, %	Home-grown wheat, %	Other wheat, %	Barley and rye, %
Feb. 5	58·6	35·8	5·4	0·2
,, 19	59·6	36·2	4·1	0·1
March 5	59·9	36·5	3·5	0·1
,, 19	60·7	36·5	2·8	0·0
April 2	61·2	35·7	3·1	0·0
,, 16	60·2	35·0	4·8	0·0

The 'other' wheat was principally Plate. The proportion of Manitoba is now about 3 per cent higher than in the average grist used for milling the 82½ per cent national flour (September–December 1944). This change is reflected in the average protein content of national flour, which was 11·6 per cent in 82½ per cent flour and has risen slightly in 80 per cent flour, being 11·76 per cent at the beginning of the survey, and 11·91 per cent in the fortnight beginning April 2, 1945.

Effect of Addition of Imported White Flour and of *Creta Praeparata*

The flour as supplied to the baker contained approximately 12½ per cent of imported white flour during the first four weeks of the present survey and 15 per cent thereafter. The addition consisted, on the average, of 13 per cent of Canadian and Plate flour, plus 1·8 per cent of United States flour. Owing to the high iron content of the latter, and the low fibre content of the white flours, the effect of the addition was not wholly negligible; in the tables of results which follow, the data presented relate to the flour as supplied to the public; the effect of the additions on the flour as milled is explained in footnotes. The addition of 7 oz. of *creta præparata* per 280 lb. sack of flour increases the ash content of the flour by about 0·12 per cent.

Colour Index

Bran speck contamination was judged on the same scale as that used and described for the 82½ per cent survey (namely, 0 represents a white flour free from visible bran specks, and 100 represents a national average 85 per cent flour—capacity basis—as manufactured during July–September 1944). The percentage of all samples examined week by week that fell within the various colour index classes is shown in Table 2, for the first three weeks and for three recent weeks, together with the average colour index values, calculated on sample and capacity bases. (The term 'capacity basis' is used frequently throughout this report. It means that the particular characteristic—colour index, fibre, B_1, etc.—is weighted for the output of flour from each mill. In calculating 'national average' figures it may be misleading to give equal weight to the result from a small mill and that from a large mill.)

TABLE 2.

Colour index not exceeding	Weeks commencing					
	Feb. 12	Feb. 19	Feb. 26	Mar. 26	April 2	April 9
5	17	19	15	15	20	17
10	36	40	40	31	48	50
15	55	56	60	57	68	68
20	68	69	68	68	75	76
30	83	83	83	82	86	83
40	93	94	91	89	92	92
50	98	97	97	96	97	98
70	99	98	100	99	98	99
100	100	100	100	100	100	99
Average Colour Index: Sample basis:	19·9	19·8	19·8	21·2	18·5	18·5
Capacity basis:	13·3	12·5	12·6	13·7	11·7	11·4
Number of samples	244	254	253	254	193	237

Thus the average colour index (capacity basis) has decreased from 37, the figure recorded during the last week of the 82½ per cent survey, to 11, that is, the amount of bran speck contamination is only about one third of what it was in 82½ per cent flour, or one tenth of that in the average 85 per cent flour.

Granularity

Every sample of flour received during the survey was sifted over a No. 10 standard bolting silk (aperture = 0·135 mm.) under standardized conditions, using a mechanical sifter, and the percentage weight and the character of the fraction failing to pass through the silk (overtails) were recorded. Samples were encountered with up to 34 per cent tailing the silk, whereas others passed through entirely. The arithmetic mean of the percentage weight of overtails of 10 silk from 936 samples received during four consecutive weeks was 7·3 per cent, while the most frequent value was 5·5 per cent.

TABLE 3. FIBRE AND ASH IN 80 PER CENT FLOUR.

	Week commencing										
	Feb. 12	Feb. 19	Feb. 26	March 5	March 12	March 19	April 2	April 9	April 16	April 23	Av. 10 weeks
(*a*) Determined on individual samples											
Average fibre, %	0·20	0·23	0·18	0·19	0·20	0·22	0·20	0·24	0·21	0·21	0·21
,, ash, %	0·76	0·79	0·74	0·75	0·72	0·76	0·79	0·77	0·75	0·79	0·76
,, *creta* addition, oz./sk.	5·7	5·4	5·1	5·1	5·4	4·9	5·0	5·2	4·4	6·5	5·3
Number of samples	13	13	14	15	11	15	10	10	12	16	
(*b*) Determined from composite samples (fortnightly)											
Fibre, %											
Sample basis	0·18		0·23		0·22		0·20		0·23		0·21
Capacity basis	0·18		0·21		0·19		0·17		0·21		0·19

(i) The fibre content of the flour *as milled* is approximately 0·016% *higher* than that given in the table on account of the presence of 12½–15% of imported white flour in the flour analysed.

(ii) The figure for ash contains approximately 0·09% due to added *creta*. The statutory addition of *creta præparata* is 7 oz. per 280 lb. sack of flour; the average value for samples from 231 mills analysed during the last six weeks of the present survey was 6·0 oz./sk.

TABLE 4.

	Weeks commencing											
	Feb. 12	Feb. 19	Feb. 26	March 5	March 12	March 19	March 26	April 2	April 9	April 16	April 23	April 30
Av. B_1, I.U./gm. :												
Sample basis	0·77	0·77	0·78	0·80	0·78	0·80	0·80	0·77	0·82	0·81	0·77	0·79
Capacity basis	0·77	0·78	0·80	0·81	0·79	0·81	0·81	0·77	0·81	0·82	0·79	0·80
No. of samples analysed	127	131	136	143	125	135	140	108	87	125	133	133

Note : The figures for average vitamin B_1 content above include approximately 0·01 I.U./gm. derived from added United States white flour.

Fibre and Ash

Fibre and ash were determined on all samples sent by inspectors (about twelve samples per week). In addition, fibre was determined fortnightly on composite samples representing approximately 250 mills. From these determinations, averages, on sample and capacity bases, could be calculated (Table 3).

Vitamin B_1

The weekly average values, on sample and capacity bases, of vitamin B_1 in the samples as received are given in Table 4.

Riboflavin, Nicotinic Acid and Iron

The fortnightly average values for these constituents, on mill and capacity bases, are shown in Table 5.

TABLE 5.

	Fortnight commencing					
	Feb. 19	Mar. 5	Mar. 19	April 2	April 16	Average for 10 weeks
Riboflavin, p.p.m. sample and cap. bases	0·8	—	0·8	0·75	0·8	0·8
Nicotinic acid, p.p.m., sample and cap. bases	17	16	16	17	16	16·5
Iron, p.p.m. :						
Sample basis	15·8	16·5	16·4	16·5	15·8	16·2
Cap. basis	15·8	16·8	16·5	16·7	15·6	16·3

Note : Added United States flour contains approximately 29 parts of iron per million, while Canadian and Plate flour contain approximately 10·5 p.p.m. ; the iron content of the national flour, *as milled* (before addition of imported flour) is therefore approximately 0·6 p.p.m. *higher* than the values given in the table. Any correction for nicotinic acid and riboflavin is well within the experimental error of the determination.

Colour Index of Flour and Fibre Content

Since colour index is an estimate of the amount of bran in the flour, it should be closely related to the fibre content. Fibre determinations on 209 samples of 80 per cent national flour confirm this relationship (Table 6).

For flours with a fibre content of about 0·25 per cent or less, the colour index is probably a better estimate of the amount of bran in the flour than is the fibre determination.

Colour Index of Flour and Vitamin B_1 Content

The relation between colour index and vitamin B_1 content was tabulated above for the most recent vitamin B_1 determination on samples from 283 mills.

TABLE 6.

Colour index	Average fibre content %	Average vitamin B_1 content I.U./gm.
5	0·17 (26)*	0·80 (27)*
10	0·20 (35)	0·78 (68)
15	0·21 (28)	0·81 (60)
20	0·21 (23)	0·78 (37)
25	0·21 (21)	0·75 (19)
30	0·22 (12)	0·75 (20)
35	0·23 (11)	0·78 (9)
40	0·25 (11)	0·79 (15)
45	0·26 (12)	0·83 (1)
50	0·25 (11)	0·80 (17)
60	0·29 (6)	0·73 (8)
70	0·33 (4)	0·79 (1)
80	0·36 (2)	—
90	0·37 (3)	—
100	0·39 (4)	0·92 (3)

* The number of determinations is shown in parentheses.

A similar conclusion to that drawn in the sixth report[1] is evident, namely, that there is little relation between colour index and vitamin B_1 for such a wide range of samples, that is, it is possible to combine good colour and a high B_1 value.

Comparison of 80 per cent Flour with 82½ per cent and 85 per cent Flour

Average values for 80 per cent extraction flour are below set against values for 82½ per cent and 85 per cent extraction flours as given in the sixth[1] and fifth[2] reports respectively.

TABLE 7.

	80%	82½%	85%
Period covered	12.2.45 to 5.5.45	16.10.44 to 2.12.44	1.1.44 to 30.6.44
Vitamin B_1, I.U./gm. :			
Sample basis	0·79	0·88	0·975
Capacity basis	0·80		
Riboflavin, p.p.m.	0·8	1·0	1·3
Nicotinic acid, p.p.m.	16·5	18	17
Iron, p.p.m. :			
Sample basis	16·2	19·4	20·7
Capacity basis	16·3		
Protein, %	11·8	11·6	10·7
Fibre, % :			
Sample basis	0·21	0·31	0·50
Capacity basis	0·19	0·27	
Ash, %	0·76	0·88	0·98
Colour Index :			
Sample basis	20	51	
Capacity basis	13	41	100
Granularity, av. % wt. over No. 10 silk	7·3	9·8	15·5

Note : The above figures relate to national flour as received : the value for ash in the flour *as milled* (that is, before the addition of *creta præparata* and imported flour) is slightly *lower*, those of iron and fibre are slightly *higher*, as indicated in the relevant tables.

Quality of Bread

Loaves baked from national flour survey samples. During the period under consideration, 388 samples of flour were baked under ideal conditions in the laboratory and the resulting loaves judged for volume,

colour and quality of crumb, and were classified as follows :

Quality of bread	Number of loaves	Per cent of total
Good	300	77·4
Fair–good	55	14·2
Fair	22	5·7
Poor	11	2·8

Survey of commercially baked bread. During the same period, 775 samples of bread purchased from bakers in different parts of Great Britain have been examined and judged for quality (commercial standards) with the following results :

Quality of bread	Number of loaves	Per cent of total
Good	87	11·2
Fair–good	386	49·8
Fair	218	28·1
Poor	84	10·9

Although there is a marked difference between the average quality of bread sold and the bread that could be made from the flour available, the great difficulties of the baking industry—particularly that of labour—must not be overlooked.

This work was carried out at the Cereals Research Station, Ministry of Food, St. Albans.

[1] *Nature*, **154**, 788 (1944).
[2] *Nature*, **154**, 582 (1944).

OBITUARY

Dr. K. J. W. Craik

KENNETH CRAIK was born on March 29, 1914. He died as the result of an accident on V.E.-Day, May 8, 1945. Into this brief period he managed to pack achievements and promise far beyond the range of most people whose span of life is normal. His school was Edinburgh Academy. He was almost wholly on the Classical side. At seventeen he entered the University of Edinburgh. Here he read philosophy with distinction, was given his first taste of psychology by Prof. James Drever, and won the Hamilton and then the Shaw Fellowships. By now he had developed many hobbies, collecting all kinds of natural objects, constructing models, learning the accurate and minute use of tools, and developing a wide, lively and rather unconventional interest in the methods of natural science and the results of their application.

In the autumn of 1936 Craik joined the Cambridge Psychological Laboratory as a research student. It was his chief desire to undertake investigations which would bring together physical, physiological and psychological interests and methods in intimate relation. Naturally he turned to the study of the special senses. He chose 'visual adaptation' as his general problem, and devised and carried out many new experiments dealing with bright- and dark-adaptation, with those conditions at and above the threshold under which the human eye is most keenly discriminative, and with some of the phenomena of visual after-images. In 1940 he received the Ph.D. degree, and a year later, when he had considerably enlarged his dissertation, and added, in particular, a section describing a number of new and exceedingly ingenious scientific instruments for the investigation and measurement of a variety of sensory and motor functions, he was elected to a fellowship at St. John's College. Under war-time arrangements, the fellowship was suspended, and Craik, still keeping his Cambridge headquarters, embarked upon four and a half years of strenuous and devoted national service. In 1944 the Medical Research Council, for which he had carried out many of his most remarkable investigations, decided, with the concurrence of the University, to establish at Cambridge a Unit for Research in Applied Psychology. Its home was the Cambridge Psychological Laboratory, and Craik was made its first director.

No mere list of dates and honours can convey any adequate impression of Craik's vivid and vital personality, or of his promise and power. He would meet people of every rank and station in life, and of the most diverse interests and skill, and in a few minutes produce an unforgettable impression of unassuming but complete mastery. To him and to his work all three of the Fighting Services and several of the departments of civil defence owed far more than can yet be told. As his reputation rapidly grew, and as more and more problems accumulated which required for their solution a knowledge of human responses to the signals and controls of the instruments of war, it became almost a matter of course, in scientific and research units scattered all over the country, to say "Ask Craik, he'll know." He generally did. If he did not, he would set to work to find out. Wherever he was required he went with a tireless spirit and an indomitable good temper. He took the greatest risks, at sea, on land and in the air, and enjoyed them all.

One remarkable character stamped almost all Craik's work. He would take perfectly specific questions, such, for example, as the most effective design of a particular radar display, and find in the answer some fruitful suggestions for fundamental scientific advance. At first, as a natural development of his earlier work, he was chiefly concerned with visual problems, particularly with vision at night or in conditions of bad visibility, with the design and placing of special lighting systems, and with how to arrange visual displays on many types of mechanical and electrical instruments so as to promote ready and accurate interpretation. In war and in peace, in the laboratory or in the world outside, visual signals and displays are generally used to guide operational control, and perhaps most frequently of all to set up voluntary movements in a human operator. Inevitably, therefore, Craik became more and more interested in the mechanics of bodily activity and the fundamental characteristics of voluntary movement. When the details of his work in this direction become publicly available, it will be found that they open up a vast, and largely a new, field of research.

Craik's contacts were wide and his friends many. But only those who knew him well at work, and at play, can fully appreciate the fineness of his mind and the complete honesty of his character. In experiment he was silent, absorbed, concentrated. In the workshop he showed amazing speed, unfailing resource and beautiful craftsmanship. Through many a long night of fire-watching he planned and constructed the instruments which he and others with him used to great effect. When the work was done, he flung himself into any game or discussion or party that offered, or rushed off on a journey or a visit with equal enthusiasm.

Craik's work will continue. There is no doubt about that. The Unit which he led is on the move. Whatever of good in scientific achievement it accomplishes will be the tribute which he himself would most have desired. F. C. BARTLETT.

NEWS and VIEWS

British Representatives at Soviet Academy Celebrations

AT the invitation of the Academy of Sciences of the U.S.S.R., transmitted through the Ambassador of the Union of Soviet Socialist Republics to the Court of St. James, a party of scientific men and scholars left England for the U.S.S.R. on June 14 to participate in the celebration of the two hundred and twentieth anniversary of the founding of the Academy of Sciences of the U.S.S.R. The foundation of this Academy was in some measure due to the visit which Peter the Great paid to England in 1698, when he met men like Evelyn and Halley, who were then prominent members of the Royal Society of London. The following are taking part: Prof. N. K. Adam; Prof. E. N. da C. Andrade (representing the Physical Society, also the University of London); Prof. E. D. Adrian (also representing the University of Cambridge); Prof. J. D. Bernal; Prof. P. M. S. Blackett; Prof. Max Born; Prof. V. Gordon Childe (also representing the Royal Society of Edinburgh); Dr. E. M. Crowther, Sir Charles Darwin (also representing the Institution of Naval Architects); Prof. P. A. M. Dirac; Prof. F. G. Donnan (also representing the Chemical Society); Mr. W. N. Edwards; Prof. C. N. Hinshelwood (also representing the University of Oxford); Sir Thomas Holland (representing the Geological Society); Dr. J. S. Huxley; Sir Harold Spencer Jones (Astronomer Royal); Prof. E. A. Milne; Prof. N. F. Mott; Dr. Alex Muir; Prof. R. G. W. Norrish; Dr. W. G. Ogg; Lord Radnor (representing the Rothamsted Experimental Station); Prof. E. K. Rideal; Sir Robert Robinson (representing the Royal Society of London); Prof. A. Sorsby (representing the Anglo-Soviet Medical Council; Prof. R. H. Tawney; Dr. Henry Thomas (representing the British Museum); Prof. D. M. S. Watson (also representing the British Association); Dr. W. A. Wooster (representing the Association of Scientific Workers).

James Alfred Ewing Medal: Award to Mr. B. N. Wallis

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1944 to Mr. B. N. Wallis. The Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research. Mr. Wallis is chief of aeronautical research and development to Vickers-Armstrongs, Ltd. He invented and designed the special type of bomb used for the destruction of the Moehne and Eder Dams in Germany in 1943, and designed the Tallboy and 10-ton bombs used by the R.A.F. He was responsible for the design and construction of the airship *R*.100. Since the airship programme was abandoned, he has been engaged in the design and development of geodetic construction to enable the production of long-range load-carrying aircraft, as exemplified in the production, in collaboration with Mr. R. K. Pierson, of the "Wellesley" type monoplane, which holds the world's non-stop record of 7,162 miles made in 1938. Geodetic construction has been used in the well-known "Wellington" bomber and the "Warwick".

Geology at Columbia University: Prof. S. J. Shand

PROF. S. J. SHAND has been appointed to fill the Newberry chair of geology at Columbia University. Shand, a graduate of the Universities of St. Andrews and Münster, spent a short time at the Royal Scottish Museum in Edinburgh, and then for twenty-five years was professor of geology at Stellenbosch. In 1937 he became professor of petrology in Columbia. He has devoted much attention to the occurrence and origin of the alkali rocks. He mapped masses of nepheline-bearing rocks in Sutherlandshire and the Bushveld, describing them in a series of masterly papers. As early as 1913 he was considering the thorny problems of the classification of eruptive rocks, and has recently elaborated one. In this the role of physical chemistry in helping to choose the diagnostic features of a rock is emphasized, and the result is practical and useful. A philosophical outlook permeates all he writes, and he has proved himself one of the most stimulating of living petrologists. Many geologists and others will be happy to learn of his promotion, and know he is a worthy successor to J. F. Kemp, C. P. Berkey and Douglas Johnson.

Industry and the University: Exchange of Research Personnel

THE London, Midland and Scottish Railway has announced an important scheme whereby it will send members of its research staff for varying periods to carry out fundamental research in their particular fields in university laboratories; and, in exchange, the universities will be invited to send members of their staffs to spend a period in the company's research laboratory at Derby, working on applied problems in which they are interested from the fundamental side. The benefits should be felt by both parties to this arrangement. On one hand, it is hoped that the company's staff visiting the universities will be invited to assist in teaching, so bringing the practical atmosphere to the university lecture-room; on the other hand, university research men will be brought more closely into contact with the problems of industry. The L.M.S. Research Laboratory has a staff of seventy research workers, and has sections dealing with engineering, metallurgy, chemistry, physics, paint and textiles; hence it can provide a very varied experience for university research workers able to take advantage of the scheme. The company is to be congratulated on its foresight in promoting this exchange of research workers; it should prove an important step in promoting that two-way flow of research personnel between industry and the university, the need for which has been emphasized repeatedly in recent months. The example might well be followed in other industries.

Royal Asiatic Society of Bengal

IN the editorial article "Science and Progress in India" in *Nature* of May 5, p. 525, the history of the development of the present scientific background in India since the end of the eighteenth century is traced along two parallel lines of progress, official and non-official, the origin of the latter being the foundation of the Asiatic Society (now the Royal Asiatic Society of Bengal) by Sir William Jones in 1784. The annual address of Dr. Shyam Prasad Mookerjee, president of the Society for the year 1944–45, has now been received, as well as the annual report of the Council. It is pleasing that Dr. Mookerjee, the son of the late Sir Ashutosh Mookerjee,

one of the greatest presidents the Society has ever had, should have reached the presidential chair. An interesting point that emerges from Dr. Mookerjee's address is that while official support was given to some aspects of science in India from as early a date as that of the birth of the Asiatic Society, the study of the cultural inheritance of India was left entirely to private non-official effort, both European and Indian, largely under the inspiration and encouragement of the Asiatic Society, until so late a date as 1860. In this year, during the time of Lord Canning, the first Viceroy of India, the Archæological Survey of Northern India was constituted, while in 1862 Cunningham was appointed archæological surveyor, to become later the first director-general of archæology in India. After Cunningham came a period of stagnation until Lord Curzon reconstituted the Archæological Department under Sir John Marshall. But the study of India's history as represented by ancient documents is still left to unofficial endeavour, organized mainly by the Asiatic Society, to which some official help is given in the form of annual grants towards the cost of study and publication.

Now that proposals are on foot for the expansion of scientific, medical and industrial research in India, the Asiatic Society, with its interests in all branches of learning—science and letters—does not propose to allow the cultural side of life to lag behind. For, as Dr. Mookerjee says, "neither can India attain her full strength and glory nor can she contribute worthily to the cause of stabilizing human civilization, if we ignore the need for a proper cultural reconstruction in India". The Council of the Society, working through an advisory body formed for the purpose, has in consequence submitted to the Government of India during 1944 proposals on (1) the establishment of a Travellers' Department in India; (2) the necessity for a Central Record Office in Bengal; (3) the future development of the Archæological Department; (4) the establishment of a National Museum at New Delhi as a war memorial; (5) the amendment of the Ancient Monuments Preservation Act; (6) the establishment of a School of Architecture in India; (7) the necessity for a National Cultural Trust; (8) the establishment of a National Academy of Art and Letters; (9) the constitution of national parks. These projects are for the future. As a useful activity for the present the Society has organized a series of discussion meetings to which invitations have been extended to all members of the Allied Forces in Calcutta. No less than thirty-nine meetings were held during 1944, addressed by a variety of lecturers on historical, literary, economic, industrial, and scientific subjects. The British and American military authorities co-operated in making these meetings a success, the one by a contribution towards the expenses, and the other by gifts of materials for providing refreshments. The Asiatic Society of Bengal proposes next year to celebrate the bi-centenary of the birth of its founder, Sir William Jones.

Astronomy in France during the Occupation

IN the February issue of *The Observatory* (66, 23; 1945), D. Chalonge gives a brief history of French astronomy and astronomers during the German occupation. Among the astronomers dismissed under the Vichy racial decrees—M. Lambert, director of the Bureau International de l'Heure, M. Mendès, M. Beloritzsky and Mlle. Bloch, assistants at the Observatories of Bordeaux, Marseilles and Lyons respectively—all have been reinstated except M. Lambert, who was arrested in August 1943 and deported to Germany, and about whose safety there is anxiety. M. Mineur, director of the Institut d'Astrophysique, was several times imprisoned for political reasons. Removed by the Vichy Government from his post at the Observatory of Paris, he devoted much of his time to the resistance movement, and is now back with his former colleagues. M. Danjon, director of the Observatory of Strasbourg and dean of the Faculty of Science in the University, was also many times arrested by the Germans during the Gestapo campaign against the University, and was finally dismissed by the Vichy Government. Many astronomers were, however, allowed to work in the tranquillity of their observatories. In some cases this tranquillity covered patriotic activities, the observatories becoming meeting-places for the local resistance groups where pamphlets were printed and arms stored. Observatory buildings throughout France have come through the War unscathed, except perhaps those at Strasbourg, about which news is still lacking.

Development of the Service d'Astrophysique, founded in 1936, was interrupted by the outbreak of war. The Institut d'Astrophysique buildings in Paris were finished externally in 1940 when the Germans forbade further work, but this edict was clandestinely evaded with such success that workshops and laboratories were ready for use by January 1944. At the Observatory of Haute Provence, which forms part of the Service d'Astrophysique, many of the projected buildings were completed, and a 120-cm. telescope was brought into use a year ago. An 80-cm. telescope will shortly be installed in a dome already awaiting it. Work has continued on the Pic du Midi, where Lyot has carried on his researches on the solar corona outside eclipse and on planetary surface detail. Other researches published or to be published in the *Annales d'Astrophysique* include work on the night sky spectrum; photometric and spectrophotometric studies of lunar eclipses; investigations, observational and theoretical, on the continuous spectra of stars and diffuse nebulæ; observations of total hydrogen absorption in certain stellar spectra; and a study of the monochromatic brightness across the sun's disk.

Public Health in San Salvador

AN article on this subject appears in the February issue of the *Boletín de la Oficina Sanitaria Panamericana* by Dr. Manuel Zúnica Idiáquez, head of the Department of Health Education of the El Salvador Ministry of Health. San Salvador's public health organization traces its origin to the Superior Board of Health at the beginning of this century, which was succeeded in 1920 by the National Department of Health. Since then much progress has been made as regards the preventive, rather than the curative, side of public health and the training of staff. The Rockefeller Foundation and the Pan-American Sanitary Bureau have been of great help, especially as regards the formation of a body of specialists in public health. At the present time valuable aid is also being received from the Co-operative Inter-American Public Health Service, permitting the installation of safe water and sewage disposal systems, malaria control work, sanitary materials, public laundries and new buildings and health centres.

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

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

Principal: J. E. Myers, O.B.E., D.Sc. (Manchester), A.R.I.C., J.P.

DEGREE COURSES IN TECHNOLOGY

The Prospectus of University Courses gives particulars of the courses leading to the Manchester University Degrees (B.Sc.Tech., M.Sc.Tech., and Ph.D.) and Certificates in the Faculty of Technology, in the following Departments:

MECHANICAL ENGINEERING (Professor H. Wright Baker, D.Sc., M.I.Mech.E., M.I.A.E.).
ELECTRICAL ENGINEERING (Professor J. Hollingworth, M.A., D.Sc., M.Sc.Tech., F.C.G.I., M.I.E.E.).
MUNICIPAL ENGINEERING (R. J. Cornish, M.Sc., M.Inst.C.E., A.M.I.Mech.E., A.M.I. Struct.E., F.R.San.I.).
APPLIED CHEMISTRY, including General Chemical Technology, Metallurgy and Assaying, Fermentation Processes (including Brewing), Electro-Chemistry, Colouring Matters, Foodstuffs, Fuels, and Chemical Engineering. (Professor J. Kenner, D.Sc., Ph.D., F.R.S.).
TEXTILE CHEMISTRY (Bleaching, Dyeing, Printing and Finishing; Paper Manufacture). (F. Scholefield, M.Sc., F.R.I.C., F.T.I.).
TEXTILE TECHNOLOGY (Professor W. E. Morton, M.Sc.Tech., F.T.I.).
BUILDING (W. B. McKay, M.Sc.Tech., M.I. Struct.E.).
INDUSTRIAL ADMINISTRATION (Post-Graduate Certificate Course), (A. Roberts, M.Com., Ph.D.).

Part-time (Evening) Courses are provided in Engineering, Mathematics, and Physics, leading to the external degrees of London University in Engineering and Science.

MATHEMATICS DEPARTMENT (F. Bowman, M.A., M.Sc.Tech.).
PHYSICS DEPARTMENT (W. H. Taylor, Ph.D., D.Sc.).

For further information apply to the Registrar, College of Technology, Manchester, 1.

UNIVERSITY COLLEGE OF SWANSEA

(A constituent College of the University of Wales)

Principal: C. A. Edwards, D.Sc., F.R.S.

The twenty-sixth Session will open on October 2, 1945

Courses of Study are provided for

(a) Degrees of the University of Wales in Arts, in Pure Science and in Applied Science (Metallurgy, Engineering and Metallurgical Engineering).
(b) Diplomas of the College in Metallurgy and in Engineering.
(c) The training of teachers for elementary and secondary schools.
(d) The first medical examination of the University of Wales.
(e) The first year of the course for the degree of *Baccalaureus in Architectura*.
(f) The Preliminary Part of the scheme of study for the degree of *Baccalaureus in Pharmacia*.
(g) A one year full-time course in Youth Leadership and Organization.

College courses in Pure Science are recognized by a number of medical licensing bodies as constituting a first year of medical study.

The College maintains a Hall of Residence for women students.

Entrance scholarships will be offered for competition in April 1946.

Particulars concerning admission to the College, and of the entrance scholarships, may be obtained from the undersigned.

EDWIN DREW,
Registrar.

Singleton Park,
Swansea.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER IN BOTANY. Stipend £350 per annum. Duties to commence September 29, 1945. Applications must be sent, not later than June 30, 1945, to the Registrar, The University, Manchester 13, from whom further particulars may be obtained.

UNIVERSITY OF CAMBRIDGE

DEMONSTRATORSHIPS IN BIOCHEMISTRY

The Appointments Committee of the Faculty Board of Biology "B" give notice that they intend to appoint two University Demonstrators in Biochemistry, to hold office from October 1, 1945. The appointments will be subject to the Statutes and Ordinances of the University. The initial basic stipend of a University Demonstrator is £200 a year; but the Faculty Board, subject to the approval of the General Board, may resolve that an additional payment not exceeding £150 a year be made to a Demonstrator who is not a Fellow of a College, and a further additional payment of approximately £100 a year may be made for teaching in excess of the basic amount.

Candidates are requested to state their age and give the names of not more than three referees, together with any evidence of qualifications they may desire to submit. Applications should reach Dr. W. Rushton, Secretary of the Appointments Committee of the Faculty Board of Biology "B", University Physiological Laboratory, Downing Street, Cambridge, on or before Monday, July 9, 1945.

CITY OF LEICESTER EDUCATION COMMITTEE

LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: L. W. Kershaw, O.B.E., B.Sc., A.M.Inst.C.E.

APPLICATIONS are invited for the post of CHIEF LECTURER IN MECHANICAL ENGINEERING.

Applicants should possess a good honours degree with first class experience in teaching and in industry.

Ability to organize and carry out the teaching and course work required for candidates for the B.Sc. Engineering Degree of the University of London will be considered a recommendation.

The post ranks as a Senior Assistantship (salary £600 × £25 to £750 per annum) under the new Burnham Scales.

Further particulars of the duties attaching to the post may be obtained on receipt of a stamped foolscap envelope addressed to the Principal.

Applications, together with two testimonials and the names and addresses of two referees, should be forwarded to the Principal not later than June 23, 1945.

H. S. MAGNAY,
Director of Education.

CITY OF LEICESTER EDUCATION COMMITTEE

LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: L. W. Kershaw, O.B.E., B.Sc., A.M.Inst.C.E.

APPLICATIONS are invited for the post of LECTURER in the DEPARTMENT OF MATHEMATICS.

Applicants should have an Honours Degree in Mathematics.

Salary will be in accordance with the New Burnham Scale, with allowances for approved Teaching and Research experience.

Applications, together with copies of two recent testimonials and names of two persons to whom reference may be made, should be sent to the Principal, College of Technology and Commerce, The Newarke, Leicester, not later than June 23, 1945.

H. S. MAGNAY,
Director of Education.

UNIVERSITY OF ABERDEEN

LECTURESHIPS IN THE DEPARTMENT OF PHYSIOLOGY

The University Court will shortly proceed to the appointment of two Lecturers in the Department of Physiology, to commence duty on October 1, 1945, or a date to be arranged.

One Lecturer will require to have special knowledge of Experimental and Human Physiology, the other to have training and experience in Biochemistry.

Salary according to qualifications and experience. Scales of salaries are: Grade I, £650 to £800; Grade II, £500 to £650.

Persons desirous of being considered for either office are requested to lodge their names with the Secretary to the University on or before July 7.

The conditions of appointment and Form of Application may be obtained from the undersigned.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

UNIVERSITY OF ABERDEEN

STRATHCONA-FORDYCE CHAIR OF AGRICULTURE

The Strathcona-Fordyce Chair of Agriculture which is under the patronage of the Curators of the Chair is vacant through the resignation of Professor Sir John Orr, D.S.O., M.C., LL.D., F.R.S. Persons who desire to be considered for the post are requested to lodge their names with the Secretary of the University by August 31, 1945.

Conditions of appointment may be obtained from the undersigned.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

UNIVERSITY OF ABERDEEN

APPOINTMENT OF UNIVERSITY ASSISTANT IN CHEMISTRY

Applications are invited for the post of Assistant in the Department of Chemistry. The Assistant will require to have a special knowledge of Physical or Inorganic Chemistry. Salary £300 to £350 according to qualifications, and the Assistant will take up duty on October 1, 1945.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

UNIVERSITY OF BIRMINGHAM

Applications are invited for the post of Grade II(b) LECTURER IN MECHANICAL ENGINEERING. Candidates should have an Honours degree in Engineering with some practical experience, and a keen interest in research.

Commencing salary £500. Applications would be considered from candidates who are unable for a period to secure release from work of national importance.

Applications should be sent before July 31 to the undersigned, from whom further particulars may be obtained.

C. G. BURTON,
Secretary.

The University,
Birmingham, 3.

UNIVERSITY OF BIRMINGHAM

APPOINTMENT OF LECTURER IN DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for the post of Lecturer in Civil Engineering. Commencing stipend at the rate of £500 per annum.

Candidates must hold a University Degree and have had practical experience. They must be prepared to undertake research.

Three copies of application, with testimonials or references, must be sent on or before June 23 to the undersigned, from whom further particulars may be obtained.

C. G. BURTON,
Secretary.

The University,
Edmund Street,
Birmingham, 3.

UNIVERSITY OF LONDON

UNIVERSITY COLLEGE

Applications are invited for the position of Deputy Librarian. Applicants should be graduates of a British University and have had experience, preferably in a scholarly library. Salary not less than £650 per annum. The successful applicant will be required to take up his duties on or as soon as possible after August 1, 1945. Applications, accompanied by the names of two persons to whom reference may be made, should be received by the undersigned, from whom further particulars may be obtained, not later than June 25, 1945. E. L. Tanner, Secretary, University College, London (Gower Street, W.C.1).

CAMBRIDGE UNIVERSITY

The Vice-Chancellor gives notice that the Appointments Committee of the Faculty of Engineering will shortly proceed to appoint a University Demonstrator in Engineering. The appointment will be subject to the Statutes and Ordinances of the University.

Candidates are requested to address any inquiries, and to send their applications with particulars of qualification and experience to Dr. R. D. Davies, Secretary of the Appointments Committee, Engineering Laboratory, Cambridge, on or before Monday, July 2, 1945. Consideration will also be given to names submitted by the friends of those who are not in a position to communicate with the Secretary themselves.

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL SCHOOL

FARNBOROUGH, HAMPSHIRE

Applications are invited for three permanent appointments as LECTURER IN ENGINEERING SUBJECTS in the above apprentices' day school (one including Engineering Drawing).

Candidates should hold University Degree or equivalent, should have had some industrial and, preferably, teaching experience and be able to teach up to standard of Higher National Certificate. Duties will commence on September 1, 1945.

The salary payable will be in accordance with the Burnham Scale for teachers in Technical Schools and Colleges and will be subjected to the Teachers' Superannuation Act. Additional allowances may be made to a highly qualified candidate.

Write, quoting C.2641.A, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by June 26, 1945.

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL SCHOOL

FARNBOROUGH, HAMPSHIRE

Applications are invited for a permanent appointment as SENIOR LECTURER IN PRODUCTION ENGINEERING in above day school.

Candidates, who should hold a University Degree or equivalent, should have had considerable industrial and, preferably, teaching experience.

The successful candidate, who will be required to teach up to Higher National Certificate standard, will commence duties on September 1, 1945.

The salary payable (£600 to £750) will be in accordance with the Burnham Scale for Teachers in Technical Schools and Colleges and will be subjected to the Teachers' Superannuation Act.

Write, quoting C.2639.A, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by June 26, 1945.

COUNTY BOROUGH OF DONCASTER EDUCATION COMMITTEE

GRAMMAR SCHOOL

HEADMASTER: DR. S. E. J. BEST

Applications are invited for the post of full-time Laboratory Steward (Senior), which will become vacant on July 1, 1945. Duties include care and maintenance of furniture and apparatus; preparation of apparatus for class and demonstration use; proficiency in glass and metal work desirable; a knowledge of electrical installations will be expected; also ability to undertake simple instrument repairs. The Science Department is housed in 14 rooms and experience in a similar post will be a recommendation. Salary £208 × £13 to £234 plus War Bonus, which at the present time is £1 3s. per week. The post is pensionable under the Local Government Officers' Superannuation Act. The successful candidate will be expected to pass a medical examination.

Applications should be sent to the undersigned not later than June 20, 1945.

V. H. HOSKIN,
Chief Education Officer.

Education Offices,
Doncaster.

PORTSMOUTH MUNICIPAL COLLEGE

PRINCIPAL: L. B. BENNY, M.A.

DEPARTMENT OF PHARMACY

Applications are invited for the position of LECTURER IN PHYSIOLOGY, qualified to teach the subject to the standard of the Ph.C. and B.Pharm. Examinations. The Lecturer should also be able to assist with Pharmaceutical Chemistry, or any other subject of the Pharmacy Course. Salary according to the Burnham Technical Scale.

Particulars and forms of application may be obtained from the Registrar, the Municipal College, Portsmouth, to whom they should be returned not later than June 27.

E. G. BARNARD, M.A.,
Chief Education Officer.

UNIVERSITY COLLEGE OF WALES

ABERYSTWYTH

Assistant Lecturer in Agriculture required to commence duties in October. Salary £400. Applications should be sent to the Registrar (from whom further particulars can be obtained) by June 26, 1945.

UNIVERSITY COLLEGE OF WALES

ABERYSTWYTH

Special Lecturer in Biochemistry for a period of three years in the first instance, at an initial salary up to £800 according to qualifications and experience. The person appointed will be required to participate in the research programme of the Department of Animal Health and to take some part in the teaching of his subject in the Department of Chemistry. Six copies of application to be forwarded, not later than July 15, to the Registrar, from whom further particulars can be obtained.

UNIVERSITY COLLEGE OF WALES

ABERYSTWYTH

Assistant Lecturer in Agricultural Botany required to commence duties in October. Salary £400. Applications should be sent to the Registrar (from whom further particulars can be obtained) by June 26, 1945.

NORTH STAFFORDSHIRE ROYAL INFIRMARY

STOKE-ON-TRENT

Applications are invited for the post of Physicist to the Stoke-on-Trent Regional Radium Centre. Some experience in hospital physics is desirable. Applications stating age, qualifications, experience and salary required, together with copy testimonials to be forwarded, as soon as possible, to the House Governor.

WORKINGTON COUNTY SECONDARY SCHOOL AND CUMBERLAND TECHNICAL COLLEGE

REQUIRED IN SEPTEMBER:

Graduate Mistress for Biology. Games desirable. Burnham Scale. Applications (no forms issued) should be sent to the Principal.

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

Applications are invited for the CHAIR OF PHYSICS. Salary £1075 (N.Z. currency.) Allowance for travelling expenses. Appointment is for three years in the 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.

UNIVERSITY OF SYDNEY

CHAIR OF AGRICULTURE

The Universities Bureau of the British Empire have been instructed by the University of Sydney to announce that no further applications are required for the Chair of Agriculture recently advertised.

Applications are invited by a Research Association for the following posts:

WOMAN ABSTRACTOR with science degree or equivalent with experience in scientific and technical abstracting to assist in preparation of Abstracts covering: (a) Packaging Industries, (b) Printing and Allied Industries. Knowledge of Russian and/or Scandinavian languages an advantage. Initial salary between £275 and £400 per annum according to experience and qualifications. Superannuation under the F.S.S.U. Ref. F.4217.XA.

GRADUATE PHYSICAL CHEMIST, with research experience in Rheology or Surface Chemistry, to work on physical and chemical properties of adhesives used in Printing and Packaging Industries. Knowledge of Adhesive Industry an advantage. Initial salary between £500 and £650 per annum according to qualifications and experience. Superannuation under the F.S.S.U. Ref. F.4218.XA.

PHYSICAL CHEMIST with honours degree and aptitude for research. An interest in Surface Chemistry an advantage. Initial salary between £300 and £500 according to experience and qualifications. Superannuation under F.S.S.U. Ref. F.4219.XA.

Write, quoting appropriate reference number, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by July 12, 1945.

Overseas Employment—Government of Punjab, India. Applications are invited for post of Co-ordinator of Research and Principal, Punjab Agricultural College, Lyallpur. Candidates must be natural-born British subjects, not less than 45 years of age on March 23, 1945, with high academic distinctions in science, preferably in agriculture and sciences applied to agriculture; research experience in a scientific institution of renown, preferably connected with agriculture and allied sciences, and experience of administration in a College. Appointment for 5 years, subject to one year's probation and terminable at one month's notice. Pay Rs. 2,000 per mensem rising by annual increments of Rs. 50 to Rs. 2,250 per mensem (re. = 1s. 6d.) plus £30 per mensem overseas pay for appointee of non-Asiatic domicile. Rent-free bungalow. Free passage to and from India. Applicants should write, quoting F.4220.A, to the Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before June 26, 1945.

H.M. Colonial Service. Required, Lecturer in Biochemistry for the Yaba School of Medicine, Nigeria. Candidates must be British subjects preferably under 35 years, and have had lecturing experience. To teach organic chemistry, physiological chemistry and biochemistry to medical students in the pre-clinical stage at Yaba College and in addition to undertake all biochemical work for the hospitals at Lagos. Salary £550, £575, £600 × £30—£840. Initial salary above minimum offered exceptionally. Free quarters or allowance in lieu and free passages to the Colony. It is unlikely that selected officer's wife would be able to accompany husband on first appointment. Pensionable appointment after probationary period. Applicants should write, quoting F.4082.A, to the Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before June 25, 1945.

Sudan Government (Research Division, Department of Agriculture and Forests) has vacancy for a PLANT PATHOLOGIST. Age 22 to 34. Good University Degree with specialization essential. Good physique. Starting salary £E.480 to £E.780 according to age, experience and qualifications rising to £E.1,080 per annum. (£E1 = £1 0s. 6d.) Appointment on probation for pension. Free passage on appointment. At present there is no income tax in the Sudan. Applicants should write, quoting F.4139.A, to the Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before June 26, 1945.

Queen Mary College (University of London). Applications are invited for the position of Assistant Lecturer in Physical and Inorganic Chemistry; research facilities available; salary £350 to £400 p.a., according to experience. The appointment will date from September 1, in London. Applications (8 copies, naming 3 references) should be sent by June 30 to the Acting Registrar, Queen Mary College, c/o King's College, Cambridge.

Lecturer in Mechanical Engineering (temporary) required at Military College of Science, Stoke-on-Trent. Qualifications: preferably Honours Degree in Engineering with practical experience in engineering works or research laboratories in strength of materials and mechanical design. Salary £400 to £600 p.a. plus present war bonus £60 p.a., according to qualifications and experience. Write, quoting C.2645.A, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by June 26, 1945.

Laboratory Steward and two Junior laboratory assistants (either sex) required for a College Chemical Laboratory (Central London area). Apply, stating previous experience and salary required, to Box 370, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

12 vols. of Schlomann Illustrated Technical Dictionary in 6 languages, 1907–1920. Also eleven piece set Wichmann Precision drawing instruments in first class condition. Box P. 113, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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Medical Research in Sweden

A COMMITTEE of Swedish experts has drawn up plans for the establishment of a Central Council for Medical Research, and the granting of yearly allocations of Kr. 1,000,000 for medical research. The committee recommends that the annual sum of Kr. 400,000 should be granted for medical research at the Universities of Uppsala and Lund, the Caroline, Odontological and Veterinary Institutes, and that Kr. 600,000 should be put at the disposal of the Council. As projected, the sum of Kr. 400,000 is to be divided among the five university colleges every year. Further, the sum of Kr. 135,000 would be used for bursaries of Kr. 5,000 each for students' theses on medical and related subjects. The Council would, among other things, have the task of organizing collaboration between scientific men working on research in natural science and medicine.

Summer School in Social Biology

AT the Summer School in Social Biology which the British Social Hygiene Council (Tavistock House North, Tavistock Square, London, W.C.1) will be holding at University College, Nottingham, during July 28–August 11, interest will be directed chiefly to problems of education and social life likely to arise through the coming increase in the school-leaving age. The director of the School will be Prof. Winifred Cullis. The School is open to teachers, social workers and members of the general public interested in education and social problems from a biological angle. The morning lecture programme has been planned to illustrate the aims and content of social biology. Tea-time discussions will be reserved for subjects concerned with actual classroom problems of teaching social biology. In addition, an elementary course in the dissection of certain animal types will be available for those teachers who make special application. At the evening sessions lectures will be given by a distinguished group of visiting speakers on the broader application of biological knowledge to human life and culture. Acceptances to speak have been received from Prof. T. H. Pear, Sir Drummond Shiels, Dr. Otto May, Father Leycester King, Dr. Glover and Dr. David Mace. One special feature of the Summer School will be the Sunday sessions, at which lectures and discussions will be held upon the relation of biological science to "higher values and spiritual life". Further information about the School can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

South-Eastern Union of Scientific Societies

THE fiftieth annual congress of the South-Eastern Union of Scientific Societies will be held this year on July 7 at Harpenden, the headquarters being at the Rothamsted Experimental Station. The president-elect is Dr. W. G. Ogg, who will speak on some aspects of the work at Rothamsted, of which he is director. The sectional presidents and their addresses are: Mr. Edward Yates (archæology), "Church Chests"; Dr. W. E. Brenchley (botany), "Trace Elements"; Mr. P. Evans (geology), "Some New Weapons in the Geological Armoury"; Dr. C. S. Orwin (social science), "Country Planning"; Dr. E. S. Russell (zoology), "Fishing Research and the Overfishing Problem". The honorary general secretaries of the Union are Mr. A. Farquharson and Mr. F. J. Epps, 78 Dunwich Road, Bexley Heath.

University of London Appointments

DR. A. B. HILL, since 1933 University reader in epidemiology and vital statistics at the London School of Hygiene and Tropical Medicine, has been appointed to the University chair of medical statistics tenable at the School, as from October 1. During 1939–42 Dr. Hill was in charge of the Statistical Section in the Research and Experimental Department of the Ministry of Home Security, and since 1934 he has served part-time on the staff of the Medical Directorate of the Royal Air Force and was appointed consultant in medical statistics to the Royal Air Force.

Dr. Karl R. Popper, since 1937 senior lecturer in philosophy at Canterbury College, New Zealand, has been appointed to the readership in logic and scientific method tenable at the London School of Economics, as from October 1.

The title of reader in organic chemistry in the University of London has been conferred, as from October 1, on Dr. E. R. H. Jones, in respect of the post held by him at the Imperial College of Science and Technology.

Television—Past and Future

IN the account in *Nature* of May 26 of an address by Mr. H. L. Kirke, the statement is made (p. 622) that a mobile transmitter was "developed by the B.B.C." for supplying outside broadcast television features. Mr. Kirke writes stating that the script of his lecture read: "the pioneer development work in the use of Post Office cables in this way was done by the B.B.C.". He adds, "the development of the mobile transmitter was undertaken by Messrs. E.M.I., although I did not actually mention this in my lecture or in the script."

Announcements

SIR PEIRSON FRANK, chief engineer of the London County Council, has been elected president of the Institution of Civil Engineers for 1945–46.

AT the annual general meeting of the Institute of Physics, held on June 4, the following were elected to take office on October 1, 1945: *President*, Sir Frank Smith; *Vice-President*, Prof. A. M. Tyndall; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. J. A. Crowther; *Ordinary Members of the Board*, Dr. B. P. Dudding, Mr. A. J. Maddock, Prof. W. Sucksmith and Dr. C. Sykes. Prof. C. T. R. Wilson was elected an honorary fellow of the Institute.

MESSRS. NEWTON CHAMBERS AND CO., LTD., are providing the South Yorkshire Section of the Royal Institute of Chemistry with a sum of £100 per annum for five years for the award of an annual prize for contributions to the subject of chemistry and industrial welfare. The 1945 competition is open to any fellow, associate or registered student of the Institute who had not reached his thirty-sixth birthday by January 1, 1945, and the award is offered for an essay, paper or papers, published or unpublished, embodying the candidate's own observations, or experimental work, on some aspects of the application of chemistry to the promotion of industrial welfare. A critical examination of existing knowledge is admissible, provided that the conclusions reached constitute an addition to the knowledge of the subject. Papers must reach the honorary secretary of the South Yorkshire Section, Royal Institute of Chemistry, c/o Newton Chambers and Co., Ltd., Thorncliffe Works, Sheffield, by December 31, 1945.

LETTERS TO THE EDITORS

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

Dirac's Equation for the Neutron and Proton

IN the attempt to discover a place for Dirac's equation in the geometry and metric of the physical world, it has been proposed to make use of Weyl's concept of gauging. It was thus proposed to bring about the union of gravitation and electromagnetism by Kaluza's suggestion of the adoption of a five-dimensional continuum leaving the idea of gauging free to bring about the union of the quantum theory with these branches of physics.

In order to carry out this idea, it was found necessary to introduce the concept of matrix-length and to apply a parallel displacement to it. A gauging factor, ψ, was introduced which was identified with the ψ of Dirac's equation. The result of the argument was the equation

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = 0,$$

as the condition that there should be no change in length in a parallel displacement. In this equation the matrices (γ^μ) are five in number and are readily related to the familiar Dirac matrices. The equation can be regarded as a gauging equation and is identical with Dirac's equation[1].

In the original work the equation was more general and can be expressed in the form:

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = H_\mu \gamma^\mu \psi.$$

This is the result of a close analogy with the idea of Weyl that a change of length occurs with a parallel displacement, and in place of the electromagnetic potential (φ_μ), the operator (H_μ) occurs. It appeared from the identity of the equation, which resulted from placing $H_\mu = 0$, with Dirac's equation that the purpose of incorporating Dirac's equation in a natural way into physical theory was achieved by this simple condition. But the development of the theory of the nuclear field has shown that it bears to the five-dimensional framework a relation similar to that which exists between the electromagnetic theory and gravitation[2]. Thus it would be natural to drop the simple equation $H_\mu = 0$ when a nuclear field exists. If we can decide upon the correct expression for H_μ in this case, the result should lead to Dirac's equation for the neutron and proton.

Following Weyl, it would be expected that H_μ depended linearly upon the potential components, usually denoted by U_μ. But in the five-dimensional theory these are the components, ($T_{\mu\nu}$), of the tensor of the nuclear field in which the suffix 5 appears. Thus it is in the interest of generality to express H_μ linearly in terms of the components, $T_{\mu\nu}$.

The simplest operator form is that which results from combining the matrices (γ^μ) with ($T_{\mu\nu}$) in order to produce a covariant quantity H_μ. At the same time it is necessary to include the matrices $\tau = \begin{pmatrix} 00 \\ 10 \end{pmatrix}$ and $\tau^* = \begin{pmatrix} 01 \\ 00 \end{pmatrix}$ to account for the neutron-proton interchange. Thus the simplest form is $H_\mu = g\gamma^\nu(T_{\mu\nu}\tau + T^*_{\mu\nu}\tau^*)$, where g is a constant, and where as usual in the field theory we combine $T_{\mu\nu}\tau$ and its conjugate complex quantity. Thus the proposed quantum equation for the neutron and proton is

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = g\gamma^\nu\gamma^\mu(T_{\mu\nu}\tau + T^*_{\mu\nu}\tau^*)\,\psi.$$

This equation appears in a paper by H. J. Bhabha[3], in which he develops equations for the nuclear field by the Hamiltonian method. A characteristic feature of the form of the equation developed here is the appearance of one constant, g, only. In other presentations the field is characterized by the appearance of two constants, g_1 and g_2. It would appear from this equation that $g_1/g_2 = 2\pi M_0 c/h$, where M_0 is the mass of the particle emitted in the neutron-proton interchange. This agrees with the five-dimensional formulation of the nuclear theory[4].

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[1] Flint, *Proc. Roy. Soc.*, A, 150, 432 (1935).
[2] Flint, *Phil. Mag.*, vii, 29, 330 (1940).
[3] Bhabha, *Proc. Roy. Soc.*, A, 166, 520 (1938).
[4] Flint, *Phil. Mag.*, 7, 33, 369 (1942).

Coloured Haloes Surrounding Inclusions of Monazite in Quartz

QUARTZ crystals with zonal colour from the Transbaikal region were found with inclusions of monazite crystals (diameter 0·1–1·0 mm.) around which the quartz was of an intense smoky colour. The coloration, more intense at the centre, shaded off gradually towards the periphery of the halo. Although the boundaries of the halo were not sharp, yet they were sufficiently distinct to enable measurements of the halo to be made (Fig. 1). Haloes of all dimensions from 0·5 mm. to 5–6 mm. diameter can be found in the same quartz specimen.

The formation of these spherical haloes can be attributed to the corresponding radioactive emanations (β or γ). Calculations have shown that haloes of such dimensions and with sufficiently well-marked boundaries could be produced by the action on quartz of hard β-rays (in quartz $\mu \simeq 10$ cm.$^{-1}$) spreading

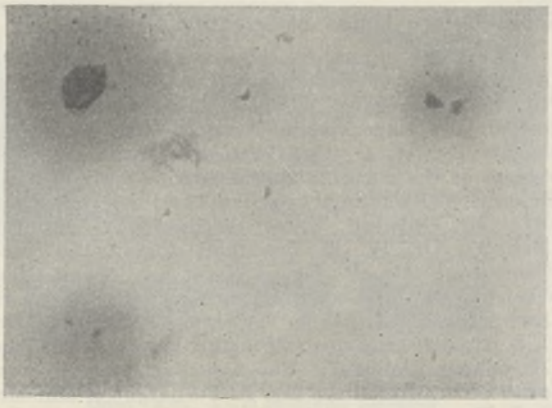

Fig. 1. × about 7.

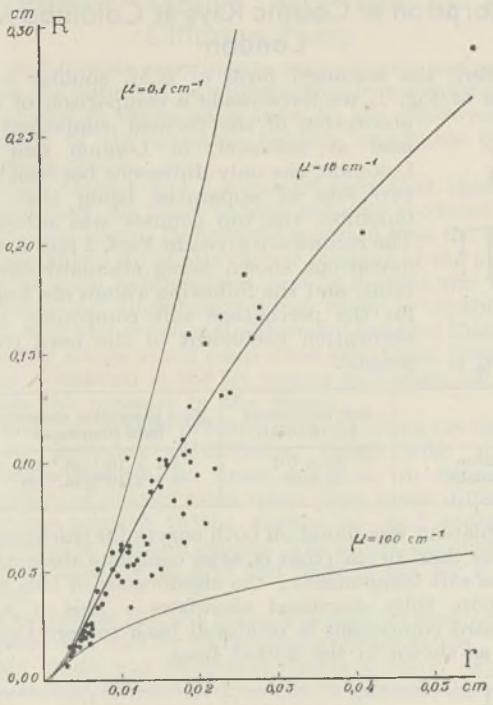

Fig. 2.

from the monazite and presumably emanating from disintegration products of thorium contained in monazite. These spherical haloes in quartz are the first clearly observed natural colouring action of β-rays, and can be called β-haloes to distinguish them from the well-known concentric α-haloes.

For haloes of the same geological age (in the same quartz specimen), the radius r of the inclusion can be related, as a first approximation, to the radius R of the halo by the equation $r = \sqrt[3]{kR^2e^{\mu R}}$, confirmed by observation (Fig. 2).

With geological ageing, owing to accumulation of the pigment, the boundaries of the halo gradually extend. After comparing the action on a given specimen of a standard preparation to determine the constant k, an attempt can be made to determine approximately, from the length of the radius of the β-halo, the time necessary for the production of a just perceptible coloration in the quartz, at a given distance from a source of given intensity. The formula: $t \simeq \tau \ln [(k^1Q_t^{-1} R^2e^{\mu R}) + 1]$, where $\tau = 1/\lambda$ (λ is coefficient of disintegration) enables such calculations to be made.

In addition to the intensity of the source of radiation and the time of action, the radius of the β-halo depends also on the power of the given medium to colour, that is, the degree of its sensitivity (due possibly to presence of Fe). Thus sometimes, far beyond the boundaries of the halo itself, in the more sensitized layers of the quartz crystal, traces of the action of the radiation can be observed as coloured streaks.

By artificial action of, say, X-rays, the whole crystal becomes coloured and layers of more intense colour appear which were not apparent before. Previously only those layers of quartz were coloured, considerably fainter than the haloes, which were formed at a time when monazite crystals were being deposited. The quartz presumably adsorbed from solution the sensitizing as well as the active admixture. This occurred in periods of growth following periods of rest or even re-solution of the crystal due to external phenomena, indicated by the rounding of zones at the apexes and edges of the crystal below the coloured zones where inclusions of monazite with surrounding β-haloes are found.

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Chromatography of Two Solutes

THE complete theory for the chromatography of a single solute has been given recently[1,2], but the general case of two or more solutes has not yet been solved[2,3].

We consider the problem for two solutes I and II, where the amounts adsorbed are given by the respective adsorption isotherms:

$$q_1 = f(c_1,c_2) \quad , \quad q_2 = g(c_1,c_2).$$

There is no need to assume a specific form for f and g, but we shall suppose, what is almost certain to be the case, that they are regular functions of c_1 and c_2 for small c_1 and c_2.

It is well known that the following differentia equations are satisfied:

$$\frac{\partial c_1}{\partial x} + \frac{\partial f}{\partial v} = 0 \ , \ \frac{\partial c_2}{\partial x} + \frac{\partial g}{\partial v} = 0. \qquad (1)$$

One can show that under normal initial conditions c_1 and c_2 are functions of v/x. However, sometimes in the subsequent development of the bands with pure solvent this may cease to be true.

Writing $y = \frac{v}{x}$, we can show that either $\frac{dc_1}{dy} = \frac{dc_2}{dy} = 0$ which implies that c_1 and c_2 are constants, or

$$\frac{df}{dc_1} = \frac{dg}{dc_2} = y; \qquad . \quad . \quad . \qquad (2)$$

from which we deduce that:

$$\frac{dc_1}{dc_2} = \frac{2f'_{c_2}}{(g'_{c_2} - f'_{c_1})} \left\{ 1 + \sqrt{1 + \frac{4f'_{c_2}\, g'_{c_1}}{(g'_{c_2} - f'_{c_1})^2}} \right\}^{-1}.$$

This equation determines c_1 as a function of c_2, and then each can be obtained as a function of (v/x) from the relation:

$$\frac{v}{x} = f'_{c_1} + \frac{2f'_{c_2}\, g'_{c_1}}{(f'_{c_1} - g'_{c_2})} \times \left\{ 1 + \sqrt{1 + \frac{4f'_{c_2}\, g'_{c_1}}{(g'_{c_2} - f'_{c_1})^2}} \right\}^{-1} \qquad (3)$$

It has been shown already by Wilson[3] and de Vault[2] that if a chromatogram is made from a solution of two substances, the normal result is to obtain a band in which the two solutes I and II are mixed in constant proportions determined by the original concentrations, and then below this a band containing only one of the solutes with a uniform distribution determined by the original concentrations.

If the original concentrations do not differ greatly, then the lower band will usually contain the solute which is the less strongly adsorbed. However, if the concentration of one solute is small compared with the other, then the lower band may very likely contain the more concentrated even when it is the more strongly adsorbed component. For convenience of expression, we shall always suppose that the lower band consists of solute II.

When we develop the chromatogram with pure solvent, both bands move down the tube and a third band is formed at the top. This new band consists of solute I if

$$(f'_{c_1})_{\substack{c_1=0\\c_2=0}} > (g'_{c_2})_{\substack{c_1=0\\c_2=0}}; \quad . \quad . \quad (4)$$

and of solute II if the inequality opposite to (4) is satisfied. The resulting chromatogram will normally consist of a band of solute I of varying concentration, a band of a mixture of solute I and II, and below this a band of solute II. However, if the original concentration of the solute I is small compared with that of II, and if the opposite inequality to (4) is satisfied, then we may have a band of II, a mixed band and then a band of solute II again and no free solute I.

Let us suppose that the inequality (4) is satisfied. The top edge of the band of solute I after development with a volume v of pure solvent will then be given by:

$$\frac{v}{x} = (f'_{c_1})_{\substack{c_1=0\\c_2=0}}; \quad . \quad . \quad . \quad (5)$$

and the top edge of the band consisting of a mixture of solutes I and II by the simultaneous equations:

$$\frac{v}{x} = (f'_{c_1})_{c_2=0} = (g'_{c_2})_{c_2=0}.$$

This enables us to estimate the amount of solute I set free by development with a given volume of pure solvent and the volume of pure solvent required to separate completely the two solutes. If $F(c_1) = f(c_1,0)$ and if c'_1 is determined by:

$$F'(c'_1) = [g'_{c_2}(c'_1, c_2)]_{c_2=0}, \quad . \quad . \quad (6)$$

then the amount of pure solute I after development with volume v will be

$$v\left\{\frac{F(c'_1)}{F'(c'_1)} - c'_1\right\}.$$

If the original chromatogram was formed from a volume v_0 of the solutes I and II, then the volume v of pure solvent required to separate completely the solutes is given by:

$$v\left\{\frac{F(c'_1)}{F'(c'_1)} - c'_1\right\} = v_0 c_1^0, \quad . \quad . \quad (7)$$

where c'_1 is given by (6) and c_1^0 is the original concentration of solute I.

A full account of the theory will be published elsewhere, and related experimental work is in progress.

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[1] Weiss, J., *J. Chem. Soc.*, 297 (1943).
[2] de Vault, D., *J. Amer. Chem. Soc.*, **65**, 532 (1943).
[3] Wilson, J. N., *J. Amer. Chem. Soc.*, **62**, 1583 (1940).

Absorption of Cosmic Rays at Colombo and London

USING the standard form of G.M. counter telescope of Fig. 1, we have made a comparison of the absorption of the vertical component in lead at sea-level, in London and at Colombo, the only difference between the two sets of apparatus being that, at Colombo, the top counter was missing. The results are given in Figs. 2 and 3, the deviations shown being standard deviations, and the following values are found for the percentage soft component and absorption coefficient of the hard component.

Fig. 1.

	Soft component (% of total)	Mass absorption coefficient hard component
London	$29 \pm 0{\cdot}7$	$5{\cdot}1 \times 10^{-4}$ cm.^{2}/gm.
Colombo	23 ± 1	$5{\cdot}1 \times 10^{-4}$ cm.^{2}/gm.

A plateau was found on both curves for thicknesses greater than 10 cm. (that is, after complete absorption of the soft component); the significance of this will be more fully discussed elsewhere. This is why the hard component is produced back to zero thickness as shown in the dotted lines.

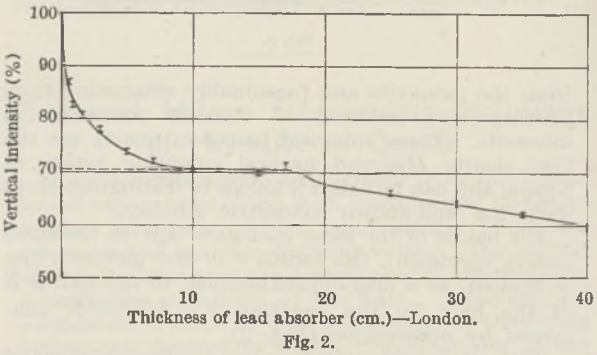

Fig. 2.

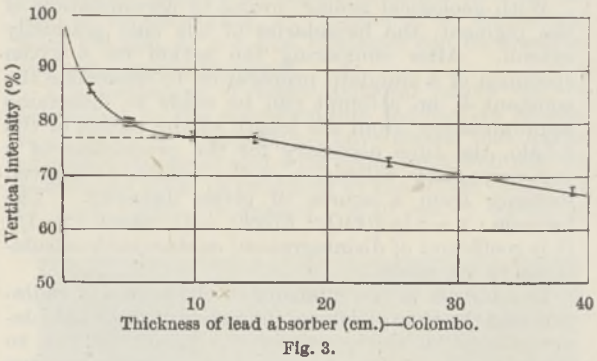

Fig. 3.

The absorption coefficient of the meson or hard component is found to be the same in both places and agrees with that found by other workers[1], but there is a significant drop in the percentage of the electronic or soft component at Colombo.

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[1] Sittkuss, *Z. Phys.*, **108**, 432 (1938).

Ultimate Vacuum Attainable by a Diffusion Pump

THE following experiments were recently performed to see the nature of pumping action inside a diffusion pump and to throw some light on the controversial question of the ultimate vacuum attainable by a diffusion pump.

While Gaede[1] and Langmuir[2] held that there is theoretically no limit to the vacuum produced by a diffusion pump, Hickman[3,4] reported that the limit of pumping is set at the vapour pressure of the pump fluid at room temperatures, and he devised the 'self-fractionating' oil-diffusion pump which is capable of producing higher vacuum. Newman[5] believed that the pumping action would cease when the partial pressure of air, contained in the jet vapour as contamination, equals the pressure in the vessel.

Table 1 shows the pressure gradient down the barrel of an orthodox oil-diffusion pump with single umbrella-type jet, all brass and 4-in. in diameter. Tappings of nozzles were taken from seven different positions relative to the vapour jet, and could be connected to vacuum gauges. The pump was charged with Apiezon oil *B*, and had been in use for a few weeks.

A rubberless McLeod gauge was used for reading the pressure and also for calibrating a Pirani gauge. The Pirani gauge was calibrated across a liquid oxygen trap, so that without the trap the Pirani reads the total pressure (partials of air and vapour), as contrasted with a McLeod gauge which reads air pressure only.

Table 2 shows the vacuum (partial and total) attained by a three-stage mercury diffusion pump without a cold trap.

It is brought out clearly by the experiments that a diffusion pump can reduce the partial pressure of air far below the vapour pressure of the fluid, and so long as the pump is running, the vessel is not filled with the fluid vapour up to its saturation value for the room temperature. The partial pressure of air contamination of the jet will, similarly, not manifest itself fully in the vessel.

The successful functioning of a diffusion pump is apparently vitally dependent on the streamline issue of the jet vapour, and the small differences of vapour pressure of the fluid are not likely to affect the vacuum to any great extent. A perfect streamline flow of the jet vapour directed away from the diffusion aperture (neck) would cause only the diffusing out of the air (or vapour, etc.) from the vessel into the jet stream, where the molecules would be caught by the forward stream of vapour and knocked on towards the backing pump, and would lead theoretically to perfect vacuum with time.

TABLE 1. DISTRIBUTION OF PRESSURE IN μ (10^{-3} MM. HG) INSIDE A SINGLE-STAGE OIL-DIFFUSION PUMP (WITHOUT A TRAP).

Position of tappings relative to vapour jet	Pressure measured by McLeod gauge (partial press. of air)	Pressure measured by Pirani gauge (total press.)	Partial press. of oil vap. = diff. of cols. 2 & 3	Ratio of vap. press. to air press. = col. 4 / col. 2
1	2	3	4	5
1. 7·0 in. above jet	0·05	0·40	0·35	7
2. 3·0 in. above jet	0·02	0·26	0·24	12
3. 1·5 in. above jet	0·03	0·23	0·20	6·6
4. At the jet	4·0	6·0	2·0	0·5
5. 1·5 in. below jet	2·5	8·0	5·5	2·2
6. 3·0 in. below jet	2·0	5·0	3·0	1·5
7. 6·5 in. below jet (at backing)	2·0	4·0	2·0	1·0

TABLE 2. VACUUM PRODUCED BY A THREE-STAGE MERCURY-DIFFUSION PUMP. PRESSURE IN μ OR 10^{-3} MM. HG. (WITHOUT A TRAP).

Measured by McLeod gauge	Measured by Pirani gauge	Partial press. of Hg (diff. of 1 and 2)	Vapour press. of Hg at room temp. 26°C.	Ratio of back diffusion of mercury vap. to saturation pressure = col. 3 / col. 4
1	2	3	4	5
0·02	0·50	0·48	2·0	0·24

The practical vacuum, however, would depend upon the degree of back-streaming at the jet for several reasons, chiefly, the imperfection of the jet design, and the turbulence and pressure condition below the jet. The back-diffusion consists of vapour (easy to freeze out) as well as air. The latter (air) comes from the contaminated fluid from the boiler where the fluid returns through the air-laden column at the lower ('compression') part of the diffusion pump barrel. The turbulent condition set up by the abrupt rise of pressure below the single jet is also responsible for the back-escape.

The process of 'self-fractionation', originated by Hickman, not only helps in grading out the degenerated fractions of the oil but also helps very much in freeing oils of the inner compartments from air contamination. The inclusion of a number of jets in the fractionating pump also helps in getting more perfect streamline flow of vapour at the upper jets. This picture accords well with the success of a fractionating oil diffusion pump without laying too much stress on the vapour pressure of pump fluid, as demanded by the diffusion theory and the present experimental evidence.

Work is in progress and the details will be published elsewhere.

Our thanks are due to Prof. M. N. Saha for his keen interest in the work. Our thanks are also due to Mr. J. R. Basu Mallik, for designing the tappings and getting the oil diffusion pump constructed for the purpose. We also acknowledge our thanks to the authorities of the Board of Scientific and Industrial Research for kindly permitting the work to be published.

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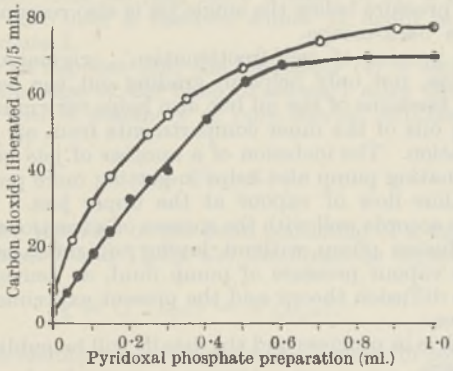
[1] Gaede, W., *Ann. Phys.*, **46**, 357 (1915).
[2] Langmuir, I., *Phys. Rev.*, **8**, 48 (1916).
[3] Hickman, K. C. D., *J. Frank. Inst.*, 221, 215 (1936).
[4] Hickman, K. C. D., *J. App. Phys.*, 11, 303 (1940).
[5] Newman, F. H., "Production and Measurement of High Vacuum", 52.

Codecarboxylase Function of 'Pyridoxal Phosphate'

SIX specific amino-acid decarboxylases have now been obtained in a cell-free state from various bacteria[1,2,3,4]. Of these, the enzymes decarboxylating *l*(+)-lysine, *l*(−)-tyrosine, *l*(+)-arginine and *l*(+)-ornithine have been resolved into apoenzyme moieties activated by the presence of a common codecarboxylase of which a concentrate has been prepared from yeast[5]. The remaining enzymes,

specific for *l*(−)-histidine and for *l*(+)-glutamic acid, have not been resolved and appear not to contain codecarboxylase. The four codecarboxylase enzymes are highly sensitive to cyanide, hydrazine, hydroxylamine and semicarbazide, suggesting that a keto-group is involved in their action[4].

Strains of *S. fæcalis* which possess tyrosine decarboxylase are unable to produce the enzyme when grown in a simplified medium[6], the active enzyme being formed only if the medium contains amounts of nicotinic acid and pyridoxin in excess of simple growth requirements[7]. Organisms grown in pyridoxin-deficient media are almost inactive towards tyrosine but can be activated by the addition of pyridoxal to the suspensions[8]; if the cells are dried, then pyridoxal is active in the presence of adenosine-triphosphate but inactive alone[9]. In the latter case an active substance can be obtained by treating pyridoxal with thionyl chloride followed by silver dihydrogen phosphate or with phosphoric acid alone[9]. Pyridoxal and pyridoxamine act as the 'pseudo-pyridoxin' growth-factor for *S. lactis* R.[10].



EFFECT OF 'PYRIDOXAL PHOSPHATE' CONCENTRATION ON RATE OF DECARBOXYLATION OF *l*(−)-TYROSINE BY TYROSINE APO-DECARBOXYLASE (●—●); OF *l*(+)-LYSINE BY LYSINE APO-DECARBOXYLASE (○—○).
Manometer cups contain: 0·3 ml. apo-enzyme preparation; 0·5 ml. *M*/15 tyrosine or lysine; 1·5 ml. *M*/5 acetate buffer *p*H 5·5 (tyrosine enzyme) or *M*/5 phosphate buffer *p*H 6·0 (lysine enzyme); water/'pyridoxal phosphate' preparation to 1·0 ml. Temperature = 30° C.

We have now tested the codecarboxylase activity of 'pyridoxal phosphate' with the apo-decarboxylases specific for lysine, tyrosine, arginine and ornithine prepared and tested under optimal conditions as previously described[1,2,4]. We obtained pyridoxal in about 20 per cent yield by oxidation of pyridoxin with neutral potassium permanganate under conditions similar to those described by Harris, Heyl and Folkers[11]. The 2 : 4-dinitrophenylsemicarbazone was prepared, m.p. 212° (found: C, 46·1; H, 4·0; $C_{15}H_{14}N_6O_7$ requires C, 46·2, H, 3·6 per cent). Pyridoxal was inactive as codecarboxylase when tested against tyrosine apo-decarboxylase but was activated if incubated in the presence of the enzyme preparation and adenosinetriphosphate. Before phosphorylation, pyridoxal was purified through the oxime and acetal, and the hydrochloride of the aldehyde then refluxed for five minutes with an excess of thionyl chloride before standing overnight. Excess reagent was removed *in vacuo* and the product shaken with a suspension of silver dihydrogen phosphate in glacial acetic acid for 24 hours. Filtration followed by removal of acetic acid *in vacuo* left a resin. This was dissolved in water and silver ions removed by addition of dilute hydrochloric acid. The preparation was preserved as the lead salt.

TABLE 1. CODECARBOXYLASE ACTION OF 'PYRIDOXAL PHOSPHATE'. Activities estimated manometrically, as previously described[1,2,4].

Apo-enzyme	μl. CO_2 liberated from substrate/5 min. Alone	+ excess codecarboxylase	+ excess 'pyridoxal phosphate'
l(−)-Tyrosine decarboxylase	2	110	116
l(+)-Lysine decarboxylase	15	106	104
l(+)-Arginine decarboxylase	15	70	75
l(+)-Ornithine decarboxylase	29	78	74

Table 1 shows that the preparation is active as codecarboxylase for the four enzymes, and the accompanying figure shows the shape of the curves obtained by adding increasing amounts of the preparation to a given amount of the apo-enzymes of lysine and tyrosine decarboxylases and measuring the resulting decarboxylase activities. Codecarboxylase from yeast is stable to mild alkaline hydrolysis and unstable to acid[5]; table 2 shows that the active material in the 'pyridoxal phosphate' preparation has similar stabilities. Proof of the identity of the synthetic and natural products must await their isolation in a pure state: the concentrate of natural product was stated formerly to be phosphate-free (Weiler)[5], but this has now been submitted to re-analysis and proves to contain 0·8–1·0 per cent P (Roche). Assuming that the dissociation constant for the tyrosine apo-decarboxylase-coenzyme complex is of the same order as that determined indirectly for pyridoxal using inactive whole organism[8], it is possible to calculate the approximate yield of 'pyridoxal phosphate' from the curve for the recombination of tyrosine decarboxylase: in two preparations the yield of 'pyridoxal phosphate' calculated on this basis represents approximately 0·1 per cent of the pyridoxin used.

TABLE 2. STABILITIES TO ACID AND ALKALI OF CODECARBOXYLASE AND 'PYRIDOXAL PHOSPHATE'.
Activities expressed as units codecarboxylase/ml. preparation estimated against tyrosine apo-decarboxylase[5].

Treatment	Codecarboxylase Units/ml.	'Pyridoxal phosphate' Units/ml.
Initial (untreated)	32	23
After 1 hr. at 100° C.		
(*a*) in 0·1 *N* NaOH	31	24
(*b*) in *N* NaOH	31	20
(*c*) in 0·1 *N* H_2SO_4	11	7

Failing the isolation of the active substance in a pure state, it is not possible to assign a formula to it with certainty, but from the nature of the reactions described above, it seems probable that 'pyridoxal phosphate' bears a phosphoryl residue on the primary hydroxyl group of pyridoxal.

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Effect of Change of Coat on the Growth of Epidermal Warts in Mice

THE paper on the artificial production of coat colour in the albino rat by Haddow and others[1] throws light upon some observations, recently made, on the growth of epidermal tumours in mice in relation to the growth of the nearby hair. The results had already been written up and are as follows.

It is well known that epidermal warts in mice produced by painting with tumour-producing agents often show periods when their growth-rate is reduced or their size diminished, or they may even temporarily disappear. Having occasion to observe the growth of hair near warts for other purposes, it was noted that diminution in growth of the warts occurred when in black mice the surrounding skin, normally pale, became pigmented as it does when the hair bulbs are enlarging preparatory to the formation of a new coat. In white and pale-coloured mice, this early growth of the hair bulbs cannot be seen, and the onset of a new coat shows itself later by the eruption of new hair.

The correlation between pigmentation of the skin in black mice and diminished growth of the warts thereon is shown in Fig. 1.

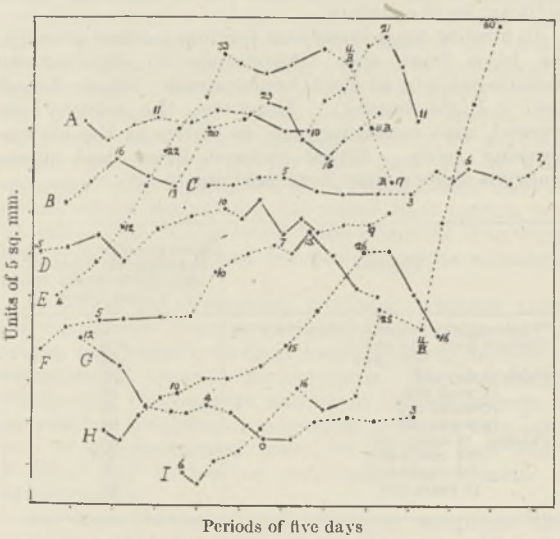

Fig. 1. THE FIGURE SHOWS THE SUPERFICIAL DIMENSIONS (MAJOR × MINOR AXES) OF EPIDERMAL WARTS IN BLACK MICE, PRODUCED BY PAINTING WITH BENZPYRENE, PLOTTED AGAINST TIME. DOTTED LINES INDICATE TIMES WHEN THE SKIN AROUND THE WARTS WAS PALE AND FULL LINES WHEN IT WAS PIGMENTED. THE NUMBERS ON THE LINES GIVE THE AREA OF THE WARTS IN SQ. MM.

Times of pigmentation are clearly associated with diminished growth of the warts. Bleeding (*B*) and ulceration (*U*) of the warts also have this effect (see warts *E* and *I*). Wart *H* disappeared for a short time at *O*. The periods of pigmentation are about a week in duration.

Many warts are of a full pink colour during life; but as soon as the surrounding skin became pigmented, it was noticed that they changed from pink to white or bluish-white, suggesting that their blood supply had been greatly reduced. Sections were therefore made of the skins of black mice in various stages of hair growth, and it was found that the capillaries surrounding the hair bulbs were widely dilated with blood when they were actively growing and forming pigment: at the same time, it was noted that the capillaries of the dermal papillæ were much less in evidence than in skins in which the hair bulbs were quiescent.

The conclusion was drawn that the growing hair bulbs caused a diversion of blood to them and away from the overlying epidermis and warts; hence their blanching, their lowered growth-rate and diminution in size.

If a rosy and a blanched wart be ligatured during life, fixed and sectioned, there is seen a great difference in the extent to which the capillaries and venules are distended with blood, sufficient to account for the considerable diminution in size and the complete flattening out of small warts.

The number of mitoses in the epidermis was counted before, during and after hair growth, and it was found that the number was greatly reduced during the time when the hair bulbs were actively growing. Details of these findings are given in Fig. 2.

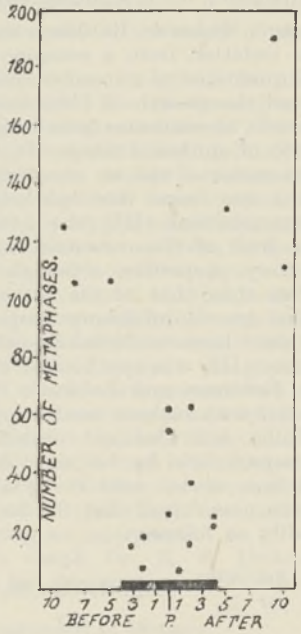

Fig. 2. THE FIGURE SHOWS THE NUMBER OF METAPHASES PER 100 MM. OF SECTIONS OF SKIN 7 μ THICK ON DAYS BEFORE, DURING AND AFTER PIGMENTATION OF THE SKIN (*P*) IN PREPARATION FOR A CHANGE OF COAT. ALL SPECIMENS WERE TAKEN AT 10 A.M. TO AVOID DIURNAL VARIATION. THE BLACK BLOCK INDICATES THE DURATION OF PIGMENTATION.

This inhibition of mitosis is presumably the result of the lessened blood supply to the epidermis. Though a lowered rate of mitosis can account for the warts growing more slowly, it cannot account for their diminution in size as can the collapse of blood vessels.

Thus was independently observed the close correlation between hair growth and dilatation of the local capillaries, described by Haddow. He suggests that variation in blood supply controls hair growth; but it may be the reverse, that hair follicles stimulated to grow call forth capillary dilatation. In either case, secondary effects follow: a diminution of blood supply to the epidermis and a temporary lowering of epidermal cell division.

The way in which new coats of hair spread gradually across the skin, as described by Haddow, for the rat, was also seen in the mouse. In the mouse there is a lateral line down the flank, well seen in black and tan mice, along which new coats of hair start and spread either dorsally or ventrally, not both ways

at any one time. When mice are painted on the flanks with single applications of benzpyrene, the yield of tumours is affected by the condition of the hair at the time of painting, but because the spread of the new coat is very easily disturbed, for example, by plucking the hair or even by clipping it, controlled conditions are difficult to maintain. This confirms Haddow's finding that coat change is easily disturbed.

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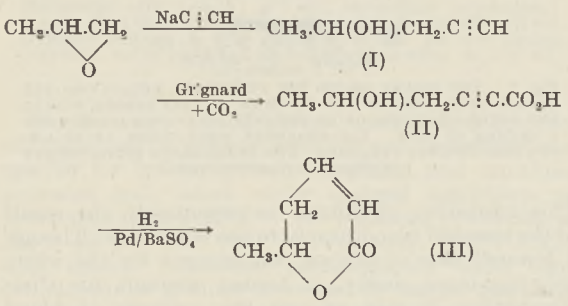
Synthesis of the Differential Growth Inhibitor, δ-Hexenolactone

Two years ago, Medawar, Robinson and Robinson[1] described the isolation from a commercial malt extract of small quantities of a steam-volatile substance which inhibited the growth of fibroblasts and other mesenchyme cells at concentrations which permitted the free growth of epithelial tissue. It seemed probable that this material was an unsaturated lactone, $C_6H_8O_2$, and it was found that synthetic specimens of *dl*-δ-$\Delta^{\alpha\beta}$-hexenolactone (III) (the *d*-form of which occurs in the fruit of the mountain ash) exhibited similar inhibitory properties, although the activity was rather less than that of the natural inhibitor. The differential growth-inhibitory properties of this lactone have since been confirmed by other workers[2].

The *dl*-lactone (III) was synthesized in small yield by Medawar, Robinson and Robinson by condensation of acetaldol with malonic acid in pyridine solution, and Kuhn and Jerchel[3] obtained it from β : δ-dibromocaproic acid by boiling with water, the overall yield from sorbic acid being about 25 per cent. We have now found that the lactone can be prepared readily as follows :



Condensation of propylene oxide with sodium acetylide in liquid ammonia gives the carbinol (I) in 50 per cent yield. Treatment of the carbinol with two equivalents of ethylmagnesium bromide followed by carboxylation with carbon dioxide under pressure results in a 75 per cent yield of the crystalline hydroxyacetylenic acid (II), m.p. 59°, which on semihydrogenation employing a 0·3 per cent palladium – barium sulphate catalyst gives *dl*-δ-$\Delta^{\alpha\beta}$-hexenolactone directly, as a colourless stable oil, the overall yield from propylene oxide being about 35 per cent. The constants of the lactone are in agreement with those recorded by Kuhn and Jerchel[3], and it exhibits the expected growth-inhibitory action*.

* We are indebted to Sir Robert Robinson and Dr. Medawar for a report on the inhibitory properties.

This synthesis has the advantage of being readily adaptable to the preparation of related lactones, and these lines are being actively pursued.

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Metabolism of Quinine in Chick Livers

IN a recent paper Oldham, Kelsey, Cantrell and Geiling[1] reported that in White Leghorn chicks dosed with quinine the concentrations of alkaloid in the tissues were lower in young chicks than in grown birds. They suggested that quinine was metabolized more rapidly in chicks than in older birds. *In vitro* experiments by these workers on the quinine oxidase activity of the tissues, however, failed to show any activity in the liver, and showed only very slight activity in the kidney.

In similar experiments on quinine oxidase activity, we have been able consistently to demonstrate definite activity in chick livers (strain : Rhode Island Red × Light Sussex). Moreover, the activity decreased with increasing age, as shown in the accompanying table. Chick embryo livers and whole embryos show a very high activity.

Material	Mean quantity of quinine (micrograms) metabolized in 2 hours by 0·5 gm. tissue
Whole embryo (10 day) (wt. unknown)	720
Embryo liver (10 day)	216
,, ,, (20 day)	154
Chick (1 day old)	87
,, (1 week old)	97
,, (2 weeks old)	69
,, (4 weeks old)	94
Chicken (8 weeks old)	53
,, (17 weeks old)	45
,, (26 weeks old)	19
,, (3 years old)	26

The discrepancy between our observations and those of Oldham *et al.* might be partly due to the fact that we used the phosphate buffered salt solution of Krebs and Henseleit[2] instead of ordinary Ringer-Locke solution, and also raised the temperature of incubation to 40° C. to correspond with the body temperature of the birds. In one experiment on the liver from a three-week old chick in Ringer-Locke, only 30 micrograms of quinine were metabolized. Other causes of the difference of results might be differences in the strain of birds used, or dietary variations. We have in some cases experienced large variations in the quinine oxidase activity among birds of similar age.

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Meiosis in Tropical *Rhoeo discolor*

MEIOSIS in *Rhoeo discolor* growing under temperate conditions has been described by Bhaduri[1], Darlington[2,3], Sax[4], Sax and Anderson[5] and by Kato[6], but the last-named author's work has not been available. An examination of two collections of tropical material, (1) from St. Augustine, Trinidad, and (2) from the Botanic Gardens, Port of Spain, has revealed certain interesting features which are reported below.

Metaphase associations are given in Table 1, for the two collections separately.

TABLE 1. METAPHASE ASSOCIATIONS IN *Rhoeo discolor*.

Coll.	Ring of 12	Chains 12	10-2	9-3	8-4	6-4-2	other	Total
(1)	6	9	3	3	1	3	15	40
%	15·0	22·5	7·5	7·5	2·5	7·5	37·5	100
(2)	5	10	3	2	3	2	5	30
%	16·7	33·3	10·0	6·7	10·0	6·7	16·7	100

In the first collection, none of the rings of twelve and two only of the chains were disjunctionally arranged, while the corresponding figures for the second collection were one and five respectively. Thus in only 5 per cent of P.M.C.s of the first collection and in 20 per cent of the second were there found disjunctional associations of twelve chromosomes. These figures indicate a considerably higher degree of irregularity than was found by Sax and Anderson[5] and Darlington[2], who stated that rings occurred with a frequency of about 30 per cent, single chains about 45 per cent, and that a "bare majority" were disjunctionally arranged. Sax[4] gave no details about association but noted that pairing was variable, that chains were more common than rings and that about half of the first divisions examined were disjunctional.

It would be interesting to know whether these differences are genetic or merely environmental in origin, particularly as Sax[4] found varying degrees of asynapsis at lowered temperatures. Such variation emphasizes the dangers attendant on comparison of association frequencies estimated without any control of environmental error (cf. Myers and Hill[7], Steinitz[8] for review of environmental control of pairing, etc.).

An examination of cells between anaphase and telophase, that is, phases of separation in which the chromosomes could still be separately distinguished, yielded the following data (Table 2), in which are given the frequencies of the various types of separation observed, six to each pole, seven to one and five to the other, six to one and five to the other with a laggard, etc. In addition, a very few cells were seen with bridges but no fragments: they may be due to inversion crossing-over (Darlington[3], Bhaduri[1]).

TABLE 2. ANAPHASE-TELOPHASE DISJUNCTION.

Coll.	6–6	7–5	6–1–5	6–2–4	6–3–3	7–1–4	5–3–4	5–2–5	Total
(1)	8	1	2	–	1	–	–	–	12
%	66·7	8·3	16·7	–	8·3	–	–	–	100
(2)	37	11	12	2	–	1	1	2	66
%	56·1	16·7	18·2	3·0	–	1·5	1·5	3·0	100

It will be seen that, in the two collections, 25·0 and 27·2 per cent of cells respectively contained at least one lagging chromosome (cf. the 45 per cent found by Bhaduri[1]). There was a well-marked interphase in which complete despiralization took place. In a total of 438 interphases and first telophases in which despiralization had occurred, only 17 (3·9 per cent) were seen in which a chromosome had not been included in one of the polar nuclei, a very marked reduction compared with anaphase. This is no doubt due to the relatively very great volume of the resting nuclei: it must be rare that a lagging chromosome is so placed that it avoids inclusion in the expanding nucleus, once despiralization starts. The few chromosomes that were not so included remained condensed, a situation which has been found in *Tradescantia bracteata* (Darlington[3]) and *Tripsacum laxum* in which an alternative behaviour was the formation of micronuclei (Dodds and Simmonds[9]). It may be surmised that the failure of despiralization is connected with the failure of loss of nucleic acids (cf. Darlington[10]), and it is suggested that a study of the behaviour of such excluded chromosomes in favourable material might prove helpful in the study of the nucleic acid cycle.

The presence of an interphase is interesting since Sax[4] stated that "the chromosomes retain their individuality during interkinesis", thereby presumably implying that there was no interphase despiralization. Again, it would be interesting to know whether this is a genetic or environmental difference.

Second division appeared normal, but a few diads were seen in which one cell was at second telophase and the other had not divided at all. In view of the normally high degree of synchronization between cells of a diad, it is possible that such cells represented failure of the second division and might thus have given rise to diploid spores. One second metaphase was seen in which were present two chromosomes apparently joined end-to-end and which had presumably failed to disjoin at the first division. This failure of separation is in accord with the observation of Darlington[2] but constitutes an exception to his statement[11] that undivided associations generally separate during an interphase.

I wish to thank Dr. K. S. Dodds for helpful criticism in the preparation of this note.

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Plant Nutrients in the Sea

I HAVE recently been attempting a valuation of potential fish production of the banks of the Seychelles-Mauritius arc. The figures following indicate that the suggestion to increase the fertility of suitable parts of the sea by the addition of fertilizers[1] is an established process in certain places and circumstances in the ocean.

The estimated annual basic total catch (catch from professional fishermen only) of the Mauritius fisheries is 1,650 metric tons, derived almost entirely from

135 square miles of coastal water, of which 25 square miles is partially reserved by the prohibition of net fishing. The average annual catch is thus rather more than 12 tons per square mile. I believe that the area is fished to the limit of productiveness, so that this figure (area-year production) really has some meaning. The number of professional fishermen is estimated at 1,200–1,500, giving a man-year production (from the more favourable figure) of 1·38 tons. It is interesting to find that a return taken at random from the fisheries census just completed gives the estimated catch of a basket-trap fisherman for the year, excluding Sundays only, as 1·58 tons, which is probably very close to the figure calculated from the totals when the other non-fishing days are taken into consideration.

Figures for Rodriguez, 350 miles to the east of Mauritius, suggest an area-year production of 5·8 tons per square mile and a man-year production of 1·48 tons. The area is not fished to its capacity.

According to Hornell[2], the Seychelles area of 12,000 square miles, worked by seven hundred fishermen (a "moderate" estimate), produces 1,100 tons, giving a man-year production of 1·57 tons and indicating a very slight exploitation of the enormous fishing area.

In a private communication, written at the end of 1943, G. C. L. Bertram, then chief fisheries officer, Palestine, commented on the "extremely small" catch of the fishermen there—"well under two tons per year on the average".

The similarity of the man-year production figures suggest that the productiveness of the grounds and the other factors—methods of fishing, nature of the fishermen, frequency of bad weather, and so on—are similar in all these places. The intensity of exploitation differs. Five tons per man per year was postulated by Bertram[3] for the 'productive' fishery of the south coast of Arabia. This fishery, however, depends on sharks (south-west monsoon, April to September) and then on sardines (October to March), the latter with their large and voracious followers, the tunnies, bonitos and kingfishes. It is a pelagic fishery comparable in its results with the drift-net fisheries of northern waters rather than with the normally laborious process of capturing bottom fishes with hooks and lines.

The islets, reefs and shoals of St. Brandon (Cargados Carajos) lie 220 miles north-north-east of Mauritius. The Raphael Fishing Company of Mauritius operates there with about a hundred men who fish with hooks and lines for approximately six months of the year (I give these notes and figures by courtesy of Mr. Couacaud, of the Company). From the production of salt fish the man-year production of fresh fish must be at least 8·4 tons. One of the best fishermen brought in, during fifteen days of fishing in August 1944, no less than 798 kgm.—a rate of more than 18 tons annually. I say these men work for six months at fishing; for the other six months they are digging guano! The area is about 1,000 square miles of shallows, but only a few favoured localities are fished, so that the area-year production of less than half a ton per square mile indicates slight exploitation only.

The solution, reactions and precise effect of natural guano in the sea have yet to be studied. In the light of certain other facts, a practical application at Mauritius can be projected; and as the argument in its favour bears on the point raised by Dr. Atkins[4] and answered by Prof. Ritchie[5] I make no apology for summarizing it here. Rapid dissipation into the ocean from the narrow coastal belt around tropical oceanic islands appears likely—as likely indeed as it does from the middle of the North Sea. But many of the economic species of fishes of these islands feed directly on vegetable matter (seaweeds and fixed species of diatoms), so that the conversion of fertilizer into fish is an even more rapid process than that outlined by Prof. Ritchie. There is another factor of conservation. Experiments with surface drift bottles off Bermuda in 1932 and 1933 (as yet unpublished) showed a centripetal surface drift during the winter months and a stabilized 'saucer' of warm water oscillating about the islands in the summer, both due to temperature and thermal currents of the shallow waters in and around the islands. In the absence of storms, the coastal water is thus pinned to the land, with the pelagic eggs, larval and post-larval stages of the marine organisms, including the fishes, contained therein. Fertilizer spread between tide-marks of such islands as Bermuda and Mauritius would, in my opinion, have little chance of dissipation; but the movements of the inshore waters both here and elsewhere require extensive investigation.

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Longevity of *Schizophyllum commune*

IN October 1909 the late A. H. R. Buller collected at Winnipeg fresh fruit-bodies of the xerophytic agaric *Schizophyllum commune* Fr. and placed them in his laboratory. On December 10, 1910, a number of whole or part pilei were sealed in glass tubes in a vacuum of less than 0·1 mm. pressure of mercury, and stored in the dark at room temperature[1,2]. His notes, found recently at Kew with the remaining tubes, show that he planned to test the vitality of the fungus after 1 week, 6 weeks, 4 months, 1, 2, 3, 4, 5, 6, 10, 15 and 25 years. Tradition and experience rate the life of a mushroom as short. Actually, he opened only four tubes: the fungus revived after 1 week, 3½ months, 16½ months; and after 19 months, the last three weeks of which were spent at the temperature of liquid air, as noted below.

On March 5, 1945, I opened a tube containing five parts of pilei, moistened them, and placed them in a damp chamber. All expanded, but four of the parts failed to shed spores. The fifth formed a spore-print within a day, and continued to shed spores until it was removed after three days. The spores were normal for the species, 6–7·5 × 2μ, asymmetrical, and when placed in water some of them germinated. Sections of the gills of this fan-shaped piece of pileus, 25 mm. long and 15 mm. wide at the edge when moist, showed normal basidia, sterigmata and spores in various stages of development.

Another tube was opened on March 8, 1945, the contents (one small pileus and a part of a pileus) removed with sterile forceps, moistened with sterile

water, and placed on agar. The part-pileus was dead, but the whole one soon formed a spore print and, since there was very little contamination and practically every *Schizophyllum* spore germinated, I readily obtained pure cultures, the hyphæ of which developed clamp-connexions. The living pileus was removed from the agar after two days, placed on a slide in a damp chamber, remoistened and moved each day: it continued to produce spores sufficient to make a visible spore-print until March 31. Meanwhile rudiments of new pilei developed near the margin, one grew to 10 × 6 mm., and from its gills spores were shed so as to make a spore print from March 23 until April 2. This total of 24 days of spore production may be a record for the species; at least it shows that the fungus had maintained its vitality.

A few of the remaining fruit-bodies collected during October 1909 were taken by Dr. Buller to Birmingham where, on June 5, 1912, they were sealed in a very high vacuum "at about the X-ray stage"[1]. I opened one of these tubes on March 1, 1945; it contained two pieces of pilei, one of which shed spores normally when moistened.

Two or three of the vacuum tubes of 1910 were taken by Dr. Buller to Birmingham and immersed in liquid air (−190° C.) for three weeks in 1912. One was then opened, as noted above. I opened another on March 8, 1945; it contained one piece of pileus which shed spores normally. I obtained pure cultures also from these spores.

Eleven of the vacuum tubes remain for future tests. The four opened each contained a specimen still living 35½ years after it had developed, 34¼ (or, in one instance, 32¾) years of which were spent *in vacuo*. This is a noteworthy maintenance of 'suspended vitality'. Additional evidence is provided in favour of Buller's theory[3] that an agaric which sheds spores is alive, and that spores discharged normally are capable of germination.

I do not know whether anyone has tested recently the retention of vitality in *S. commune* kept in 'dry' air. Buller[1] reported that pilei exposed to the unusually dry air of a room in Winnipeg were still alive after 6¼ years. A pileus collected at Canterbury on February 1, 1935, and filed in Kew Herbarium, revived after moistening on March 7, 1945, and shed normal spores.

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April 16.

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Anther and Petal Colour of Potato Varieties

WHILE anther colour has long been used as a diagnostic character in the identification of potato varieties, there is a lack of agreement in some of the published descriptions of the colours. Thus both Davidson[1] and Salaman[2] describe the anther colour of the variety Majestic as 'orange' and that of Arran Victory as 'pale yellow' and 'yellow, pale' respectively, which indicates some degree of agreement in their use of colour description. Nevertheless, Salaman refers to the anther colour of Up-to-Date as 'yellow, pale', while Davidson describes it as 'orange'.

To ascertain whether the differences were due to variation in the anther colour, or to inconsistency in describing it, the colours of the anthers of several varieties from various sources, and, in the majority of cases in two or more years, were matched, after removal of the petals, against the Horticultural Colour Charts issued by the British Colour Council in collaboration with the Royal Horticultural Society in 1939 and 1942. The anther colour of some varieties was found, in fact, to exhibit a certain amount of variation although the limits of such variation were usually not wide. Its range is given in the accompanying table, the number of years over which the examinations extended being placed in parentheses after the name of the variety. The name of the colour is in each case followed by its reference number, the number in bold type being that of the full hue of which the colour given may represent a tint, shade or greyed hue.

Petal colours were determined at the same time, and these are also included in the table. Primrose yellow potato flowers are normally described as white.

ANTHER AND PETAL COLOUR OF POTATO VARIETIES.

Variety	Anther colour	Petal colour
Arran Banner (1)	Saffron yellow **7**	Primrose yellow 60 1/3
Arran Peak (2)	Saffron yellow **7**	Primrose yellow 60 1/3
Arran Pilot (2)	Buttercup yellow **5** to saffron yellow **7**	Mineral violet 6 **35**/1 to Dauphin's violet 0 **39**/1
Arran Victory (2)	Buttercup yellow **5** to saffron yellow **7**/1	Primrose yellow 60 1/3
Ballydoon (2)	Lemon yellow **4** to buttercup yellow **5**	Primrose yellow 60 1/3
British Queen (2)	Lemon yellow **4**	Primrose yellow 60 1/3
Catriona (2)	Aureolin **3** to lemon yellow **4**	Mauvette 5 **37** to Dauphin's violet 0 **39**/2
Di Vernon (2)	Buttercup yellow **5**/1	Spectrum violet 7 **35**/1 to violet **36**
Doon Star (1)	Buttercup yellow **5**/1	Primrose yellow 60 1/3
Duke of York (1)	Aureolin **3**/1	Primrose yellow 60 1/3
Dunbar Standard (2)	Buttercup yellow **5**/1 to buttercup yellow **5**	Primrose yellow 60 1/3
Eclipse (1)	Empire yellow 60 **3**	Primrose yellow 60 1/3
Epicure (1)	Buttercup yellow **5**	Primrose yellow 60 1/3
Gladstone (2)	Buttercup yellow **5** to chrome yellow 60 **5**	Primrose yellow 60 1/3 to primrose yellow 60 1/1
Great Scot (1)	Indian yellow **6**/1	Primrose yellow 60 1/3
Kerr's Pink (3)	Lemon yellow **4** to buttercup yellow **5**/1	Primrose yellow 60 1/3
Majestic (2)	Saffron yellow **7**	Primrose yellow 60 1/3
Ninetyfold (1)	Aureolin **3**	Primrose yellow 60 1/3
Red Skin (1)	Saffron yellow **7**	Primrose yellow 60 1/3
Sharpe's Express (2)	Lemon yellow **4**	Rose purple 5 **33**/1 to pansy violet 00 **33**/2
Up-to-Date (3)	Buttercup yellow **5**/1 to Indian yellow **6**	Mauvette 5 **37** to Dauphin's violet 0 **39**/3

The relation between the colours in the table and those in common use is illustrated by the classification provided with volume 2 of the Horticultural Colour Charts. This shows the gradation of yellow colours from 'greenish yellow' (Dresden yellow **64**—the last of the 64 full hues and therefore, on a circular arrangement of colours, adjacent to sulphur yellow **1**) through 'yellow' (lemon yellow **4**) and 'orange yellow' (saffron yellow **7**) to 'yellowish orange' (tangerine orange **9**), and of violet colours from 'reddish violet' (orchid purple **31**) through 'violet' (violet **36**) to 'bluish violet' (methyl violet **39**).

W. G. BURTON.

"Pontesbright",
Babraham Road,
Cherryhinton,
Cambridge.

[1] Davidson, W. D., "Potato Growing for Seed Purposes" (Dublin: Stationery Office, 1937).
[2] Salaman, R. N., "Potato Varieties" (Cambridge, 1926).

VISCOSITY AND LUBRICATION

AT a joint meeting of the Institute of Petroleum and the British Rheologists' Club, held at Manson House, Portland Place, London, W.1, on April 18, five papers dealing with different aspects of flow problems were discussed. Prof. E. N. da C. Andrade, president of the British Rheologists' Club, and Prof. F. H. Garner, president of the Institute of Petroleum, were the chairmen for the two sessions of the meeting.

Dr. G. Barr presented a paper on "The Precision and Accuracy of Viscometry Using B.S.I. Tubes". The paper dealt with data on viscometry collected by the Institute of Petroleum and analysed by Prof. Garner and Dr. A. H. Nissan. U-tube viscometers conforming to B.S.I. specifications were sent to a number of laboratories in Europe, the United States and Britain with three oils, with requests to determine flow-times of the oils in the tubes supplied. Further, each laboratory was invited to report the kinematic viscosity of the oils in absolute units at 20° C., according to the method used in the laboratory and country concerned. As a result of analysis of the results returned by some of the laboratories—the outbreak of war prevented many from doing so—it was concluded that dimensional specifications of viscometric tubes were not sufficient to ensure agreement between tubes for the same oil in the same laboratory of better than 0·1 per cent. To ensure such a high degree of agreement a 'dynamic quality control test' is suggested in which flow tests are made on a number of viscometers in order that master tubes may be selected from a set of apparently equally good tubes.

In comparing the viscosity of the oils as measured by British and American methods, it was found that there was a consistent deviation of 0·35 per cent between the two countries. In the discussion it was suggested that the variation in g in different countries might influence the apparent value of the unit of kinematic viscosity in different countries and possibly account for the difference between the American and British determinations. It has since been pointed out by Dr. Nissan, however, that the viscometer tubes were calibrated by liquids of known viscosity, and therefore g does not enter into the calculation of these results.

The dynamic control test was criticized in that U-tube viscometers which were found satisfactory by time of flow tests on two reference oils might not be satisfactory for times of flow different from those used for calibration; it would therefore be advisable to use more than two reference oils for calibration of viscometers in the dynamic flow test. The accuracy required in viscosity determinations is to some extent influenced by the determination of viscosity index—a measurement of viscosity variation with temperature—which was discussed in a later paper; the determination of viscosities with a maximum error of 0·1 per cent brings in many factors imperfectly controlled or understood at the present time. Among these factors, in so far as the reference oils are concerned, are thermal and mechanical hysteresis or the solution of air in oil. The influence of errors in timing including that of the operator was discussed. Dr. Barr pointed out that in changing from an aqueous solution to a hydrocarbon oil anomalies have been observed which are difficult to explain. If a No. 3 B.S.I. tube is used for the determination of a hydrocarbon oil and calibrated at intervals with the 60 per cent sugar solution, difficulties are experienced in obtaining consistent times of flows, even when the tubes have been very carefully cleaned between the oil and sugar-solution tests. It is difficult to imagine what effect can produce this result, as any retained film must be much too small to affect the dimensions of the tube.

The second paper dealt with "The Testing of Greases for Ball-Bearings" and was presented by Mr. S. R. Pethrick. It was emphasized that conventional methods for testing greases are of little assistance in the selection of greases for particular applications. It was suggested that tests on lime-base greases should include: (1) flow measurements at various rates of shear and at various temperatures, (2) an oxidation test with an examination of the oxidation products, and (3) a syneresis test involving capillary action. Soda- and lithia-base greases vary widely in texture, cohesion and adhesion, and some method of measuring these properties is desirable. The author described an apparatus using the torque exerted on the housing of a ball-bearing rotating under controlled conditions and lubricated by the grease, as a measure of the cohesion, adhesion and lubricating properties of the grease. The stability of the grease can also be determined in the same apparatus by churning it first and then measuring the torque under standard conditions.

The present standard methods of test for greases, such as penetration or drop point, while of value for routine checking of a particular product, do not render it possible to select a grease for a particular application without a full-scale test in the equipment to be lubricated.

The development of bearing tests for greases should enable such a selection to be made much more readily and might lead to a more precise definition of physical properties which can be characterized by fundamental measurements.

It was suggested that, in the main, greases are used at moderate temperatures at fairly high speeds and that such conditions should supplement those suggested by Mr. Pethrick.

The second half of the session was opened by a paper on "A Rational Basis for the Viscosity Index System. Part I", by Mr. E. W. Hardiman and Dr. A. H. Nissan. The viscosity index of an oil is given as a comparison of the drop in its viscosity between 100° and 210° F. with those of two oils, one of low variation in viscosity with temperature (H series) and another of high variation (L series) for the same temperature range. Thus

$$\text{Viscosity Index} = \frac{L - U}{L - H} \times 100,$$

where U is viscosity of the oil at 100° F., cs.; L and H are viscosities at 100° F. of the series L and H oils respectively, having the same viscosity at 210° F. as the oil under test, cs.

Tables were issued by the originators of the V.I. (viscosity index) system from which L and H can be read. This system has been adopted as a standard method for petroleum oils both in the United States and Great Britain. It appears that, for viscosity index values exceeding 140, the value of the index obtained from the tables and this equation are not unique solutions, since two oils both having the same viscosity at 100° F. but very different values of viscosity at 210° F. can give the same viscosity index. The authors presented a method whereby the index can be calculated as

$$\text{Viscosity Index} = (60{\cdot}0 - \text{antilog } n) \times 3{\cdot}63 ;$$

$$\text{where} \qquad n = \frac{\log U - 0{\cdot}4336}{\log \text{viscosity at } 210^\circ \text{ F.}}.$$

This viscosity index is a single-valued function. Furthermore, this scale does not differ fundamentally from the Dean and Davis original V.I. system between 0 and 100, but corrects its anomalies above 140.

The viscosity index scale was criticized because it is not directly connected with the temperature slope and also because it is not additive as regards mixtures; but it was pointed out that the law of mixtures for viscosity even of pure liquids is as yet not fully understood. From the viscosity index and viscosity at one temperature, it is possible by the use of charts, such as that issued by The American Society for Testing Materials, to ascertain viscosities over a range of temperature, and with the modified scale suggested in the paper this can be done with oils of very flat viscosity-temperatures such as are now being made by the employment of special additives to lubricating oils. The scale can be applied to oils with no change in viscosity with temperature which would have a viscosity index of around 200 and even to oils which show an increase in viscosity with rise in temperature. For the modified scale to be of value in characterizing some of the more recently developed lubricants for which the original viscosity index scale is not satisfactory, it must be adopted as a standard method by such bodies as the American Society for Testing Materials and the Institute of Petroleum Standardization Committee.

Dr. A. Lahiri presented a paper on "The Problem of Engine Deposits", by Dr. E. W. S. Mardles and himself. The paper is an extensive report on rheological and other colloidal studies of oils under oxidizing conditions simulating very closely those existing in internal combustion engines. The oxidizing apparatus can be used as a rotating viscometer of the Stormer type. Studies of specific viscosity have revealed the probable shapes of dispersions in aero-engine oils, while work with the rotating viscometer on oxidized oils has shown that rigidity develops slowly at first with time; then the oxidizing oil suddenly gelates when the concentration and polymerization of the oxidized products reach a critical value. The tendency of oils to keep in suspension soot or other detritus has also been studied. In general, a high degree of flocculation of carbon black, etc., results in high specific viscosity, high sedimentation-rates and volumes, high rigidities and yield values of the suspension.

In the discussion it was pointed out that performance tests on lubricating oils for use in internal combustion engines have been extensively developed using engines of different types, but it was felt that such tests are not complete unless information can be derived from the used oils in addition to that obtained from the condition of the engine after the test. The work described in the paper suggested a new and logical approach to this problem. In the selection of temperatures used for the oxidation tests described, the authors used thermocouples inserted at various points in pistons of aero-engines, and found that the temperature at which the oil functions is of the order of 200–300° C.; and hence the fact must be faced that oxidation takes place at such temperatures. Within this range of temperatures there is, however, a marked difference in the behaviour of the same oil; thus for the same oil at 200° C. gelation developed in 40 hours, whereas at 235° C. 5 hours was sufficient. For the chromatographic examination of used oils columns of 2 in. diameter and 6 ft. long have been used with various adsorption media such as activated silica.

The final paper was presented by Dr. A. S. C. Lawrence on "Lubricating Greases". Lubricating greases are mixtures of soaps dispersed in oil. If a soap is mixed with a hydrocarbon at low temperatures, it exists as a solid suspension. At a certain temperature T_1, the system assumes a gel structure which it maintains up to another critical temperature T_2, when it becomes a fluid solution of soap in the hydrocarbon. Peptizers may be used to change suspensoids of soap in oil into gels. A tentative structure of the gel by co-ordination was given. The rheology of greases was very briefly given.

Attention was directed to the paucity of information on the temperature-flow relations of greases, although such information would be of direct practical interest and also of great value in determining the energy of flow of the different phases in grease.

The importance of rate of cooling on the structure of greases was emphasized in the discussion, which largely centred about the application of knowledge gained in the investigation of soaps for pure fatty acid to commercial grease manufacture. The character of the mineral oil used is a factor of importance, and certain types of refined oils are unsuitable. Although the water content of greases is very low, and cannot be detected readily by electrical conductivity measurements, it plays an important part in peptization, that is, in increasing the degree of dispersion: it is possible that it acts as a hydrolyser of the soap and that the most effective peptizer is stearic or other fatty acid.

It was pointed out that although greases prepared from more than one metal may result in loss of consistency, in practice lime and soda greases and extreme pressure greases containing lead and calcium are found to be required industrially. Pure anhydrous sodium soaps of the fatty acids have probably never been prepared, although aluminium tri-stearate can be prepared and forms gels as do the other aluminium stearates.

All the papers and discussions reported here will be published in a separate volume by the Institute of Petroleum.

DENTAL HEALTH IN BRITAIN

THE Interim Report of the Interdepartmental Committee on Dentistry (Cmd. 6565. H.M. Stationery Office, 1944) records this Committee's opinion that the dental health of Britain is bad and that its effect upon general health is also bad. The dental profession itself cannot be blamed for this. Its ideals are high. They see in dentistry, not merely attention to teeth, but also that basic relation between dental disease and general ill-health which is the basis of the scheme of dental education outlined by C. Bowdler Henry (*Lancet*, 26, Jan. 6, 1945), who advocates a basic medical education for dental students and also the education of stomatologists who would act as consultants to dentists and would study dental problems in relation to other diseases and to the general biology of man. But the best dental profession in the world cannot operate in a vacuum; it must have the respect and co-operation of the people whom it seeks to serve; and the facts

recorded in this report show that the British people not only do not take full advantage of the public dental services which now exist, but also they do not appreciate the effects of dental disease upon their general health.

As a preface to the discussion of this unsatisfactory position, the Committee outlines the history and present position of the dental profession and its educational and research facilities. Dental education in Britain is given in five dental schools in London, seven in the English provincial cities (Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle and Sheffield), three in Scotland (Dundee, Edinburgh and Glasgow), one in Northern Ireland (Belfast) and four in Eire. Before the War, these schools had a capacity of 2,000–2,500; most of them were staffed largely by teachers on a part-time basis, paid or honorary, and some four hundred students a year entered the schools, of whom about 10 per cent were women. Students could prepare for either the B.D.S. degree or for the somewhat lower standard of the licence (L.D.S.); the majority took the licence, the courses for which occupied about five years, while those for the degree were rather longer. Most of the schools have some facilities for research, but most of the staff have little time for this. The dental hospitals provide treatment for the poor and clinical teaching for the students; but neither the hospitals nor the schools have enough money for expansion and improvement. Refresher courses and a limited number of hospital posts provide some post-graduate training. Figures supplied by the Government Actuary indicate that most of the dentists admitted to the register by the 1921 Act are now older than forty-five, so that there will be, in the next few years, a rapid loss of names from the Register by retirement; and the average annual rate of entry to the Dental Register in recent pre-war years in Great Britain was about 340, while the annual rate of entry of students has fallen to below three hundred, some 10 per cent of whom do not, for various reasons, become dentists. It is therefore clear that the Register cannot be maintained even at its present strength. Even if the annual number of persons entering the profession rose to 400 between 1948–52 and to 425 thereafter, it would still be thirty years before the present effective total of the profession would be increased. This is indeed, as this report puts it, an alarming forecast.

Nor is this Committee satisfied with the present position of ancillary dental workers, namely, dental dressers, dental attendants and dental mechanics. The dental mechanic is an essential part of any dental service, and the existing arrangements for the training of dental mechanics are inadequate.

Considering remedies, the Committee concludes that the greatest single step forward would be the creation of a single comprehensive dental service equally available to all who demand it, and paid for by the community as a whole. This service should be an integral part of the Government's national health service; it would give the dental profession its rightful place in the public estimation and would encourage the much-needed recruitment to the profession. In such a scheme certain classes of people, namely, nursing and expectant mothers, children and adolescents, require special attention, and a big expansion of dental services for school-children is one of the essential foundations of a comprehensive health service. All local authorities responsible for schemes of dental health should appoint, as some do now, a chief dental officer with adequate powers. Quotations from statements made by local authorities show that they are aware of the importance of their responsibilities in this respect.

No dentist, the report insists, should be compelled to enter the public service and all should be able to leave it if and when they desire to do so. Dentists should also be able to engage in whole- or part-time public dental service and in any branch of it. The patient must have free choice of the dentist and liberty to change to another at will. The right to private dental service should especially be preserved. General dental practitioner service should be broadly analogous to that of general medical practitioner service. Dental health centres should be established; they might be experimental at first, the local dentists being consulted about their organization, design and equipment; this participation by dentists in the planning of the dental health centres is emphasized by the report, which would extend it to the planning and administration of the whole dental health scheme.

The report emphasizes the importance of education of the public in dental health. A definite policy of education of the public is required, which should include high quality of dental treatment, education at the health centres, dental hygiene in the schools, the encouragement of children to accept treatment, education at maternity and child welfare centres and the supply of publicity material from central sources. The report concludes with the recommendations that suitable ex-Service men and women should be encouraged to become dentists, that dental teachers should be recalled from service as soon as possible and that dental equipment now being used in the Services should be made available for the public dental service.

The unanimity and brevity of this report enhance its value. Its recommendations should be widely known, for without the intelligent co-operation of the public no health scheme can succeed.

METCHNIKOFF CENTENARY CELEBRATIONS

A MEETING was held at the Opera House in Moscow on May 15 to celebrate the centenary of Metchnikoff's birth; it was opened by G. Miterev, the Soviet Commissar of Public Health. A great gathering of representatives of the medical profession and of bacteriology had come together to honour the memory of the great Russian man of science and philosopher.

Ilya Metchnikoff was one of the first Russian Darwinists, and proved by his experimental work the existence of general laws of evolution applying to all animal organisms. His biological research on comparative embryology led him to problems of pathology and medicine, in which he obtained epoch-making results, formulating a theory of phagocytosis. After working for a long time at the Pasteur Institute in Paris, he became head of a new school of microbiology investigating especially problems of immunity as it affects medical practice, particularly vaccination. During the latter part of his life, Metchnikoff gave much attention to the study of old age, longevity and death. His point of view was that people do not live so long as they should do, and that, by appropriate modes of living, life could be considerably lengthened.

The role of Metchnikoff in science was the subject of a special paper read by Vassili Parin, general secretary of the Academy of Medical Science. "Metchnikoff," he said, "who obtained such important results in his theoretical work, did not despise practice and gave much time to find a scientific basis for fighting infections and epidemics such as cholera, typhoid and tuberculosis. His philosophy was full of optimism and faith in humanity and in the final triumph of science."

Metchnikoff died in 1916, but his numerous pupils in the Soviet Union pursued on a large scale his microbiological research for the welfare of the people.

The Opera House meeting was the first of a series of conferences extending over several days, at which reports were presented on various problems of bacteriology, and papers read on Metchnikoff's philosophical conceptions and his work in the fields of Darwinism, zoology, embryology, immunity, parasitology, microbiology and epidemiology.

To mark the centenary, the Soviet Government has decided to erect a monument to Metchnikoff in Moscow and to put memorial tablets in the University of Kharkov, where he was a student, and in the University of Leningrad, where he lectured. The University of Odessa, where he occupied a professorial chair, will bear his name. Metchnikoff gold medals and prizes are to be awarded by the Moscow Academy of Sciences, and Metchnikoff scholarships for students and research workers are to be founded by the Academy of Medicine and by the Medical Institutes of Kharkov, Moscow, Leningrad and Odessa. A biography of Metchnikoff is to be published, together with a uniform edition of his complete works; and a film on his life and work will be issued in 1946.

LYDIA BACH.

SCIENTIFIC AND INDUSTRIAL RESEARCH IN CANADA

A PRELIMINARY review of the work of the National Research Council of the Dominion of Canada in 1944, issued by the Research Plans and Publications Section, in addition to indicating the way in which the Council organizes and co-ordinates the national co-operative research programmes, outlines a few of the major items in the work under the Council's direction.

In aerodynamics, some of the new work involves such problems as balancing of controls on aircraft, work on aircraft skis, the design of tailless aircraft and investigation of factors which arise in their operation. In hydrodynamics there are two main fields: model-testing and basin-tests on aircraft floats and seaplanes, and hydraulic studies on harbour and river problems, in which such factors as silting, tidal effects, turbulence, location of piers, etc., are involved. Much test work is done on aircraft engines, and unsuspected savings in aviation fuel consumption have been achieved by developing a new type of cracked fuel which can be used in place of straight-run gasoline in certain operations. Photography has been utilized to study droplets in clouds surrounding aircraft in flight, and physical chemistry has shown a way of dispelling the raindrops which fall on the pilot's turret and tend to obscure his vision.

In the field of applied biology, war requirements have placed great emphasis on the need for work on foods and their preservation and methods of transport. The development of canning methods for chicken, pork and ham has been undertaken as part of the war effort, and the industrial utilization of agricultural products is an important branch of work. The shortage of rubber led to the study of fermentation methods for the production from wheat of butylene glycol, recently shown to be useful as an anti-freeze, as well as a basis for the production of many useful chemicals. Methods are being developed for modifying wheat starch as a substitute for other starches and for the production of syrups and sugars. A pilot plant using a mechanical method for extracting resin rubber from native plant materials such as milkweed is in full operation.

The activities of the Division of Chemistry have involved much research on adapting substitute materials to war requirements and in developing new methods for strategic chemicals. Substantial advances have been made in the technique of rot-proofing, flame-proofing, and water-repellency treatment of fabrics. The synthesis of new toxic compounds has been carried on as part of the programme of the Directorate of Chemical Warfare and Smoke. Alkaloids from Canadian plants continue to receive attention, and the Paint Laboratory has been occupied with the development of new protective coatings. A new method of glueing based on electrical resistance has been developed and is in commercial use. Research on the prevention of corrosion by the use of inhibitors is continuing, as well as on the protection of aluminium alloys against sea water. Work has also been carried out on the photo-sensitized polymerization and hydrogenation of butadiene.

In the Division of Physics and Electrical Engineering much work has been done during the War on the detection of sound under water at ultra-sonic frequencies. The General Physics Laboratory facilities have been used in such problems as measurement of muzzle vibrations of rifle bullets, ballistics cameras, vibrational measurements, construction and testing of fire-control apparatus, counter chronographs, automatic plotter for air-ground training and other work for the Armed Services. Much work of the Heat Laboratory has been suspended, but infra-red studies and work on land-mine detectors have been carried out with success. The Optics Laboratory has made a substantial contribution to the war effort, and can claim a fair share of credit for the establishment of an optical glass industry in Canada, besides contributing largely to aerial photography. The radio staff has grown to several hundreds, with special laboratories constructed to meet demands for radar studies, and post-war applications may include air-navigation methods, improved blind-landing technique, compact recognition equipment for all types of ships and aircraft and new types of shore beacons to supplement lighthouses, anti-collision alarm signals, etc. Industrial radiology has opened up a wide field of inspection which has been applied in the non-destructive detection of flaws in metal. The X-ray diffraction study of materials is becoming increasingly useful as new techniques are discovered, and electron microscopy is also providing the physicist and chemist with fundamental data not previously attainable.

The National Research Council has devoted much time and thought to preparation for the post-war period, and, under pressure of war, Canada is already spending five times as much on research as in the pre-war years.

FORTHCOMING EVENTS

Tuesday, June 19

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, London, S.W.7), at 6 p.m.—Mr. H. K. Bourne: "Photographic Light Sources" (lecture-demonstration).

Wednesday, June 20

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

ROYAL ENTOMOLOGICAL SOCIETY (joint meeting with the ROYAL METEOROLOGICAL SOCIETY) (at 41 Queen's Gate, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton, M.B.E.: "Phenological Relationships of Meteorology and Entomology". Dr. C. B. Williams: "Fluctuations in Insect Populations as related to Weather Conditions". Dr. A. E. Slater: "Vertical Air Currents as Agents of Insect Dispersal". Dr. B. P. Uvarov: "The Organization of Bioclimatic Research".

Thursday, June 21

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Major Albert Pam, O.B.E.: "The Snake-Venom Serum Institute in San Paulo, Brazil"; Mr. G. H. Locket: "The Availability of Water to Plants in Chalk"; Mr. W. B. Dowson: "The Habits of some Fishes of Nigeria".

Friday, June 22

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the MANUFACTURE GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 10.30 a.m. and 2.30 p.m.—A Series of seven Short Papers.

PHYSICAL SOCIETY (OPTICAL GROUP) (in the Physics Department, Imperial College, London, S.W.7), at 3.30 p.m.—Dr. A. F. C. Pollard: "Instrument Design".

APPOINTMENTS VACANT

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

LECTURER IN PHYSICS at the Burnley Municipal College—The Director of Education, Education Offices, Burnley (June 20).

LECTURER IN BIOLOGY, with honours degree in Zoology, at the South-East Essex Technical College, Dagenham—The Clerk to the Governors (June 20).

LECTURER IN CHARGE OF ZOOLOGY (*not* Botany, as previously stated) at University College, Leicester—The Registrar (June 20).

LECTURERS IN GENERAL ENGINEERING SUBJECTS and in ELECTRICAL SUBJECTS at the South-West Essex Technical College, Walthamstow, London, E.17—The Clerk to the Governors (June 23).

LECTURER IN PHYSICS at the Leicester College of Technology—The Principal (June 23).

A LECTURER IN MECHANICAL AND MARINE ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING, at the Marine School of South Shields—The Principal (June 25).

DEPUTY LIBRARIAN at University College, Gower Street, London, W.C.1—The Secretary (June 25).

PLANT PATHOLOGIST in the Research Division, Department of Agriculture and Forests, Sudan Government—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2 (quoting F.4139.A) (June 26).

ASSISTANT LECTURER IN AGRICULTURE and an ASSISTANT LECTURER IN AGRICULTURAL BOTANY in the University College of Wales, Aberystwyth—The Registrar (June 26).

LECTURER IN FOODSTUFFS in the Manchester Municipal College of Technology—The Registrar (June 30).

A PLANT PHYSIOLOGIST, a PLANT ECOLOGIST, a MICROBIOLOGIST and a FOREST ECONOMIST, in the Department of Forestry, University of Oxford—The Professor of Forestry, Imperial Forestry Institute, Oxford (June 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF METALLURGY, University of Liverpool—The Registrar (July 5).

LECTURER IN ENGINEERING in the Department of Civil and Mechanical Engineering, University of Glasgow—The Secretary (July 9).

TWO UNIVERSITY DEMONSTRATORS IN BIOCHEMISTRY in the University of Cambridge—The Secretary, Appointments Committee of the Faculty Board of Biology "B", University Physiological Laboratory, Downing Street, Cambridge (July 9).

A WOMAN ABSTRACTOR (Ref. No. F.4217.XA), and two PHYSICAL CHEMISTS with research experience in Rheology or Surface Chemistry (Ref. Nos. F.4218.XA and F.4219.XA) for a Research Association—Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, London, W.C.2 (quoting appropriate reference number) (July 12).

SPECIAL LECTURER IN BIOCHEMISTRY in the University College of Wales, Aberystwyth—The Registrar (July 15).

LECTURER IN GEOGRAPHY, with special qualifications in Cartography, in the University of Reading—The Registrar (July 16).

STRATHCONA-FORDYCE PROFESSOR OF AGRICULTURE in the University of Aberdeen—The Secretary (August 31).

AN OFFICIAL FELLOW AND TUTOR IN ECONOMICS at Magdalen College, Oxford—The Secretary to the Tutorial Board (Sept. 1).

TWO official FELLOWS AT NUFFIELD COLLEGE, Oxford, for research in ECONOMICS and POLITICS—The Warden (Sept. 1).

PROFESSOR OF ELECTRICAL ENGINEERING at King's College, London, W.C.2—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (Sept. 17).

ABSTRACTORS for articles in foreign languages at the Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge—The Deputy Director.

PROFESSOR OF PHYSICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

SENIOR ASSISTANT AT THE IMPERIAL BUREAU OF HORTICULTURE AND PLANTATION CROPS, East Malling Research Station, near Maidstone, Kent—The Bureau.

LECTURER IN ENGINEERING SUBJECTS at the Medway Technical College, Gillingham—Form of application from Divisional Education Officer, Fort Pitt House, Rochester.

LECTURER IN SOCIAL STUDIES in the University of Edinburgh—The Secretary to the University Court.

PROFESSOR OF PHILOSOPHY in Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

CHIEF ANIMAL HUSBANDRY OFFICER, and an ASSISTANT ANIMAL HUSBANDRY OFFICER, for the Berkshire War Agricultural Executive Committee—The Secretary of the Committee, 1 Abbot's Walk, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Report to the Government of India on Scientific Research in India. By Prof. A. V. Hill. Pp. 55. (London: Royal Society, 1945.) [125

National Parks in England and Wales: a Report to the Minister of Town and Country Planning. By John Dower. Pp. 58. (London: H.M. Stationery Office, 1945.) 1*s.* net. [195

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