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REPLANNING GREAT BRITAIN

THE satisfaction which was given by Lord Reith in his statement in the House of Lords on February 11, announcing the establishment of the Ministry of Works and Planning, to be endowed with the necessary powers derived in part from the existing Town and Country Planning Acts and in part from forthcoming legislation, including that designed to give effect to the recommendations of the Uthwatt Committee, passed into concern in view of succeeding ministerial changes and the absence of the promised statement from the Government. That concern has been largely dispelled by the statement made by Lord Portal in the House of Lords on April 21. Following on Mr. Bevin's address to the opening session of the Emergency Committee of the International Labour Organisation, and succeeded by Mr. Oliver Lyttelton's broadcast on April 26, it afforded reassuring evidence not only that the policy outlined by Lord Reith is unchanged, but also that the Government is facing the problems of the post-war world, and that some at least of its members fully realize the contribution a reconstruction policy can make to the winning of the War.

Lord Portal said that Lord Reith's statement made in February still stands. The Bill already introduced in the Commons, the second reading of which was moved by Mr. H. Strauss on April 29, was the first step in the creation of a Ministry the objective of which would be to secure the right use of land for all purposes. It would be the duty of the Minister to see that policies in regard to agriculture, transport, etc., are properly co-ordinated. Legislation has been drafted after consultation with Mr. Justice Uthwatt and Lord Justice Scott, whose reports should be available in the near future.

Lord Portal said that he fully agreed with what was said in a previous debate about the excessive number of planning authorities. Considerable reduction has been effected by the voluntary combination of local authorities, and it is the policy of the Government not only to reduce the number by planning over wide areas but also to accelerate the process. Area officers have already been selected to assist by collaboration with the local authorities, whom they will also aid in their planning work, keeping the local authorities informed of the national considerations which must be taken into account, and the Ministry of what is taking place in each area.

Referring to the need for speeding up the working of the Town and Country Planning Act, Lord Portal said that no planning would be complete which does not provide for the preservation of extensive areas of great natural beauty, and especially the coast-line. Protection of national parks and coasts from ill-considered building must be fully examined. He said he is working in the closest collaboration with the Paymaster-General on this and other questions; and with regard to the personnel of planning, directly the War is over, it will be essential to have the building industry organized to cope with the vast amount of work with which it will have to deal. A well-balanced programme for new houses, schools and other buildings and repairs, and for having the men available

quickly to do the work, is already well advanced. Demobilization both from the Services and the munition factories has already received attention, and a long-term programme of training on demobilization is an essential factor which requires to be thought out.

Lord Portal indicated that he appreciates the importance of the location of industry and of co-ordinating the contributions to post-war reconstruction from different Government departments. The services of the advisory panel of experts set up by Lord Reith will still be available, and a Bill will be introduced to take over the powers of the 1932 Planning Act.

This Bill, which received its second reading on April 29, is admittedly only a very small step, and little enthusiasm could be discerned for it in the House of Commons debate. It provides for the transfer to the Minister of Works and Planning of all the existing functions of the Commissioners of Works and the Commissioners of Public Works in Ireland and of the Town and Country Planning functions of the Ministry of Health. The exact extent of the transfer of powers, like the precise relations between the Minister of Works and Planning and the Postmaster-General, is not quite clear.

The meagre advance represented by the new Bill is apparent from the valuable report issued by the Reconstruction Committee of the Royal Institute of British Architects on "Legislation affecting Town and Country Planning"*. The debate on the Minister of Works and Planning Bill is in fact calculated to arouse rather than dispel misgivings as to the Government's intention, if only from the indications it affords that the delays in the appearance of the reports of the Uthwatt and Scott Committees are due not so much to the Committees as to the diversion of their members to other duties by the Government itself. Yet until these reports have appeared, the essential legislation is deferred, and opportunities are in fact being lost and obstacles being allowed to accumulate through dilatoriness and inaction.

The Reconstruction Committee of the Royal Institute of British Architects, after a survey in some detail of present legislation affecting town and country planning, such as the Town and Country Planning Act 1932, the Local Government Act 1933, the Restriction of Ribbon Development Act 1935, the Trunk Roads Act 1936, and Acts affecting private street works and general building control, recommends first the establishment forthwith of one national planning authority with a Minister to lay down the main lines of the national plan, including trunk roads and other means of transport, assisted by expert planners, research and advisory committees as required. The establishment of regional officers of the Ministry to prepare and extend the national plan to meet the needs of the region and a grouping of the local authorities in each region for planning purposes in sub-regions or groups as required for efficient planning are next recommended. In regard to control, the report recommends that planning control should include all land, including the preservation of land essential for agriculture and public reservations for any purpose, with no exemptions for Government lands, railways or other public utilities or for agricultural buildings.

As recommended by the Uthwatt Committee, the existing control of all development by licence should be extended for a fixed period until the constructive proposals of the national plan are worked out. Such control by licence should include control over the extension of existing industry as well as the location of new industry, and a limit of not more than twenty years should be fixed for the continuation of non-conforming uses. Detailed improvements should be effected in town-planning legislation on lines which have already been recommended, subject to the adjustments necessary to fit in with the national and regional administration and to the employment of a competent architect.

On the financial side, the report recommends simplification of the acquisition of land for public purposes, with the price of acquisition stabilized at a figure not exceeding the value at March 1939, and a similar stabilization of the price of land acquisition between private persons. In each district there should be a local improvement and open spaces fund, provided partly by Government grant, partly by a limited local rate and partly by contributions payable by all developers, thus providing for essential widenings, open-space reservations and proper maintenance. Besides this, the necessary finance should be available on a national basis for the preparation and implementing of the national plan. This must cover the encouragement of agriculture and proper marketing facilities and the provision of rural water supply and electricity; the encouragement of the proper location of industry and the provision of new industrial centres, the building of suitable new towns and trading estates, including the utilization of mineral and natural resources, and the extension of public utility services; the improvement of transport, including road, rail, water and air transport; and the reservation of national and regional spaces for recreation, including national parks and coastal reserves, regional open spaces and playing fields, and the preservation of buildings of national or historic importance.

The arguments and recommendations of this report are well underlined by Mr. Roland Pumphrey in his pamphlet in the Rebuilding Britain Series*. Dealing with the relation of industry to reconstruction and particularly with the tendencies to migration to be found in industry, he gives an admirable indication of the way in which those tendencies can best be turned to account. He focuses attention on the problems which require attention, the questions, such as the probability of the drift of industries and services into the south-east of Great Britain and to the Midlands being resumed after the War, the influence of evacuation on the growth of a more decentralized metropolitan type, and the means of securing a better distribution of town and country life without injury

* Legislation affecting Town and Country Planning. (London: Royal Institute of British Architects.)

* Industry and Town Planning. By Roland Pumphrey. Pp. 36. Rebuilding Britain Series, No. 6. (London: Faber and Faber, Ltd). 1s. net.

to agriculture and amenities, to which answers must be sought before policy is crystallized.

Mr. Pumphrey stresses the importance of preparing now, by wise legislation, by judicious placing of war-factories, war-houses and hutments, by research and by a constant watchfulness over changing conditions, and by uplifting public opinion, for the tasks which lie ahead; there must be a dynamic outlook. Everything must be related to the ever-changing panorama of human and material events. Secondly, he makes the point that British democracy should not attempt to embrace and control the destinies of the people by a comprehensive planning of all social and economic life. Rather should it, by wise governance and by devolving the necessary legislation and control, ensure the ways and means to a free co-operation for the development of the whole nation, in which industry and agriculture, town and countryside, shall find a harmony and identity of interests.

The core of the pamphlet, in fact, lies in Mr. Pumphrey's conclusion that industrial and town and country planning interests should join forces in providing an outline, based not only on the common requirements of industries, towns, transport and communications, but also with equal regard to the richest agricultural lands and scenic amenities. The details of location and environment can be left to sub-regional planning councils, but the striking of a balance between the requirements of the various parts of the country requires the advice and guidance of a central planning authority, exercising powers within a general outline of territorial lay-out and location as affecting the nation at large. Aided by an industrial advisory commission, a national planning Ministry might seek further to prepare public opinion for coming tasks by setting up well-equipped regional information bureaux in all principal centres, providing a tangible link between the Ministry and industry and the community.

In the debate in the House of Commons on the Planning Bill, both Mr. Strauss and Sir William Jowitt showed in their speeches that the Government's objective is to secure the right use of the land of Britain for all purposes; thus the various aspects outlined by the Reconstruction Committee of the Royal Institute of British Architects and in Mr. Roland Pumphrey's pamphlet are evidently under review. What is principally at issue at the moment is the excessive slowness of advance. While no exception can fairly be taken to Sir William Jowitt's contention that we should await the reports of the Scott and Uthwatt Committees before attempting legislation, Mr. Greenwood's suggestion that all members of these committees are being overloaded with other work of less importance is not reassuring. At the least it indicates that the Government does not view the matter with the same sense of urgency and importance that it is viewed by the country at large.

There can be no question that already a vast amount of the necessary knowledge has already been acquired, and that what is now essential is action, particularly legislative action, so that the fuller plans can be worked out in readiness, and power exercised where necessary to prevent further obstacles developing either during or immediately after the War. Moreover, as Mr. Strauss himself pointed out, we have to think not merely in terms of plans, but also of design and construction, of civic design and of architecture, and finally of men.

In this concluding reference to the crucial importance of the architect, Mr. Strauss touched on a point which is the main theme of a further report of the Reconstruction Committee of the Royal Institute of British Architects, dealing with reconstruction and the architectural profession, and of a pamphlet, "Plan for Living", by Mr. Clough Williams-Ellis*. The report directs attention to the lack of use of the special knowledge of the architect in Great Britain during the War. The Select Committee on National Expenditure has several times pointed to waste of time and materials directly due to neglect of such knowledge and experience in furtherance of the war effort, but the present report from the Royal Institute of British Architects is concerned more particularly with the opportunities in the period of reconstruction after the War.

The failure of town and country planning to achieve the beneficial or significant results desired is attributed partly to neglect of the services of the creative architect, and the report emphasizes the desirability of establishing so far as possible the relations between architectural and planning functions before the end of the War, as well as examining the organization and potential capacity of the profession, and establishing publicly and in good time the extent of contribution it can make to national reconstruction. In regard to the design and external appearance of buildings, the value of a consultative panel of architects to whom reference should be obligatory is discussed in some detail. The importance of the status of the official architect is rightly stressed, whether in regard to Government departments or to local authorities, and in a section on the building industry after the War the functions of the architect and the importance of training are discussed with admirable lucidity and restraint.

Mr. Williams-Ellis contrives to discuss the position of the architect in post-war planning with equal felicity and detachment. His claim for the architect as the key man in the team is advanced with reason and an approach to objectivity. That it is the architect's job and not the engineer's, in the first instance, to replace our towns, is no unreasonable contention. The outlook of the modern architect is intrinsically the more likely to bring that touch of vision and creative insight essential to give us towns and countryside which hold the possibility of a full and happy life for all, and not merely a sanitary existence. It is the architect who has the vision and whose training in civic design includes the sociological, transport, engineering and legal questions that are subsidiary but essential elements in designing the successful and beautiful town.

The possibilities of securing the basic things required for a merely tolerable existence by reason-

* Plan for Living: the Architect's Part. By Clough Williams-Ellis. Pp. 36. Rebuilding Britain Series, No. 5. (London: Faber and Faber, Ltd.) 1s. net.

able forethought and planning to exclude inconvenience, ugliness, dirt, overcrowding, traffic delays, lack of sunlight or open-air amenities are ably discussed by Mr. Williams-Ellis. He reminds us of the opportunities which the bold and progressive ideas of to-day offer to constructive statesmanship, and of our comparative freedom from economic limitations if only we refuse to attempt to carry on with the old wasteful and inefficient muddle of unplanned living. If indeed we fail to seize the opportunities now before us, many of them presented by the removal of obstructions by bombing, and fail to develop a nobler community marked by the sanity, order and beauty which, as Mumford has reminded us, is the final test of an economic system, democracy will indeed have shown itself unable to learn from its present enemies.

Fortunately technical ability and taste in architecture and town planning stand high in Great Britain to-day, and that ability and taste will have unprecedented opportunities. Both Sir Stafford Cripps and Mr. Lyttelton in their recent broadcasts, moreover, have indicated a new attitude in the Government which reflects the popular demand for something different and better. We are already entitled to assume that private ownership and vested interests will not be allowed to hold up or hinder changes needed in the public interest. Further, agreement has been reached on some such points as the optimum size for towns according to their location, siting and character, the sense of citizenship and civic pride and the provision of public amenities and cultural activities. True economy consists in efficiency, which includes not only right planning for traffic, public services, utilities, industries, commerce, health and education, but also for those no less vital needs known as amenities.

There is one point on which Mr. Williams-Ellis rightly insists. The success or failure of planning and reconstruction will finally depend on the character and ability of the men who do the job. Whether they are professional men such as architects or engineers, or administrative officials, or councillors, local or national Government servants, they must hold their posts in respect of ability, zeal and probity, and no other consideration whatsoever. On that condition the job is already half done. Without it, inefficiency, indifference and corruption will yet sabotage and bring to naught any programme or plan however brilliantly conceived.

The right note of moral conviction has been struck by Mr. Bevin, by Sir Stafford Cripps and by Mr. Lyttelton in their recent speeches. They go some way to remove the uneasiness suggested by Lord Portal's and by Mr. Strauss's speeches that progress has of late been retarded rather than accelerated. The urgent need remains for the Government to give the most explicit assurance of its earnestness and of its determination to produce the measures and policies in readiness for the testing time of armistice and the advance to a new peace economy. Nothing short of a Government declaration of its clear intention to retain control of industrial organization for so long as is necessary to bridge the hazardous period of transition, and simultaneously to secure the full adaptation of the production machine to the needs of reconstruction at home and overseas and the full employment of the working population for this purpose, will suffice to secure the maintenance of the national unity which is our safeguard from disaster. If the speeches to which we refer should check any undue pessimism, they should also stimulate unceasing pressure on the Government until there is forthcoming unmistakable evidence of the driving force and conviction of urgency which will ensure to the Minister of Works and Planning the powers and the legislation to enable him to formulate, and in due course to execute, a policy which will define and implement that outlined last February by Lord Reith and Mr. Greenwood and reiterated by Sir Kingsley Wood in his Budget speech. With nothing less will the country be content and without something more its war effort may well suffer. The Government should take the earliest opportunity of removing these doubts as to its continued determination to find "practical solutions for the immediate problems of a transition from war to peace", and to outline and amplify "a policy for the years following the War which will command the support of the nation as a whole and enable united action to proceed in peace as in war".

FALLACIES OF RACIALISM

Racialism against Civilization

By Dr. I. Zollschan. Pp. 64. (London : New Europe Publishing Co., Ltd., 1942.) 1*s*. 6*d*. net.

FOR many years Dr. Zollschan has been trying to rouse public opinion to a greater awareness of the ugly aspects of the racial theories concocted by Nazi propaganda, and its predecessors, to justify the aggressions by means of which a pathological group seeks to over-compensate for its deep sense of intellectual inferiority. The German disease is an old one, as the author shows. It was raging in Bismarck's time, and, whether voluntarily or not, Wagner increased the morbid tendency by his popularization of Teutonic heathendom in the "Ring of the Nibelungs". The Christian tradition was sick almost unto death in German universities ; and theological writers, there as in Great Britain, were too often content to spin webs of sophistry to hide a void.

If we study human society objectively we cannot but realize that, whereas in the early and lowly stages of its evolution the individual is governed mainly by custom, the better equipped peoples show more tendency to value personality. Custom is apt to harden into a restrictive routine that sooner or later finds itself out of touch with ever-changing life, and the closed systems that have existed in the past have thus been led on through persecution of their best children to bankruptcy of ideas and collapse. This is the main argument for philosophic liberalism, which, in its turn, needs to guard against forgetfulness of the fact that man is a social being and has been such from the very outset of his story. To combine social order with the cherishing of personality as an agent of necessary adaptation is a chief task of mankind ; and its difficulty is seen only too clearly when we realize that most 'blue prints' of a better world envisage a static condition, a sort of millennium that cannot exist. How to change

without destruction of precious heritages and without degradation of personality is indeed the deepest of social problems. It is not to be solved by the selective analysis of purely intellectual effort; it must take into account the whole man and the whole social life of mankind.

Racialism supposes that mankind is divided into groups of long-distinct origin among which different heritages occur steadfastly. These heritages are supposed to be of different values in different cases; and those who claim that a certain heritage, for example, what is sometimes called the Aryan, or what is sometimes called the Nordic, is of outstanding value and endangered by intermixture, can only too easily work up an argument for domination and for elimination of others by the massacres and tortures in which the Nazis find delight.

Huxley, half a century ago, aptly said one should not speak of an 'Aryan race', any more than of a 'brachycephalic grammar'. Aryan languages spread in Europe and parts of Asia long ago; and no doubt considerable movements of population were involved, notably, it would seem, an exodus from the semi-arid grasslands of western Asia and southern Russia. But the vast majority of those who speak Aryan languages probably have only a little of the varied bodily heritages, if any at all, from those emigrants, in their make-up; and they are enormously varied in their physical, and, be it added, social and intellectual characteristics. The claim that the blond, tall longheads of northern Europe are in some special sense the descendants of these ancient emigrants is very ill-founded. The parallel claim that an ancient Nordic civilization arose autonomously and gave its achievements to Europe is too absurd to be discussed by anyone who has thought of the early history of the western Baltic with its fusion of at least two diverse immigrant cultures and, as usual, an interesting development following that interpenetration of different heritages and the accompanying liberation from the repressions of imposed routine obedience. It is exchanges that fertilize civilization.

There is little enough ground for ascribing a separate and isolated origin and development to the tall, long-headed blonds of northern Europe. Sweden still has individuals carrying characters, including a relative brunetness, that are widely thought to have been maintained from very early, probably Palæolithic times and are old-established even in Sweden. Archæology tells us of a number of immigrations, along the Arctic zone, from the south-east and from the south-west. Biology suggests that in this cool environment maturity comes relatively slowly and bony growth may be prolonged. The coincidences between the distribution of blondness and the area of marked cloudiness in this zone of low insolation are at least suggestive. It is thus highly probable that the different physical characters we possess have different histories and, however durable some bony features may be, they are not unchangeable. How much more is that the case with social and intellectual features!

Nevertheless, we must remember that there are interesting cases of inheritance of mental characteristics, of all grades, that are not to be ascribed by any means solely to environmental influences.

It may be that those who have lived for generations under a climate that almost forces people to activity to keep warm, and is nevertheless not so cold as to be severely repressive, may be energetic folk, may, in the terms of Sir Patrick Geddes, have a high ratio of katabolism to anabolism; but their energy may find outlets in constructive work just as well as in destruction. They are not committed to predatory effort by their biological constitution. Indeed, many a peaceful and constructive Dane very likely has more of this activity in him than the would-be Nordic Prussian who gratifies his *parvenu* Nordism and expends his intellectual activity on brutality to Poles, Czechs, Jews, French, Dutch, yea, even Norwegians and Danes.

Julian Huxley contributes a characteristically vigorous and thoughtful preface emphasizing man's power of conceptual thought which can build up a tradition; in other words, can add a transmissible heritage that need not be linked to a physical one. As he says, "most of the achievements on which our 'white' or 'Nordic' civilization is based we owe to the brains of brownish Asiatics—the alphabet, agriculture, building in stone, metallurgy, the wheel and so forth". He, like Dr. Zollschan, makes his point clearly that one of the novelties introduced by man into evolution was that of universal and conscious values which, once discovered, have an almost independent existence, a momentum of their own.

The preface might have added a little more spice had its author recalled the famous verse of Hilaire Belloc which describes the Nordic man: "His legs are long, his wits are slow". Whether Belloc's generalization has more scientific value than that of Houston Stuart Chamberlain and the Nazi demagogues one would not like to have to decide; but it at least has a touch of humour about it and none of Hitler's mentors—Haushofer, Streicher, Rosenberg—could ever be credited with that.

The presumptuous claim that racialism is founded on Darwin's work might be more drastically destroyed than it is in Dr. Zollschan's book. He is clear, as every thinker must be, that neither can victory in war be a criterion of survival, nor can survival as a biological fact be confounded with superiority of value. What he might have emphasized is that the idea of the Darwinian process as mere struggle is inadequate. The mammals have become a large, powerful and widespread group largely thanks to the elaboration among them of maternal devotion; and that factor has been much developed in the species of mammal to which we belong, one of the most widely distributed of all. With this development among mammals has gone an elaboration of group life, which, again, has had a unique blossoming in our own species. We are still, of course, at an early stage of our social evolution, and have a great deal to learn.

Dr. Zollschan sees what a large part religion plays in social maintenance and evolution. He sees, too, that insistence on untenable, anthropomorphic religious ideas has weakened the social influence of traditional religion among us. The Nazi racialism and other varieties of totalitarianism are in a large measure attempts to find a new religion which, as the author well says, in these days must inevitably try to achieve a link with the revelation of science. Whatever may be thought concerning other forms of totalitarianism, the Nazi variety essentially exemplifies the revolt of the sub-human and the degenerate against the advance of the social and ethical towards a more complete humanism.

The battle against Nazi decadence is the battle for peace and goodwill and their outcome in the wide humanism that science is making possible.

H. J. FLEURE.

EMBRYOLOGY OF THE RHESUS MONKEY

Embryology of the Rhesus Monkey (*Macaca mulatta*) Collected Papers from the Contributions to Embryology, published by the Carnegie Institution of Washington. (Publication No. 538.) Pp. iii+148+52 plates. (Washington, D.C.: Carnegie Institution, 1941.) 1 dollar.

IN 1925 the Carnegie Institution of Washington undertook a programme of research into the problem of reproduction in monkeys. Its first step was to establish a colony of rhesus macaques in its Department of Embryology, which was then directed by Dr. George L. Streeter. The Department is next door to the Anatomy School of Johns Hopkins University, where a few years earlier Dr. George W. Corner had begun similar work on the same species of primate. The close affiliation of the two laboratories proved fortunate, and the success of the Institution's programme of research, now directed by Dr. Corner, is marked by a number of monographs published in its "Contributions to Embryology". Five of these monographs have now been collected in a single volume.

The volume opens with Hartman and Corner's paper on the first maturation division of the macaque ovum. Like the others of the series it is beautifully illustrated; and it demonstrates that, as in the vast majority of mammals, the first maturation division occurs within the Graafian follicle just preceding its rupture. The second paper, by Lewis and Hartman, takes the story a stage further and discusses fertilized and unfertilized ova recovered from the Fallopian tubes, and the further behaviour of which has been studied *in vitro*. The process of segmentation has been successfully filmed, but attempts to fertilize the eggs *in vitro*, unlike similar experiments with rabbit eggs, failed. The third monograph, by Heuser and Streeter, deals with the early development of the embryo. Cleavage of the fertilized ovum leads to a selective distribution of the complex material of the original one-cell egg into the daughter cells of, first, the morula, and then the blastocyst. This process represents the specialization of 'primary orders of tissue', a process which the authors point out depends on intrinsic genetic rather than environmental factors, and by which the auxiliary elements of the egg separate themselves from the true formative elements. Strictly speaking, it is a process which does not represent growth, since the mass of the cells of the free blastocyst is in fact less than that of the original egg cell. The moment this primary differentiation has occurred, its cellular products themselves begin to exert a mutual influence upon each others' further development.

The factors responsible for the transport of the blastocyst and the determination of its site of implantation, which occurs about the ninth day after ovulation, are unknown, but the process of implantation itself has been studied in the greatest detail. So, too, has the differentiation of the 'germ disc', which in its early stages is synonymous with the so-called 'embryonic ectoderm', and which the authors regard as exercising a function similar to that of the dorsal lip of the blastopore, in so far as the disc has a "dominating influence in determining the fate of the neighbouring auxiliary cells as well as those migrating out from the germ disc itself". During this early stage of development the disc is growing as a tissue culture in a fluid medium provided by the surrounding auxiliary cells. It owes its organizing propensity to the fact that its constituent cells represent an unspecialized residuum of the original germ plasm. Further segregation of cells, as development of the disc proceeds, brings these particular cells into relation with the primitive streak. It is not until the latter has given off definitive embryonic ectoderm, mesoblast and gut endoderm cells that the residuum of primordial germ plasm is finally used up. The endodermal contribution of the germ disc is not clearly distinguishable from the cellular proliferation, perhaps induced by the germ disc, of the primitive endoderm cells—which are a direct product of the primary segregation and cleavage of the egg.

Heuser and Streeter thus define a first order of segregation or specialization in embryonic development in which the formative elements of the fertilized egg become separated from the auxiliary elements; a second order of segregation in which the formative elements containing the residuum of primordial germ plasm become organized as the primitive streak, which is the locus of the "second order of specialization"; and further orders of segregation, for example, the separation of the ganglion crest from the neural ectoderm, which finally become too numerous to be kept in serial levels. The general conclusions reached are of considerable importance to comparative embryology. The authors do not subscribe to any simple and far-reaching phylogenetic theory. As they put it, "the embryo at all stages is a living organism and is to be analysed as a biologic problem rather than purely a morphologic abstraction". For example, "what were thought to be vestiges of great phylogenetic importance appear, in many instances, to be temporary embryonic structures, essential to a particular period of development."

The fourth monograph of the series is by Schultz, and discusses fœtal growth, with special reference to body proportions, certain ectodermal structures and ossification. The rhesus monkey at birth is relatively much more advanced than a new-born human infant, but fœtal growth-changes in body proportions are much the same in both species. A notable exception is the brain, which in the new-born rhesus monkey is about half the final size achieved in post-natal life, and in man a quarter. The fifth and final monograph of the volume, by Wislocki and Streeter, is a very detailed discussion of placentation. It demonstrates clearly that, in the differentiation of the trophoblast, there is a striking similarity between man, anthropoid apes and the rhesus monkey. The human placenta can be regarded as having been derived from the catarrhine variety by the acquisition of an interstitial mode of implantation. Here the authors depart from a widely accepted view, in so far as they suggest that human interstitial implantation is not due to the trophoblast becoming more "invasive", but to the endometrium becoming less resistant to invasion —as shown by the absence in man of proliferation of the uterine epithelium at the site of implantation. This paper ends with a stimulating discussion of the functional relationships between egg and endometrium.

The Carnegie Institution is both to be congratulated on the achievement which the volume represents, and to be thanked for having made these five monographs available between the same covers. It is to be hoped that this is only the first of a series of similar ventures, and that other volumes will follow in which further related studies of primate reproduction and growth will be made available, in the same convenient form, to students of the subject. S. ZUCKERMAN.

Handbook of Chemical Microscopy

By Prof. Émile Monnin Chamot and Prof. Clyde Walter Mason. Vol. 2: Chemical Methods and Inorganic Qualitative Analysis. Second edition. Pp. xi+438. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 30*s*. net.

THE rapid development in recent years of microchemical methods of analysis has called forth an excellent series of text-books on various aspects of the subject and, of these, Chamot and Mason's "Handbook of Chemical Microscopy" holds a deservedly high place. In the second edition of vol. 2 now under review, most of the subject-matter in the original work (reviewed in NATURE, 130, 619; 1932) has been retained but a number of new tests have been included, some of them employing organic reagents such as dipicrylamine, nitrobarbituric acid and diphenylcarbazide. The most extensive additions have been to the sections dealing with the detection of the alkali metals, the metals of Group IV of the periodic classification and the anions of the sulphur group where tests have now been included for the polythionates; a scheme for the identification of the various sulphur-containing anions has also been drawn up. To illustrate these new procedures there have been included forty-eight additional photomicrographs. All the photographs are excellently clear and the same care has been expended in making the descriptive matter lucid and yet concise. The text is remarkably free from errors, while there is a good index. The volume is handsomely bound, so that the authors and publishers have collaborated to produce a book which is indeed a joy to handle and to use.

Beyond the "Isms"

By Olaf Stapledon. (Searchlight Books, No. 16.) Pp. 128. (London: Martin Secker and Warburg, Ltd., 1942.) 2*s*. net.

THERE has been a remarkable spate of books inspired by the War, and they are none of them of the furious anti-Hitler type which the case would warrant. The writers are stirred by social passion among themselves. Let them use the war as binding the nation in determined and religious ardour which will stretch far beyond the war itself. Sir Richard Gregory's "Religion, Science and Civilization" is, of course, of ampler scope and full of interesting matter. It leans in the same direction as Mr. Stapledon in stressing the religious side but avoiding any orthodox religions. The most striking feature of all these religious-social war exhortations is that they come from and go to the religious who frankly discard the accepted creed of the Church of England or any other church. Their attitude is forward-looking, but not attached to any church. The future of organized religion will therefore become more and more vague and insincere, unless the discard of impossible doctrines and legends is frankly made.

This is being done in certain churches, and, of course, in multitudes of private prayers.

The crisis is a useful one. A new archbishop to set the tone.

Religion is our attitude towards the Infinite in company with and for the good of others. This must differ from worshipper to worshipper. The Infinite may find its own. F. S. MARVIN.

Supplement to the British Pharmaceutical Codex, 1934

Part 1: Monographs (New Monographs). Pp. iv+101. (London: The Pharmaceutical Press, 1942.) 5*s*. 6*d*.

THE British Pharmaceutical Codex was last published in 1934, but it has been brought up to date by the issue of three supplements in the last few months. The first supplement deals with dressings, while the second contains additions and amendments to the formulæ for galenical and other preparations in Part 3 of the Codex. It is designed to overcome difficulties arising from the War by authorizing the use of alternative formulæ for preparations in which certain of the ingredients are either in short supply or reserved for more important purposes. The third supplement, which corresponds with Part 1 of the Codex, is most likely to interest the scientific man. It contains 66 new monographs describing substances recently introduced in medicine, and substances liberated by the recent emergency legislation from the restrictions imposed by foreign patents. About half of these substances have already been described in the various addenda to the British Pharmacopœia; the remainder now receive their first official description in Great Britain. The sections on "Action and Uses" in this supplement will interest many who are not concerned with pharmaceutical details. They give a summary of some of the more important recent advances in pharmacology and therapeutics, and are more balanced and more authoritative than many of the corresponding sections in the Codex, which have retained much that is now archaic, probably because there was no definite reason for believing it to be incorrect.

Aircraft Instruments

By George Ellis Irvin. Pp. x+506. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 35*s*.

THIS book is composed mainly of detailed descriptions, with comprehensive maintenance and testing schedules, of standard American products; the thoroughness which is characteristic of American trade booklets is evident in the treatment. Other than the omission of oxygen instruments and of the absence of synchroscopes from the chapter "Tachometers and Synchronizers", the volume covers most of the American instruments in general use. It is excellently illustrated and reproduced, and in this respect is marred only by a number of proof-reading errors.

The author makes little attempt to explain the physical conceptions leading to the design of flight and navigation instruments, and it is perhaps as well that the scope of the book is restricted in this direction. For example, the statement "Air-speed indicators show the speed of the airplane relative to the air through which it is travelling" is incorrect, unfortunately for the navigator; and in the chapter on compasses, some confusion over the north end of a magnet is evident.

The useful properties of all the instruments are fully described, but their limitations, both fundamental and in practical usage, receive little critical attention. The book is useful for reference purposes, but it cannot be recommended to the serious student of aeronautics or instrument design.

THE WEED PROBLEM*

By PROF. E. J. SALISBURY, C.B.E., F.R.S.

TO define a weed is not an easy matter since this term of opprobrium is applied in different ways by different persons. Probably the best definition is that of a plant growing where we do not want it. Nevertheless to many the designation implies a certain measure of uncontrollability, and it is more particularly these weeds, which are the bane of the farmer and the gardener, that concern us here.

It has been estimated that, before the War, the cost of weeds to Great Britain was of the order of some sixteen and a half million pounds a year. It is, indeed, probable that this is a very conservative estimate, since the monetary losses due to the indirect effects of weeds, which are by no means inconsiderable, are well-nigh impossible to assess.

The most evident effect of weeds is that they compete, with our crop and garden plants, for such essentials as water, the mineral nutrients necessary for all types of vegetation in smaller or larger degree, the carbon dioxide of the air, and for the radiant energy upon which the manufacture of sugars by the green leaf depends.

The competition for the soil moisture is of a dual character. If plants are growing in a very wet soil the amount of water which the plant can take up, provided there is adequate aeration, is probably determined more by the efficiency of the internal water-conducting system than by the extent of its roots. But when the moisture in the soil is low in amount the extent of the absorbing surface of the root which is in contact with the soil is often the governing factor in the supply, and it is naturally under just these conditions that the water supply is most important. The extent of the root system is also of importance as affecting the amount of nutrients available to the plant, since upon this will depend the volume of soil exploited. This is especially true with respect to those nutrients in regard to which the soil is most deficient.

The development of the root system of a plant is now known to be greatly influenced not only by the aeration and texture of the soil but also by the presence of root systems. The mechanism of this interference is not yet fully understood. It is likely that the intake of oxygen and the release of carbon dioxide during the respiration of roots may play an appreciable part. Indeed, most roots are intolerant of high concentrations of carbon dioxide in the soil atmosphere. The presence of numerous weed roots will therefore compete for the available oxygen and render the soil atmosphere less favourable for root development and the intake of nutrients. In addition there is experimental evidence that soluble substances are produced by roots, perhaps during the breakdown of dead cells, which are of a toxic nature and vary in their deleterious character according to the species concerned.

Some astonishing figures have been obtained by the Canadian botanist Pavlychenko showing the extent of the root system of cereals when grown with and without the competition of other plants. When wheat and rye were raised as single individuals with no other vegetation in their neighbourhood and measured as if all the roots were cut off and placed end to end, as one continuous thread, the total length was more than forty-four miles for a wheat plant and more than fifty miles for one of rye. When grown in drills, as in normal cultivation, so that the crop plants in the same row compete with one another, the root-lengths diminished to from one half to two thirds of a mile, while when weeds were present in addition, between the rows of cereals, the total length was only about one ninth of a mile. The presence of charlock in a field of wheat can reduce the root system of the cereal to one fifth or even a tenth of its extent when weeds are absent.

There is reason to believe that root competition and the resulting effects upon the supply of nutrients may often be the most important of the deleterious effects brought about by weeds. Weeds thus deprive our crop and garden plants of water and nutrients in two ways. First by reducing the volume of soil occupied, and secondly by depleting those essential requirements which the diminished volume of soil contains.

Sometimes the chief nutrient thus depleted is nitrogenous material, and the harmful influence of some weeds can be greatly alleviated by applications of nitrogenous fertilizers. Even where there is no root-competition, mere crowding, as Dr. Brenchley showed with plants in separate containers in water culture, in itself increases this nitrogen requirement. But it must be emphasized that the nearer any nutrient is to the minimum requisite for crop growth, the more likely it is that the presence of weeds will bring about a real deficiency.

We know that weeds absorb the essential elements in very different amounts. Thus the common bracken contains an exceptionally high proportion of potash, so that plants in competition with bracken are liable to suffer from potash starvation, but for the same reason bracken fronds, cut early in the season, provide a most useful material for composting in these days of shortage in potash supplies.

We now know that broad beans and beets, in particular, require minute traces of boron, and possibly all plants require some. Lack of minute quantities of copper and cobalt in a soil, and hence in the herbage developing upon it, may lead to serious and even fatal diseases in sheep. The study of these micronutrients is as yet in its infancy, and one of the gaps in our knowledge that requires filling is in respect to the effect of weeds in influencing the availability of these essentials for healthy growth. We do know, however, that these micronutrients are often present in amounts only just adequate for the crop, and one or other is not infrequently deficient, at least in an available form.

Some weeds take up these rarer elements in quantities as great or even greater than do our garden and crop plants. It is therefore extremely likely that the presence of weeds competing for these micronutrients may accentuate even if they do not create deficiencies.

So far as I am aware, gold has not yet been shown to be essential for vigorous plant growth, but data obtained by the distinguished Czechoslovakian plant physiologist, Prof. B. Němec, showed that whereas a metric ton of dried maize contained only 2 gm. of gold, that objectionable weed the field horsetail (*Equisetum arvense*) contained 63 gm. and the marsh horsetail (*E. palustre*) 610 gm., although the same dry weight of the soil only contained a tenth of a gram. Let me hasten to add that the yield per acre is not sufficient to warrant the cultivation of horsetails for this purpose.

* Substance of a lecture delivered at the Royal Institution on April 30.

There is another aspect of the weed in relation to the rarer elements that is of considerable economic importance in certain districts. Some trace elements, far from being beneficial to stock which feeds upon the herbage containing them, are extremely poisonous. A particularly striking example is afforded by the seliniferous soils of the United States. The pastures which grow on these soils may be quite innocuous, since the comparatively insoluble selenium is only absorbed in small amounts by the grasses and many species of herbs. But certain weeds which occur in these pastures, particularly species of milk vetch (Astragalus spp.) have such a capacity for absorbing and accumulating selenium that they render the herbage highly poisonous to browsing animals. The so-called 'teart' pastures of Somerset, Gloucester and Warwickshire are now known to be deleterious to cattle owing to the presence of molybdenum in the herbage, but whereas dried rye-grass growing on these soils will contain only about one part of molybdenum in a thousand, white clover will contain about nine and a half times as much. Hence on these soils the clovers, which are desirable constituents of herbage in most areas, must be classed as weeds. Applications of ammonium sulphate to such pastures reduce their toxicity partly because there is an increased proportion of grass in the herbage but also because under the more acid conditions thus induced the uptake of the molybdenum is diminished.

These few examples suffice to show that the relation of weeds to the rarer elements is an important one concerning which far more information than at present available is desirable. The amounts involved are extremely small. It has, for example, been estimated that the requisite cobalt for healthy growth of sheep in New Zealand is of the order of one part in twenty million.

Competition for light by weeds and cultivated plants is often pronounced in the seedling stages, when weeds may form a canopy of foliage that precludes all but a small fraction of the radiant energy, necessary for green leaves to manufacture the plant's food, from reaching the seedlings of our crop or garden plants. But such competition for light is by no means confined to the juvenile phases of development or to recently disturbed soil. The plantains and daisies on our lawns and golf-greens suppress the grass mainly because their close-pressed rosettes cut off the light from the turf beneath. But no better example of competition for light could perhaps be found than is exhibited by that weed of the hedgerow, the common elder (*Sambucus nigra*) because it illustrates in a striking manner those biological features which most commonly render species especially aggressive in this respect. The first of these is the remarkable capacity of this shrub to form robust shoots of great length in a single season. These may attain more than six feet and quickly outstrip the shoots of their neighbours. Secondly, the very early development of the new foliage, which expands before that of other deciduous hedgerow shrubs, confers a by no means unimportant advantage in time. Thus in the south of England the average date for the beginning of leaf expansion of the elder in a normal season is about the middle of February, whereas for our commonest hedgerow shrubs, the hawthorn, blackthorn and hazel, the average date is about the third or fourth week in March. Lastly the leaves of the elder are large and collectively constitute a canopy of foliage that is relatively impermeable to the light. The total effect of these features is that the elder can create an efficient sunshade above the surrounding hedge before the leaves of the other shrubs are even fully expanded. Added to which the seedlings of the elder are remarkably tolerant of deep shade, so that they can develop under conditions that might suppress other species, and are not infrequently to be found within the hedge itself.

In addition to the direct effects of weeds in depriving cultivated plants of light, water, and nutrients, there are other important indirect outcomes of their presence, particularly as host plants of pests which enable the parasites and predators to persist in an area from which the appropriate cultivated host is temporarily absent. Thus the flea beetle, which in the past season was such a devastating pest on turnips in some areas, finds an alternative host on the charlock. Weeds also harbour eelworms and virus diseases, while the slime fungus which causes club-root disease of our cabbages and other species of Brassica, is often to be found flourishing on Cruciferous weeds, particularly treacle-mustard (*Sisymbrium officinale*).

With respect to insect pests that attack both crop-plants and weeds, our knowledge of deterrents and attractants, though at present meagre, offers the interesting possibility of treatment that shall not merely render the cultivated plants relatively immune but may also induce such insects to afford biological control of the weeds themselves.

The solution of the weed problem can only be found by concerted action directed on one hand towards weed destruction and on the other against their reappearance. Methods of destruction, especially by chemical means, are often immediately successful and even spectacular in their achievements, but they represent an expenditure of money, material and human effort that might in many instances be avoided. Preventive measures are usually far from being spectacular and indeed are apt not to be accorded the recognition they deserve.

Cultivation of the soil by hand, while affording an effective means of control of annual species and some perennials, is dependent upon an adequate supply of inexpensive manual labour. On the farm, mechanical cultivation can achieve much to mitigate the labour difficulty, but it should be remembered that the effective application of mechanical methods to the fallow and the growing crop demands forethought in the lay-out and spacing of the plants to this end. The chief drawback to cultivation as a means of weed control is that the repeated disturbance of the soil that may be required to keep the land clean is liable to do as much harm by disturbance of the roots of the cultivated plants as it does good by the destruction of the weeds.

The high cost of labour and the risk of undue root disturbance have been responsible for the development of chemical means of control by spraying. Of these the most effective so far devised is the method of spraying with a dilute solution of sulphuric acid which was utilized with very satisfactory results in the United States and France and has been successfully developed by Mr. G. E. Blackman in Great Britain for the control of weeds in onions and other crops. By the application of a suitable amount of lime the effects of the acid on the soil are neutralized. Nitric acid has also been employed and has the merit that it increases the nitrogen content of the soil which weeds are so liable to deplete. Some measure of

control has been achieved by the use of fertilizers such as ammonium sulphate and cyanamide, and if such methods could be rendered more effective they clearly offer the advantage of avoiding expenditure of chemicals that are not in themselves of value to the crop. If more effective control by means of fertilizing sprays or dusts could be attained it would probably be greatly to the advantage of agriculture and horticulture in more ways than one. Only time can reveal the long-term influence of chemical methods on soil-structure and fertility.

Even with the most effective chemical sprays destruction of weeds is rarely complete, and those that remain, because they are freed from the competition of their neighbours, may attain a large size and in considerable measure compensate in seed yield for the small number of individuals that ripen fruit. For this reason the supplementing of mechanical or chemical control methods by hand labour may well be profitable.

On unplanted soil, drastic methods such as the application of sodium chlorate are sometimes effective against deep-rooted perennials, but little is known as to the residual effects upon the soil structure and the microscopic forms of life.

Many perennial weeds, such as the creeping thistle, the bindweed and the hoary cress, can produce shoots from quite small fragments of the roots even if these be comparatively deeply placed in the soil. Repeated destruction of the overground shoots of these until the underground parts are exhausted of their reserves of food, offer the best hope of their eradication. This has proved effective with the bracken, although the cutting has to be carried out two or three times at intervals of five or six weeks over a period of from three to five years. It has been aptly said that to stop cutting bracken before eradication is complete is like leaving a smouldering fire untended.

Biological control by the encouragement of parasites, either insect or fungal, has been utilized with varying degrees of success. Insect control has proved valuable against the cactus pest of Australia (see NATURE of September 13, 1941, p. 303). The control of bracken by means of a fungus has been attempted in Great Britain. The great difficulty in the development of biological methods is to find a parasite which is strictly limited to the kind of plant we desire to control and which will not sooner or later itself become a pest on some related or even unrelated species which we cultivate.

The weed problem is apprehended as in reality a dual one: the first being the problem of eradication, and the second the problem of preventing reinfection. The former is often far more readily accomplished than the latter, which can in general only be partially achieved.

The second category, preventive measures, are not only perhaps the most important but also their application leads us to study the biology of the weed species and thus to discover their most vulnerable points of attack.

However effectively we may have destroyed existing weeds, it is clearly imperative that they should not be re-introduced by the sowing of impurities with our seeds. Modern screening methods which take advantage of many of the differences between crop seeds and those of other plants such as size, weight, and surface texture have accomplished much, and the number of weeds that we inadvertently sow to-day are few compared with half a century ago. The former prevalence of darnel grass (*Lolium temulentum*), which was evidently a pest in Shakespeare's day, of the blue pimpernel (*Anagallis coerulea*), and the pheasant's eye (*Adonis autumnalis*), which are to-day rare cornfield weeds, was due to their repeated introduction in seed imported from the south of Europe. Even now vast quantities of weed seeds are annually sown with grass and clover seed all over Great Britain.

The returns of the official seed-testing station show that perennial rye-grass seed commonly contains 2–4 per cent by weight of impurities, cocksfoot seed about 9 per cent, and meadow foxtail between 30 per cent and 40 per cent. Clover seeds, too, often contain between 4 per cent and 9 per cent. To understand what such proportions of impurities mean in terms of actual weed seeds, I have calculated that in every year, with the sowing of clover and grass, more than six billion weed seeds were probably also sown throughout Great Britain.

Even could we completely clean the soil of growing weeds and ensure that no weed seeds were afterwards sown, we should probably not be free from weeds for a number of years owing to the long period over which buried weed seeds can remain alive.

Careful experiments carried out on seeds buried in the soil and then placed under conditions favourable to germination, after the lapse of increasing periods of years, have shown that the seeds of the shepherd's purse (Capsella) and fat hen (*Chenopodium album*) can retain their viability for at least thirty-five years, and those of the crisped dock (*Rumex crispus*) for at least sixty years. Others, such as those of the blue pimpernel, retain their viability for even longer periods.

Apart from viable seeds already in the soil and possible impurities in the seeds that we sow, there is another source of infection that is by no means negligible, namely, the accidental introduction in manure, on our boots and clothes, and even on the implements of agriculture. The moist heat that is generated as manure ferments, or in the compost heap, does, it is true, destroy the viability of many of the contained seeds, but many there are which can not only pass through the alimentary canal of the cow or horse with unimpaired or even enhanced germination, but also can survive the subsequent fermentation.

It is worth while dwelling somewhat on the accidental carriage and distribution of seeds by our own activities, since all too little attention has been paid to this by no means infrequent occurrence.

Some years ago I carried out a number of experiments designed to test the extent to which seeds were carried about in the mud upon our boots. Mud brought into churches which had paved paths leading to the porches was placed on sterilized soil and moistened. The seedlings which afterwards emerged were found to be mostly grasses, but various other weeds were also present. It is reasonable to assume that these seeds might have been carried appreciable distances before the mud dried sufficiently to fall off. Even more effective carriage in mud is accomplished in the patterned tread of motor-tyres and the wheels of farm carts and lorries, as well as those of private cars, and are an effective means of dissemination over long distances. There is little doubt that the wayside pineapple weed (*Matricaria suaveolens*), which originated from Oregon, owed its rapid spread

throughout Great Britain to this means of dispersal.

Our clothes, too, are a frequent means of seed carriage, and if after a country walk one turns down the 'cuffs' of one's trousers it is amazing the collection of seeds that can be obtained. I have sowed a number of such collections after walks in diverse types of habitat. In one instance there were no less than 325 seedlings produced when the trouser brushings were sown on sterilized soil. Of this total 284 were seedlings of various grasses, while the remaining 41 comprised five different kinds of weeds.

It is important to recognize that vegetative propagation by means of shoots that arise from the roots, though an unusual feature, is characteristic of several of our most pernicious weeds such as the creeping sorrel (*Rumex acetosella*), the creeping thistle (*Cirsium arvense*, the field convolvulus (*Convolvulus arvensis*), and the yellow toadflax (*Linaria repens*). The importance of such vegetative methods is that whereas the seedling can only successfully develop in a relatively open spot where the small food reserve in the seed will enable it to grow into the light, the shoot from a root or from an underground stem has the much larger reserves of the adult parent to draw upon and so is able to extend unchecked by the shade of its neighbours.

Owing to the prolific production of seeds (for example, a single fruit of groundsel has the potentiality of infesting about sixty-five acres in three years), it cannot be urged that because the number of seeds inadvertently introduced is small, it is therefore a matter of indifference. Indeed, when we weed our gardens it is well to remind ourselves that unless the ground is cleaned completely of all weeds our efforts may merely result in the survivors attaining to large dimensions, and thus in no small degree compensating by the magnitude of their yield for the dearth of individuals.

We must, moreover, recognize that our efforts to eliminate weeds will automatically tend to render our tasks more difficult unless it is complete. So, too, in the use of large-scale weed treatment in agriculture, it is important to bear in mind that a remedy that is only partial may in fact merely destroy the strains that are more easily killed and so we leave behind the more resistant types free from the competition of their less robust relatives; hence the latter state is worse than the first, for we have selected out a strain or strains that demand more drastic measures to compass their destruction.

If our attempt at suppression is at the seedling stage, we must know whether germination is commonly 'simultaneous' or normally 'intermittent' and what is the period of dormancy of buried seeds? So, too, it is essential to our success to know the potentialities for vegetative increase. Crops of weeds like those of economic species have their soil preferences and differential response to nutritional stimulus. In South Australia it was found that the application of copper salts to copper-deficient soils resulted in an increased yield of the cereal crop amounting to from three to eight times, but the effect upon the weeds was only to increase them by 50 per cent. It is, indeed, manifest that to combat effectively the avarice of weeds it is essential to have a far more intimate acquaintance with their biology, in all its aspects, than we at present possess. 'Know thy enemy' is as sound advice in horticultural and agricultural hygiene as in any other type of activity, and perchance we may find that a species that appears in the guise of an enemy may sometimes function as a friend.

X-RAY TECHNIQUE IN THE INDUSTRIAL LABORATORY*

By H. P. ROOKSBY

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THERE are two main ways in which X-rays have become of immense practical importance in the industrial field. The great penetrating power has been utilized in the technique of radiography for the examination of what may be described as the macro-structure of solid bodies and objects. In X-ray crystal analysis the diffraction of X-rays by the regular pattern of atoms in a crystal has been utilized to elaborate and supplement chemical and other physical methods of examining the nature and properties of a material.

X-Ray Tubes

The basic design of the modern X-ray tube is that of an evacuated jar or envelope containing two electrodes between which a high potential is applied. In an electron tube for radiographic work, the target or positive electrode usually consists of a hollow water-cooled block of copper into the face of which is set a small disk of tungsten. The other electrode is a hot tungsten filament surrounded by a metal cap or hood, the arrangement being to focus the electron stream from the filament on to the target face in the form of a rectangle. When viewed at an incident angle of about 20°, the rectangular source of the primary X-ray beam is foreshortened to a square. Comparatively compact X-ray tubes encased in oil and with shock-proof high-tension cabling are available for operation at 200 or even 400 kilovolts. Demands for radiation of great penetrating power have led to the building of units to operate at one million volts and more. One of the most recent which may be used at a million volts utilizes Freon under pressure as the insulating medium and a resonance transformer as high-tension generator. The length is only 7 ft., the X-ray tube and generator being enclosed in the one envelope[1].

For crystal analysis it is not necessary to operate the X-ray tube at voltages above 60–70 kilovolts. Moreover, some means has to be found for simple alteration of the nature of the source of X-rays in order that several different wave-lengths are available. The requirements are best met by the continuously evacuated demountable X-ray tube, with interchangeable targets each faced with a different metal. The rectangular focus is frequently viewed at almost glancing angle so that a source of X-rays effectively approaching a short line is obtained.

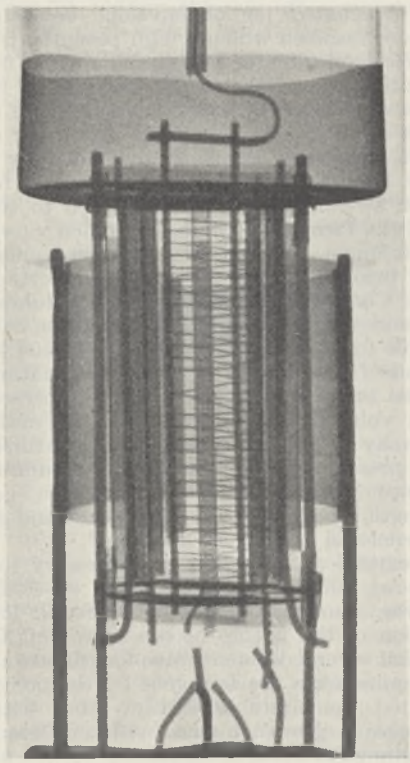
The radiation from an X-ray tube consists, in general, of two parts, the 'white' or continuous spectrum radiation and a line radiation the wave-lengths of which are characteristic of the radiating element. It is the continuous radiation which is of practical value in radiography; in the continuous spectrum there is a sharp lower limit of wave-length depending only upon the applied voltage and decreasing with increase in voltage. To a great extent the penetrating power of a heterogeneous X-ray beam increases as the lower limit of wave-length becomes shorter, so that penetrating power may be largely controlled by the X-ray tube voltage. It must be chosen to suit the subject of examination if maximum

* Abridgement of three Cantor Lectures delivered before the Royal Society of Arts on March 16, 23 and 30.

clarity and contrast on the X-ray negative is to be obtained. As a general rule, the X-ray tube voltage should be adjusted to the lowest value at which reasonable penetration of the object is obtained. The distribution of wave-lengths or 'colour' of the X-ray beam may also be modified by inserting appropriate metal filters in its path. There is then a suppression of the longer wave-length components. By such means, and by the employment of lead intensifying screens consisting of very thin sheets of lead placed on either side of the X-ray film, scattering and secondary radiation from the specimen are substantially reduced[2]. At the higher voltages this results in a considerable improvement in clarity and definition of the image.

Radiography

Probably the most important sphere of application of radiography in the industrial field is the examination of metal castings. The defects in castings that



RADIOGRAPH OF SMALL RADIO RECEIVING VALVE SHOWING INDIRECTLY HEATED CATHODE AT CENTRE OF ELECTRODE ASSEMBLY.

may be revealed by X-ray examination can be classified broadly as porosity, inclusions and cracks. These defects will in general be regions of smaller absorbing power than the surrounding metal, with the result that darkened areas will appear on the X-ray negative. The lower limit of size of an inhomogeneity which can be detected depends primarily upon the smallest difference in thickness of the metal that can be registered on the negative. For steel of the order of 2 in. thick a change of about 1 per cent may be detected. With castings of the light aluminium and magnesium alloys, which are of such immense importance in the aircraft industry, the sensitivity is generally lower, for, while it is easy to obtain adequate penetration it is more difficult to obtain good contrast.

Radiography has not perhaps been so extensively applied to the examination of assemblies, but in many varieties of radio valve radiographic inspection has proved of great aid to development and manufacture. One of the original studies was of the large water- and air-cooled transmitting valves. Sufficient penetration of the opaque copper anode had to be obtained to delineate sharply the tungsten and molybdenum inner electrodes, and yet leave a clearly defined outline of the anode to give information as to the concentricity of the whole assembly. The technique has been extended to many special forms of small thermionic valve with opaque envelopes in which clearances between the various components are particularly critical. Distortion and deformation of the parts of the assembly during operation and during life can also be studied by taking a series of X-ray photographs at different stages, and such a series may often prove a useful guide to improvements in design because the points at which imperfections in construction occur can be so readily observed. Even when the envelope of the valve is of glass, the only practical way to examine a component at the centre of the electrode system (a tungsten heater inside a thermionic cathode for example) is by X-rays.

X-Ray Crystal Analysis

With the verification of the suggestion by Laue that the X-ray wave-lengths should be of the right order for diffraction by the interatomic distances in crystals, there commenced an extensive study of the structure of crystals. The basis of practically all X-ray diffraction measurements is the law first formulated by the Braggs, namely, $n\lambda = 2d \sin \theta$; the X-rays are regarded as being reflected from planes of atoms spaced apart by a distance d.

Of the various methods devised for the determination of crystal structures, one is of outstanding value for use in the industrial laboratory. This is that commonly known as the powdered crystal method, and consists essentially of examining photographically the diffraction effects obtained when a finely powdered crystalline substance is irradiated with a pencil of monochromatic X-rays. A single wave-length incident upon a crystalline powder gives rise to a number of cones of diffraction corresponding to the atomic planar distances of which the characteristic crystal structure is made up. The cones of diffraction may be intercepted by a photographic film in several ways. In the simplest technique a flat film placed behind the specimen perpendicular to the direction of the X-ray beam records a series of concentric rings. Alternatively, the film may be placed so that the primary X-ray beam has to pass through the film before striking the specimen, the back-reflexion method. Of widest application perhaps is the cylindrical powder camera, in which narrow strips of film on its periphery almost surround the specimen which is mounted on its axis. The X-ray pattern consists then of slightly curved lines, is unique to each crystalline element or compound, and hence may be employed as a crystal 'fingerprint' for identification purposes.

Very careful design of cylindrical powder cameras is required in order that patterns of high definition and clarity should be obtained. For example, it is essential to ensure that after collimation the primary X-ray beam travels through the camera without impinging upon any other part. Usually knife edges are arranged to record fiducial shadows on the film

at a diffraction angle of approximately 85°. This enables accurate measurements of interplanar spacings to be made and errors due to film shrinkage, mounting of specimen, etc., to be avoided[3,4]. The powder is attached with an adhesive medium to a fine glass fibre or hair and rotated continuously on the camera axis during the exposures. Displacing the air in the camera with hydrogen is advantageous because this appreciably reduces general scatter of the X-radiation near the lower angles of diffraction. It is useful to have available two cameras of different diameters, for example, 10 cm. and 19 cm. respectively. The larger camera naturally increases the separation of the diffraction lines.

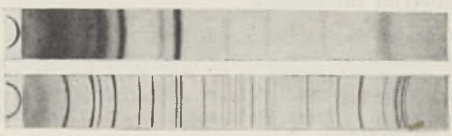
Applications of X-Ray Crystal Analysis

Identification is to a large extent achieved by comparison of the pattern of the specimen with standard X-ray patterns of known pure substances, and it is desirable to possess as large a collection as possible of standard photographs. Generally, the origin and the chemical or spectroscopic analysis of a specimen will suggest likely substances and set a limit to the possibilities, but the experience and memory of the investigator will enable much time to be saved in any given search. It would be advantageous to have a reference index in terms of interplanar spacings for as many powder photographs as possible, with a master table, for example, of two or three of the strongest lines in each. There are very considerable difficulties, however, in making the index sufficiently comprehensive.

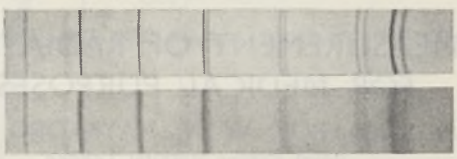
The strengths of the respective X-ray patterns from the components of a mixture are dependent upon the relative amounts present, so that a quantitative determination of composition can be made. Usually the accuracy is not very high, partly because of some uncertainty in the estimation of line intensities, but for small concentrations of one phase in another the estimation may frequently be made to 1–2 per cent.

Far from being the only application of X-ray powder photography, formal identification of a chemical compound may be but the initial step in an investigation. It is the more subtle information so readily given by the X-ray technique that is frequently of such great importance. In the first place, we often wish to distinguish between different crystalline varieties of a substance, and since it is the atomic arrangement that determines the form of the X-ray photograph, true crystalline modifications will give distinctive X-ray patterns. In the case of silica there are three polymorphic forms stable at ordinary temperatures, namely, quartz, cristobalite and tridymite. Silica bricks are employed extensively as refractories in glass and steel furnaces; the raw material is quartz and the bricks must be fired at high temperatures before use to convert most of the quartz to cristobalite and tridymite. Although the chemical composition of the brick remains unchanged, X-ray examination shows when the change in crystal form of the silica has taken place.

Mixed crystal or solid solution formation is readily revealed by X-ray powder photographs. With a continuous series of solid solutions the end members of which are isomorphous, the dispersion of the lines of the X-ray patterns usually changes systematically with composition. Such a series is formed between barium and strontium carbonates, the compounds used in the preparation of the alkaline earth oxide-coated cathodes for thermionic devices. It is often necessary to determine the composition of such oxide coatings after operation, and since the amount of material is usually extremely small and the separation of barium and strontium difficult by the more usual chemical analytical methods, X-ray analysis has been applied. The ratio of barium to strontium is determined by measuring the displacement of the X-ray pattern of the thermionic cathode coating in the form of carbonate from the patterns of the individual carbonates of strontium and barium. The study of alloys or the solid solutions formed between elements is one of the most important applications of X-ray analysis; extensive examinations have been made of ternary alloys, where complex problems of equilibrium arise and the distinction between the various phases is difficult or impossible by microscopic or other methods[5,6].



X-RAY POWDER PHOTOGRAPHS (10 CM. CAMERA, COPPER *Kα* RADIATION) OF γ AND α FORMS OF ALUMINA, ILLUSTRATING LARGE DIFFERENCE IN ULTIMATE PARTICLE SIZE.



PARTS OF X-RAY POWDER PHOTOGRAPHS (19 CM. CAMERA, COPPER *Kα* RADIATION) COMPARING (*a*) SODIUM CHLORIDE ANNEALED AT 450° C. WITH (*b*) SODIUM CHLORIDE AFTER SEVERE GRINDING.

If the average crystal size of a powder falls below a certain value, the lines of the X-ray pattern become broadened, and for very small crystals the lines are so broad as to be better described as diffraction bands. The amount of the broadening may be measured and used to calculate the average crystal size. Characteristic chemical or physical properties of a material may often be dependent upon ultimate crystal size rather than upon aggregate particle size. The γ form of alumina, for example, is used as an absorbent for water vapour in gas dryers, when it is frequently referred to as 'activated alumina'. The high absorptive properties are associated with the fact that this form of alumina, as usually prepared, consists of extremely small crystals, some 40–50 A. in size, the X-ray powder photograph showing very diffuse lines compared with the sharp lines on the pattern of the relatively inactive α alumina.

Broadening or diffuseness of the X-ray lines may also be associated with what is called lattice strain or lattice distortion. Such distortion is present in filings from a metal or in a powder which has been severely ground. The presence or absence of strain is best examined in the back-reflexion region of the X-ray pattern, where the normally sharply resolved α doublet lines of the characteristic radiation may become fused into a broad unresolved reflexion. It is often required to test the efficacy of heat treatments in freeing a metal from strains introduced by particular mechanical processes, and here the detection of lattice distortion by X-rays is of great practical importance. In the manufacture of alloys of nickel

and iron in powdered form for use at high frequencies in various types of magnetic loading and radio cores, it is inevitable that high degrees of lattice strain are introduced and this must be reduced to a minimum to obtain the magnetic characteristics required. By examining the resolution of the lines on the X-ray patterns of powders after heat treatment at successively increasing temperatures, it is possible to determine at what stage the strain is eliminated, and so an appropriate 'annealing' schedule can be chosen. Moreover, by the examination of finished powder, variations in the manufacturing conditions are quickly revealed.

The examples given here are but a random selection from the very many and varied applications of X-ray technique. They should, however, enable some picture to be formed of the extensive manner in which X-ray methods may be utilized in the industrial laboratory.

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[2] Seemann, H. E., *Proc. Amer. Soc. Testing Materials*, **38**, 284 (1938).
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MEASUREMENT OF RADIATION FOR MEDICAL PURPOSES*

By PROF. W. V. MAYNEORD
Royal Cancer Hospital, London

THE methods of measuring radiation for any purpose must in the end be determined by the fact that we are concerned with a form of energy. In particular, the biological or medical use of radiation is dominated by the rule that absorbed energy alone is effective, so that we are forced in considering the physical aspects of the use of radiations for these purposes to look very closely into the measurement of absorbed energy.

Considering the case of X rays first of all, it has for many years been recognized that the most promising basis on which to construct a system of measurement is the ionization produced by them in air, and since 1928 the röntgen based upon this finding has been used as the internationally accepted unit of dose. In 1937, as the result of a good deal of experimental and theoretical work, the use of the unit was extended to gamma rays, and a new definition of the röntgen was promulgated. The fundamental idea, namely, that we take all the electrons set free by the radiation from a certain mass of air, utilize as much as possible of their energy in producing ionization in air and measure the number of electrostatic units of charge thus liberated, appears much more clearly in the new definition.

Having in this way obtained a suitable unit, it was natural to apply it to medical problems, in particular to that of finding the dose at any point throughout the tissues of the body. First of all, the distribution of radiation along the axis of a beam of X rays was studied over a very wide range of conditions from 10 kv. up to some 2,000 kv., and so a large amount of useful information was collected concerning the effective penetration of the beams. Later the studies were extended to include the complete three-dimensional problems of distribution and the study of 'isodose surfaces'. Simple geometrical methods of dealing with these problems were demonstrated, and it is possible by the use of plaster casts to estimate fairly closely the dose received at any given point within any arrangement of beams of radiation, however inclined or concentrated. Alternatively, the best arrangement of beams of radiation in order to produce the maximum dose at the point desired while at the same time keeping down the dose to normal healthy tissue, may be investigated.

So far we have been concerned with the amount of radiation at a particular element of volume, but it is important to develop this study so as to estimate the total energy absorbed by the body as a whole, the estimates of energy absorption to be made if possible in absolute energy units.

It will be recognized that the röntgen is essentially a unit of energy absorption in air, the factor of proportionality depending upon the energy required to produce one ion pair. If this energy is 33 electron-volts, it follows that when 1 röntgen is delivered to 1 gm. of air there will be an absorption of energy of about 85 ergs. For soft animal tissues the value will vary a little with wave-length, but for many purposes may be assumed to be equal to this amount. For the further development of the theory it is also necessary to consider the relationship between the intensity of a beam of X or gamma rays in ergs/cm².sec. and the dosage-rate, that is, r./min. Evidently the relationship depends upon the wave-length of the radiation, and it is easily calculated that whereas the energy flux per cm². per röntgen for gamma rays is of the order of 3,000 ergs, for long wave-lengths of the order of 1 A. the corresponding number is about 30 ergs. The distinction between intensity and dosage-rate is a very important one, which is all too frequently neglected in theory and practice.

In considering some of the effects of radiation, it seems that the total energy absorbed throughout the body is a very important quantity. The distribution studies of dose, the isodose surfaces, coupled with the deduction of the energy absorbed per gm. per röntgen, enable estimates of the energy absorbed to be made. We have used as a unit the energy absorbed when 1 röntgen is given to 1 gm. of air, and called it 1 gram-röntgen. In clinical practice a megagram-röntgen is of a convenient order of size and may be shown very easily to be approximately 2 gm.cal.

Again, by geometrical and analytical methods (assuming simple laws of variation of radiation with depth) the integration of the energy absorbed throughout any part of the body may be carried out, and so the total energy absorbed may be estimated. This has been done for a number of conditions occurring in practice and it is found that the physical results are very instructive in relation to the clinical findings. As an example of the kind of problem in which the results are significant, we may quote the problems of the protection of staff and patients from unwanted radiation, where the differences now revealed in the total energy absorbed in the body as a whole per unit dose on the skin raise the question of the assumed independence of 'tolerance dose' of wave-length. By the use of large numbers of pressed bakelite - carbon condenser ionization chambers throughout a model of the body, this subject is being investigated further.

* Substance of a lecture delivered to the Physical Society on Feb. 27.

Having obtained estimates of the energy flux into the body and of the energy absorbed from beams of X and gamma rays, it is natural to attempt the corresponding solution for ultra-violet and infra-red rays. By the use of calibrated thermocouples, information on this subject may be obtained, and indeed in the case of ultra-violet light a good deal is already available. It seems that the total energy absorbed per square centimetre of the body when irradiated with ultra-violet light so as to produce a threshold erythema is of the same order as that given when 100 r. of medium wave-length X rays is administered. For infra-red radiation very little information was available, but we have used suitably mounted calibrated vacuum thermocouples (General Electric type) and made measurements of the intensities required for a painful sensation and of the intensities normally employed in therapy. The values of these quantities are found to vary with the colour temperature of the source, the normal intensity for a 500-watt tungsten filament lamp in a reflector being of the order of 1·5 gm.cal./cm².min.

Finally, then, we see the order of intensities and amounts of energy involved in the use of different kinds of radiations.

(*a*) Type of radiation.			Intensity in ergs/cm.²sec.
High-voltage X rays. Heavy filter	200 kv.	40 r./min.	2×10^3
Ultra-violet light		20 μ watts/cm.²	2×10^3
Infra-red		1 gm.cal./cm.²min.	7×10^5

(*b*) Type of radiation			Total energy absorbed
High-voltag e X rays	200 kv.	30 megagram-röntgens.	60 gm.cal. in 6 weeks.
Ultra-violet light		Erythema over body surface of 1,500 cm.².	8 gm.cal. at a sitting.
Infra-red		1 gm.cal./cm.²min. 20 min. Area 1,500 cm².	3×10^4 gm. cal. at a sitting.

The intensities are approximate but of interest in the correlation of all the radiations on an energy basis.

OXIDATION OF HYDROCARBONS AT LOW TEMPERATURES

By P. GEORGE, PROF. E. K. RIDEAL, F.R.S., and A. ROBERTSON

Department of Colloid Science, Cambridge

FARMER and Sundralingam in a recent paper[1] have stressed the part that hydroperoxides play as the first isolatable intermediates in autoxidations: their investigation, anticipated by Criegee, showing that olefin peroxides have the structure $-CH(OOH)-CH=CH-$, brings these peroxides into line with Rieche's alkyl peroxides, possessing the reactive group ($-OOH$). The work reported below on the uncatalysed and the heavy-metal catalysed oxidation of alkyl benzenes and long-chain saturated aliphatic hydrocarbons (C_{15} to C_{25}) in the liquid phase at 100–120° C., also supports the hypothesis that hydroperoxides are primary oxidation intermediates.

The Chain Character of the Reaction

In the case of alkyl benzenes the peroxide found after reaction corresponds to 60–80 per cent of the oxygen absorbed. The peroxides of long-chain paraffins are not so stable; and they are only found in small concentration, about 5 per cent. In the metal-catalysed oxidation good agreement is obtained between the observed peroxide concentration and that calculated from the efficiency of the catalyst in peroxide decomposition.

In the catalysed oxidations a curious independence of oxidation-rate of catalyst concentration was found above a certain value. This has been reported in other autoxidations, notably benzaldehyde catalysed by ferrous phthalocyanine[2] and linseed oil catalysed by hæmoglobin[3]. The explanation advanced was low oxygen availability due to physical conditions. This cannot be the case here, for the rate of oxidation has been found proportional to the partial pressure of oxygen. The curves obtained for long-chain paraffins catalysed by cobalt stearate and ethyl benzene catalysed by copper stearate are shown in Fig. 1.

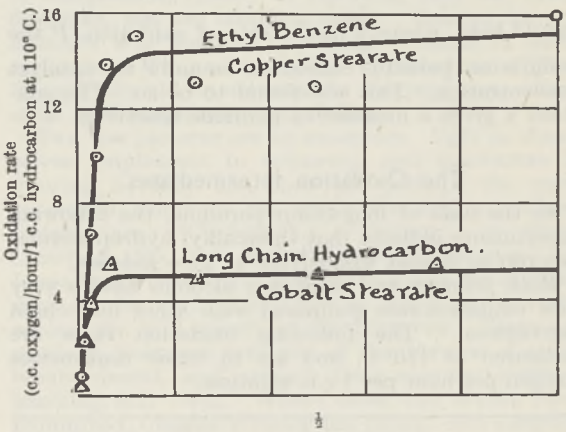

Fig. 1.

This can be explained by the hypothesis of a chain mechanism in which the metallic catalyst both starts and stops chains. This gives the expression:

$$\text{Rate of oxidation} = \frac{a + bY}{c + dY} \quad . \quad . \quad . \quad (1).$$

Y is the catalyst concentration, a the number of chains started per unit time in the uncatalysed reaction, b the number started per catalyst molecule $1/c$ and $1/(c + dY)$ the uncatalysed and catalysed chain lengths respectively.

The chain character of the oxidation has been demonstrated by inhibition with β-naphthol. It causes a marked diminution in the oxidation rate of alkyl benzenes, the rate slowly increasing with time. For catalysed long-chain paraffins complete induction periods lasting for 2–6 hours with no measurable oxygen uptake are observed, even with a 2–50 molar excess of catalyst over inhibitor. Equations have been developed to calculate the chain length from this diminished rate or induction period data. A surprising specificity of catalysts is shown by the following experimental results:

(*a*) Copper stearate catalyses the oxidation of ethyl benzene and tetralin, but not long-chain

paraffins, whereas cobalt stearate is as efficient a catalyst for all three.

(*b*) Copper stearate added to cobalt-catalysed long-chain paraffin diminishes the rate.

(*c*) Copper stearate diminishes the uncatalysed rate of octene mixtures.

All these phenomena are explicable on the assumption of different chain-starting and chain-stopping efficiencies. From equation (1), if b/d is *greater* than a/c, then the metal is a positive catalyst, whereas if b/d is *less* than a/c it is an inhibitor.

Farmer[1], Cook[4] and others have shown that heavy metal catalysts decompose hydroperoxides giving mainly ketones and alcohols. Kinetically, the decomposition of tetralin peroxide is unimolecular, the reaction constant being proportional to catalyst concentration. This suggests a 'metal catalyst hydroperoxide complex' breakdown. The efficiency of a catalyst as a chain stopper is paralleled by its effect as a catalyst in the decomposition of hydroperoxides. A kinetic study suggested that in catalysed oxidations the relation

$$\frac{dx}{dt} P = \alpha Y$$

should hold, where $\frac{dx}{dt}$ is the rate of oxidation, P the equilibrium peroxide concentration and Y the catalyst concentration. This was found to be so. The constant α gives a measure of peroxide reactivity.

The Oxidation Intermediates

In the case of long-chain paraffins, the following experiments indicate that these alkyl hydroperoxides decompose almost exclusively to give ketones.

Both primary and secondary alcohols have a very slow oxidation-rate compared with other long-chain derivatives. The following oxidation rates are measured at 110° C. and are in cubic centimetres oxygen per hour per 1 c.c. solution.

Type of compound	Uncatalysed rate	Catalysed rate with ½ per cent cobalt stearate
Sec. octyl alcohol ...	0·06	0·2
Cetyl alcohol	0·08	0·8
Long-chain paraffin ...	0·25	4·5
Laurone	2·6	8·6
Stearic acid	0·5	9·0

If alcohols were intermediates, the oxidation would tend to slow down markedly and alcohols would preponderate in the product. Furthermore, by oxidizing a mixture of hydrocarbon with a secondary alcohol (the type of alcohol produced by oxygen attack on a $-CH_2-$ group) ketone or acid, the results shown in Fig. 2 are obtained.

It is apparent that secondary alcohols inhibit the oxidation of hydrocarbons just as β-naphthol does, though not to such a marked degree; 10 per cent of alcohol produces an induction period of at least 6 hours and 25 per cent for at least 24 hours. This is very strong evidence that the oxidation does not proceed via alcohols, and so Bone's hydroxylation theory does not apply in these low-temperature liquid phase oxidations. The curves for acid and ketone mixtures indicate that these are also chain processes. The shape of the ketone-hydrocarbon curve indicates that the ketone oxidation chain-length is greater than the hydrocarbon oxidation chain-length. The converse holds for the acid-hydrocarbon curve.

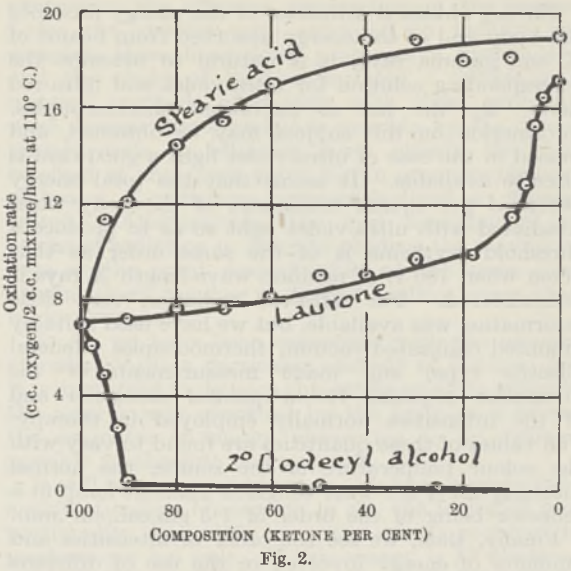

Fig. 2.

The Nature of the Catalyst

The function of the metallic catalyst in hydrocarbon oxidation is thus shown to be threefold: to start and stop reaction chains leading to the production of hydroperoxides, and to decompose the peroxides. It has been suggested in the past that the catalytic activity is due to the heavy metal ion. However, a vast number of co-ordination compounds act as catalysts[5], among them porphyrins[6] and phthalocyanines[2], and the assumption that their varying catalytic activity is due to their differing degrees of electrolytic dissociation is contrary to their physical properties and stereo-chemical behaviour. The real problem now is to decide which of the transition element properties—whether complex formation or valency change—is responsible for the chain-starting and chain-stopping process. The rates of the catalysed oxidation of tetralin and paraffinic hydrocarbons are proportional to the partial pressure of oxygen, which implies that the oxygen molecule is involved in the chain-starting process. This favours complex formation. A study of some sixty catalysts suggested that all the good catalysts are ionic complexes, which would be the case if the required bonding of the oxygen molecule were similar to that in oxyhæmoglobin, where paramagnetic hæmoglobin combines with paramagnetic oxygen giving diamagnetic oxyhæmoglobin[7].

In an attempt to poison this heavy metal catalysis with carbon monoxide, it was found to be oxidized to carbon dioxide: control experiments showed this to happen only in the presence of oxidizing hydrocarbon. It is hoped that this will help in the future to elucidate the chemical nature of the chain process.

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[2] Cook, *J. Chem. Soc.*, 1770 (1938).
[3] Robinson, *Biochem. J.*, 18, 255 (1924).
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[7] Pauling and Coryell, *Proc. Nat. Acad. Sci.*, 22, 210 (1936).

SCIENCE AND ART AT THE ROYAL ACADEMY, 1942

By DR. A. T. HOPWOOD
British Museum (Natural History)

WHEN reviewing last year's Summer Exhibition at the Royal Academy, I ventured to say that since intellectual honesty is at the foundations of both science and art, there is no fundamental distinction between them, and that apart from the objectivity of the one and the subjectivity of the other the differences are mainly those of design, of technique, and of the medium of expression. I did not attempt to define what art is because there is so much difference of opinion among professional critics, to say nothing of the disagreements to be found among painter-writers, that it seemed presumptuous for a zoologist to try to do so. On the other hand, it is but just to the artist that the critic should explain his methods so far as in him lies, and this entails an effort to define his terms.

Now a painting, a drawing, or a piece of sculpture is a report on its maker's activities. It differs from a scientific report because it records the emotions of its author, and also reveals his personality. The more sincere it is, the more complete will be the revelation of the artist's emotional personality; if this is not so the result is meaningless. When looked at intelligently, and there is a great difference between looking at an object and understanding it, it becomes a work of art to the degree in which it succeeds in conveying the artist's meaning to the mind of the beholder.

For example, at the present Exhibition "Stone Walls, Yorkshire" by Sidney Lee (No. 103) is to me a work of art because it conveys the feeling and spirit of the landscape in the Millstone Grit regions of the Pennines; but if another fails to respond to the picture, then not all the technical merit in the world will make it a work of art for that person. Again, "The Coaster" by Arthur B. Cornwell (No. 323) is likewise a work of art for much the same reason; it makes an immediate appeal to all sailors and also conveys a vivid impression of stormy coastal waters of Great Britain to those unfamiliar with them in a way that no photograph could ever do. The artist has succeeded in capturing the mood of the storm and recording it in paint. These are simple examples, but what is to be made of "Wet Fish on Tilted Tray" by Frank Goulding (No. 332)? Here we are confronted with the adumbration of a number of forms which the artist avers to be fish; fish, be it said, such as no fisherman ever saw. What then was the intention of the artist? It may be that this is a report on some experiment which I cannot understand, but it is certain that it conveys nothing to me, and therefore is not a work of art for me.

Art, then, depends on the co-operation of two persons, the artist and the spectator. When the artist succeeds in expressing the emotional imagery conjured up in his mind by a given set of circumstances in such a way that their depth and intensity are communicated to the spectator, he has achieved art. But the spectator, too, must do his share, for, to quote Sir Joshua Reynolds, "It is the lowest style only of the arts that may be said in the vulgar sense to be naturally pleasing. The higher efforts of those arts do not affect minds wholly uncultivated". Which is not so far removed from Mr. Roger Fry's dictum that "In proportion as art becomes purer the number of people to whom it appeals gets less and less. It appeals only to the æsthetic sensibility, and that in most men is comparatively weak".

If the current Exhibition is approached in some such frame of mind as that indicated in the preceding paragraphs; if the scientific man will visit the Royal Academy with the intention of examining the pictures instead of just going to see them, he will find plenty to interest him. For the zoologist it is easy, and not very clever, to walk round noting that "Peregrine Falcon" by C. F. Tunnicliffe (No. 397) is not correctly coloured; that the pochard in "Good Companions" by Jessie Hodge (No. 391) has a lack-lustre eye; and that a Suffolk Punch, or what appears to be intended for such, is scarcely an appropriate mount for a cavalryman (No. 752). The botanist will find numerous flower pieces to criticize but very little fruit or vegetables. As for the war pictures, they are of general interest. There are portraits for the social historian; aeroplanes for the aeronautical engineer; ships for the navigator; bomb-scarred buildings for the architect and town-planner; and so on. Many of these reach a high level of competence, indeed as reporting they are often first-rate, but the damning entry "Painted for the Nation's War Records" attached to some of them explains a lot, and probably "Painted as a War Record" should be attached to the majority. They often lack inspiration and feeling.

Two war pictures are an exception. Ugly in themselves, unpleasant in colouring, and inaccurate in drawing as they are, they are perhaps the most successful works in the whole Exhibition. These pictures are: "Clydebank; a Tribute", by Hugh Crawford (No. 108) and "Military Objectives" by Louis Duffy (No. 183). The first conveys the doggedness of the civil population in war-time, and the second the dull misery of the bereaved. These are symbols, poignant symbols, of the horrors of aerial bombardment, and as such their essential truth is startling and vivid. Where these two artists have triumphed, Charles Wheeler has failed. His allegory, "Wings" (No. 128), is confused alike in message and design. The winged figure to the left does not carry the conviction of the angels of Fra Angelico, or, for that matter, of the devils of Dürer and Martin Schongauer, all three of whom believed in their images; but one doubts whether Mr. Wheeler believes in his.

On the whole, however, the psychologist probably has the lion's share of this Exhibition, as of many others. He will soon discover that A. J. Munnings is so interested in figures, particularly horses and their riders, that almost any sort of a smudge will do for the rest; "Start at Newmarket" (No. 1) and "A Swimming Pool" (No. 115) illustrate this point. Gerald Kelly is obviously interested in people, but not to the detriment of their setting; indeed the care with which the quiet backgrounds are painted only serves to emphasize the importance to be attached on the subject, and the unobtrusive prominence accorded to the hands indicates his confidence and skill. Augustus John shows himself still to be a romantic at heart, more at home with a subject such as "The Mask" (No. 106) than with an official portrait (No. 110). So one might go on through the catalogue, and so the visitor should go on for himself.

Most of the exhibits in the Architectural Room are of public buildings. The most interesting are the

drawings of some portions of the Anglican and Roman cathedrals at Liverpool by Sir Giles Gilbert Scott and Sir Edwin Lutyens respectively; they are hung side by side (Nos. 704 to 708) so that comparison is made easy. Plans for domestic dwellings are few, but protest must be made against No. 666, "War-time Housing on the Wirral"; not even war-time can excuse the mechanical dullness of these brick boxes.

Much of the sculpture is pleasant and intimate although not profound. Particular mention may be made of "Head of Young Bull" by Georg Ehrlich (No. 817), the "Leopard" by Hermon Cawthra (No. 796), and "Siamese Cat" by Margaret Heaton (No. 820). "Cart-horse Lying Down" by Tonie Brignall (No. 818) is stylized but not unsuccessful.

On the whole, then, there is little of primary scientific interest in this year's Academy, but this is all to the good. The natural reaction to a picture of 'scientific interest' is to examine it for its accuracy—the science comes before the art; but this year science takes a back seat and her devotees can give themselves up to the pleasure of getting on good terms with the exhibits and, through the exhibits, with their authors. Viewed in this light, the Summer Exhibition of the Royal Academy of Arts, 1942, is very much to be commended.

OBITUARIES

The Rev. T. E. R. Phillips

IT is with great regret that we record the death of the Rev. T. E. R. Phillips, so soon after the University of Oxford had conferred on him an honorary D.Sc.

Theodore Evelyn Reece Phillips, the son of the late Rev. Abel Phillips, was born on March 28, 1868, and was educated at Yeovil Grammar School. He proceeded later to St. Edmund Hall, Oxford, and graduated B.A. in 1891, in which year he was ordained to the curacy of Holy Trinity, Taunton. He took his M.A. in 1894 and two years later, while curate at Hendford near Yeovil, he used a 9¼-inch altazimuth reflector for the systematic observation of the planets, especially Mars and Jupiter. This work was continued when he moved to Croydon, and when he was appointed curate at Ashtead in 1906 a 12¼-in. equatorial reflector by Calver was substituted for the 9¼-in. An 8-in. refractor by Cooke, which was lent to him by the Royal Astronomical Society in 1911, was used for about thirty years, chiefly for double-star work.

In 1916 Phillips was appointed rector of Headley, and he set up an observatory in the rectory glebe where, in addition to the instruments referred to, an 18-in. reflector (mirror by With), lent by the British Astronomical Association, was mounted on the equatorial stand which had previously carried the 12¼-in. reflector. This 18-in. reflector was used mostly for planetary work and especially for investigating the surface currents on Jupiter.

A short record of Phillips's work on the planets, double-star measurements and light curves of long-period variables appeared in NATURE of February 28 (p. 241), and it is unnecessary to repeat this. Some reference may be made to his analysis of the light-curves of long-period variables, which he undertook on the suggestion of the late Prof. H. H. Turner about thirty years ago. He conducted a harmonic analysis of the light-curves of nearly eighty stars, and a full account of this appeared in his second presidential address to the British Astronomical Association (*J. Brit. Ast. Assoc.*, **27**, 1; 1916). In this address he referred to his work on *S.* Herculis (*Mon. Not. Roy. Astro. Soc.*, **75**, 7), where he had gone as far as the fifth harmonic. He felt that certain assumptions were adding encumbrances to the problem and remarked ". . . we have now reached a stage when the theory of stellar variation calls for reconsideration and revision".

In addition to his interest in planetary features, variable stars and double stars, Phillips was a keen meteorologist and was elected a fellow of the Royal Meteorological Society in 1918. He kept an unbroken record of daily temperature and rainfall at Headley for twenty-five years and was working on the results before his death. He was analysing harmonically a large number of temperature curves for the British Isles and hoped to publish the results after the War. He was also interested in botany, more especially in British and Alpine flora, as well as in sketching, and he took an active part in the preservation of the countryside.

Phillips was a member of Commission 16, which is specially concerned with the physical study of the planets, of the International Astronomical Union, and was president for some years. In 1922 he was appointed by the late Archbishop Davidson as his representative on behalf of the Church of England to consider the stabilization of Easter. Later he sat on the special committee of six formed by the International Union to consider calendar problems in general. For many years he was a university extension lecturer for Oxford, Cambridge and London, and also Gilchrist Trust lecturer. In connexion with the British Astronomical Association he was director of the Jupiter Section, 1900–33, director of the Saturn Section, 1935–40, president during 1914–16, and recipient of the Walter Goodacre Medal and Gift in 1930. In 1918 the Royal Astronomical Society awarded him the Jackson-Gwilt Gift and Medal. He was secretary of the Society during 1919–26 and president during 1927–29. In February of this year, Oxford conferred on him the degree of D.Sc. *honoris causa*, an honour which he greatly appreciated.

His published works include his revision of Ball's "Popular Guide to the Heavens", and "Astronomy and Modern Thought". In addition to these, he collaborated with Dr. W. H. Steavenson in editing "Splendour of the Heavens", 2 vol., and he contributed articles in the "Encyclopædia Britannica" on "Planets".

Phillips's genial disposition made him very popular in astronomical circles, where he will be greatly missed. During his illness many anxious inquiries were made about his progress and there were hopes that he might rally and attend the meetings again, but early in May it was known that his condition was extremely grave, and he died on May 13. The interment took place at Headley on May 16, when a number of astronomical and other friends were present. In 1906 he had married M. H. Kynaston, who, with a son, survives him. M. DAVIDSON.

Mr. W. A. Douglas-Rudge

WE regret to record the death, on February 14, of Mr. W. A. Douglas-Rudge, late science master of Rugby School. Mr. Douglas-Rudge was a scholar of

St. John's College, Cambridge (B.A., 1899; M.A., 1903), where he obtained a first class in Part I of the Natural Sciences Tripos. He was science master of Woodbridge School from 1903 until 1907, when he was appointed professor of physics at University College, Bloemfontein. During his residence in South Africa he made a special study of atmospheric electricity in that part of the world. Several of his papers were published in the *Transactions of the Cambridge Philosophical Society*. He returned to Great Britain and was appointed science master at Rugby in 1916, a post which he held until his retirement at the end of 1930. Many of his old students at Woodbridge, Bloemfontein and Rugby will remember with gratitude his inspiring lectures, which were always illustrated with many experiments.

NEWS and VIEWS

U.S. National Academy of Sciences : Elections

THE following elections were made at the annual meeting of the U.S. National Academy of Sciences held during April 27–28 : *Foreign Secretary* (to succeed the late Prof. L. J. Henderson) : Prof. Walter B. Cannon, Harvard Medical School, Boston, Massachusetts (term : four years ending June 30, 1946) ; *New Members of Council* : Prof. George W. Corner, professor of anatomy, Strong Memorial Hospital, Rochester, N.Y. ; *Foreign Associate* : Prof. Robert K. S. Lim, professor of physiology, Peiping Union Medical College, Peiping.

Members of the Academy : Prof. Homer Adkins, professor of chemistry, University of Wisconsin, Madison, Wisconsin ; Dr. Lyman J. Briggs, director, National Bureau of Standards, Washington, D.C. ; Prof. H. T. Clarke, professor of biochemistry, Columbia University, New York City ; Prof. Ralph E. Cleland, Indiana University, Bloomington, Indiana ; Prof. C. H. Danforth, professor of anatomy, Stanford University, California ; Prof. C. A. Elvehjem, professor of agricultural chemistry, University of Wisconsin, Madison, Wisconsin ; Prof. Michael Heidelberger, professor of biochemistry, Columbia University, New York City ; Prof. John Gamble Kirkwood, Cornell University, Ithaca, New York ; Dr. Paul D. Merica, metallurgist, 67 Wall Street, New York City ; Dr. Thomas Midgley, jun., chemist, Worthington, Ohio ; Prof. Francis D. Murnaghan, professor of applied mathematics, Johns Hopkins University, Baltimore, Md. ; Dean John T. Tate, professor of physics, University of Minnesota, Minneapolis, Minnesota ; Prof. Alfred M. Tozzer, professor of anthropology, Harvard University, Cambridge, Massachusetts ; Prof. E. E. Tyzzer, George Fabyan professor of comparative pathology, Harvard Medical School, Boston, Massachusetts ; Prof. S. A. Waksman, professor of soil microbiology, Agricultural Experiment Station, New Brunswick, New Jersey. Prof. Albert Einstein, professor of mathematics, Institute for Advanced Study, Princeton, New Jersey, was also elected a member ; his status as a foreign associate, dating from 1922, before he became an American citizen, will not be affected by the new election.

History of Science in Scotland

THE Regional Committee for Adult Education of the University of St. Andrews has followed up the issue of twelve pamphlets on "Britain and its People" by the publication of a further dozen under the general title "Scotland and its People". These pamphlets provide, in a very readable form, much general information about Great Britain, and particularly about Scotland. Through the help of the Pilgrim Trust, it has been possible to distribute them free of charge to members of H.M. Forces and Allied troops. Among the titles in the second series are "The History of Science in Scotland", by Sir D'Arcy Thompson, "Scotland and Advances in Medicine and Surgery", by Dr. J. Patrick, "The Scottish Universities", by Sir James Irvine, and "Scottish Agriculture and Industry", by Mr. J. W. Nisbet. In his rapid survey of Scottish science Sir D'Arcy Thompson points out that Napier of Merchiston was the first true man of science in Scotland since Michael Scot. Soon after Napier's death, began the long line of "academic Gregories", contributing some fourteen professors of mathematics, medicine and chemistry to the Scottish universities during the succeeding two hundred years. "There is hardly such another instance known of scientific heredity, unless perhaps that of the Cassinis, who directed the Paris Observatory for nearly as long." John Napier, James Gregory, Colin Maclaurin and James Stirling are characterized as the four great Scottish mathematicians ; "but there came after them many a good man", including Ivory and Tait.

Among outstanding figures in chemistry are Black, Graham, Couper, Dewar, Ramsay and James Young ; in physics and engineering, emphasis is laid upon Watt (whom Davy likened to Archimedes), Robison, Russell (the builder of the *Great Eastern*), Brewster, Clerk Maxwell and Lord Kelvin. Of the last-named Sir D'Arcy writes : "Somehow he is not quite so great, he is not near so lovable, as Clerk Maxwell ; but his achievements were in touch with the spirit of his time, and his fame was prodigious." In astronomy, John Lamont of Braemar became Johann von Lamont, head of the Munich Observatory and an authority on terrestrial magnetism, and with him are mentioned Broun, Buchan and Henderson. Geology is represented by James Hutton, 'the father of modern geology', and many another ; for "Scotland has done so much for geology that this science seems peculiarly her own". Finally, in natural history and botany we encounter Sir Robert Sibbald, founder of the Edinburgh medical school, Goodsir the anatomist, Edward Forbes, Wyville Thomson, and Robert Brown of Montrose—Humboldt's *facile princeps botanicorum*. One lays down this attractive and admirable account with a lively sense of the truly remarkable nature of Scotland's contribution to pure and applied science.

Irish Sea and Inland Fisheries

A VERY satisfactory state of affairs is shown in the report of the Minister for Agriculture (Eire) on the sea and inland fisheries for 1940. The yield of sea fish exceeded that of any year since 1930 and was appreciably larger and of greater value than in 1939. The position has been affected materially by the

work of the Irish Sea Fisheries Association, Ltd., which began to function in 1931, and during the period intervening was engaged in the provision and equipment, on hire-purchase terms, of more than 130 motor-vessels which constitute the bulk of the existing fishing fleet. The larger landings in the year are attributable mainly to the efforts of the inshore fishermen, who found themselves well equipped at the onset of war conditions which have caused such a radical change in the operation of supply and demand for the output of sea-fishing in common with other food-producing industries. The increased earnings now obtainable are attracting more and more men.

The Dingle fishermen again did remarkably well, and their landings were just double the value of those of the preceding year. The summer and winter herring fishery, contrasted with 1939, showed quantitative increases of 21 per cent and 56 per cent respectively. The catches of salmon and sea-trout are better than those of the three preceding seasons, but are still below the average for the previous four decades. The drift-net fishings for salmon off the north and north-west coasts were also below average. The spawning season was a good one in nearly all fishing districts and the run of smolts, so far as was ascertainable, up to the average of previous years. The bad weather, however, interfered seriously with hatching experiments, although the output from the experimental brown trout hatchery at Lough Owel was nevertheless the highest yet recorded.

Meteorology in Iraq

THE fifth annual report of the Director of the Meteorological Service of the Government of Iraq, which covers the year ending March 31, 1941, describes the work of this Service during a period when it was much affected by the entry of Italy into the War on June 10, 1940. The amount of civil aviation in Iraq was greatly reduced, but the companies still carrying on were supplied with reports and forecasts on the usual lines. The greatest difficulties arising from the entry of Italy into the War were in connexion with supplies of equipment from Great Britain. The supply of balloons required for making observations of the upper winds became erratic, and larger reserves had to be built up, which gave rise to problems of storage in a climate very unfavourable for rubber storage. The experiment was made of getting balloons made in Australia and the United States. In both cases results were satisfactory apart from the extra expense.

Other innovations included the making of the hydrogen required for the balloons on the spot with the aid of French generators employing ferro-silicon, and the construction by the Ordnance Department of Stevenson screens and rain-gauges, the former at a cost less than half that involved when obtaining the screens from England. What is described as the outstanding event of the year under review was the setting up of synoptic reporting stations at Hail and Riyadh in Saudi Arabia with the help of King Ibn Saud. A new observatory was also established at Kut al Hai, and a Dines pressure tube anemometer was installed at Rutba at considerable expense. A beginning was made with the preparation for publication of all available climatological data based on observations made in Iraq. The report, therefore, shows that the year was one of progress in spite of the unusual difficulties in the way of advance.

The Ray Society

THE report of the Council of the Ray Society, which has just been circulated, states that, with the consent of the members, the annual general meeting has again not been held, and the present officers and council will continue to act for the current year. The accounts show that the reduction in the amount received from subscriptions has again been less than was anticipated and the sales of the Society's publications have been well maintained. A volume on "The Larvæ of Decapod Crustacea" by Dr. Robert Gurney will shortly be issued to subscribers for 1941. A work on the British Mysidæ (Opossum shrimps) by Prof. W. M. Tattersall is in preparation and is intended to form the issue for 1942. Owing to shortage of materials, the publications will, for the present, be issued in paper covers, but it is hoped later to supply covers for binding uniform with the volumes already published. The Council reminds members that, under present conditions, considerable delay in the publication of the annual volumes cannot be avoided. It is mentioned that at least one author has lost, by enemy action, all the notes and manuscripts prepared for a work to be offered to the Society.

Diseases and War

THE April issue of the *Quarterly Review* contains an interesting article on this subject by Major Frederic Evans, who discusses the problems of an army so far as the maintenance of health is concerned. He classifies the diseases which it is important to prevent in the following nine groups: (1) louse-borne diseases, which consist of typhus fever, trench fever and relapsing fever, (2) mosquito-borne diseases, namely, malaria and yellow fever, (3) diseases caused by sandflies in hot regions, such as sandfly fever, oriental sore and probably kala-azar, (4) excremental diseases, namely, typhoid, paratyphoid, cholera, dysentery and infectious diarrhœa, (5) diseases due to droplet infection, such as cerebro-spinal fever, diphtheria, scarlet fever, measles, smallpox, influenza and pulmonary tuberculosis, (6) venereal diseases and skin diseases, especially scabies, (7) diseases caused by environmental conditions, namely, heat stroke, frostbite and trench foot, and (8) food deficiency diseases, such as scurvy, beriberi and night-blindness. In conclusion, Major Evans emphasizes the importance of the medical officer training his sanitary duty squad as thoroughly as he trains his stretcher bearers and medical orderlies.

The Far East and the War

PROF. P. M. ROXBY'S admirable pamphlet on "China" (Oxford Pamphlets on World Affairs, No. 54. London: Oxford University Press. 4*d*. net) provides an excellent introduction, for those who have only now come to realize the importance of China in the War, to an understanding of the place of China in the struggle of the United Nations. Within the compass of thirty pages, he gives a succinct description of the land of China, the impact thereon of the West, and of the Nationalist movement and the progress of reconstruction up to 1931. The latter part of the pamphlet deals with the Japanese seizure of Manchuria and the consequences of the Sino-Japanese war which broke out in 1937. With Sir John Pratt's "Japan and the Modern World" (Oxford Pamphlets on World Affairs, No. 55. 4*d*. net) a penetrating analysis is afforded

of the causes which have merged the European and the Far Eastern conflicts into a single war. Sir John Pratt, moreover, in tracing the course of Japanese foreign policy and particularly of Japanese relations with Great Britain, goes to those fundamental differences in national temper and outlook which explain the present hostility of Japan and Great Britain, and indeed raise the question as to the desirability from the start of the Anglo-Japanese Alliance of 1902.

The Indian Science Congress

THE following have been elected presidents of the various sections of the 1943 session of the Indian Science Congress, to be held in Lucknow during January 2–8, 1943. The fourteen sections into which the Congress originally divided its work have been regrouped into twelve sections. *Mathematics and Statistics*, Dr. S. C. Dhar, University of Nagpur; *Physics*, Dr. H. J. Bhabha, Indian Institute of Science, Bangalore; *Chemistry*, Dr. S. S. Joshi, Benares Hindu University; *Geology and Geography*, Lieut.-Colonel E. A. Glennie, Survey of India, Dehra Dun; *Botany*, Dr. K. Biswas, Royal Botanical Garden, Sibpur, Calcutta; *Zoology and Entomology*, Dr. B. N. Chopra, Zoological Survey of India, Calcutta; *Anthropology and Archæology*, Dr. N. Chakravarti, Archæological Survey of India, New Delhi; *Medical and Veterinary Sciences*, Dr. F. C. Minett, Imperial Veterinary Research Institute, Mukteswar; *Agricultural Sciences*, Rao Bahadur Y. Ramchandra Rao, Imperial Council of Agricultural Research, New Delhi; *Physiology*, Dr. B. Narayana, P.W. Medical College, Patna; *Psychology and Educational Science*, Dr. B. L. Atreya, Benares Hindu University; *Engineering and Metallurgy*, Prof. K. Aston, Indian Institute of Science, Bangalore.

Night Sky in June

NEW moon is on June 13d. 21h. 02m. U.T., and full moon on June 28d. 12h. 09m. Lunar conjunctions with the planets occur as follows: Venus on June 10d. 05h., Venus 2° N.; Saturn on June 12d. 08h., Saturn 3° N.; Mars on June 17d. 07h. Mars 4° N. On June 29d. 20h. Venus is in conjunction with Uranus, Venus 1·7° S. Mercury is near the sun during the month and souths at 13h. 03m. and 10h. 39m. at the beginning and end of the month respectively. Venus is a morning star and souths at 9h. 22m. in the middle of the month. Jupiter, in conjunction with the sun on June 25, is too close to the sun to be observed. Saturn is a morning star and souths at the end of the month at 9h. 49m. Only two occultations occur in the month and the brighter of the two stars, 44 Virginis, occulted on June 22d. 22h. 50m., is mag. 5·9. The sun enters the sign of Cancer on June 22d. 01h., the summer solstice, and at this time the nights in the latitude of London are about 7 hours long. If civil twilight is taken into consideration (sun 6° below the horizon) the time of darkness is only 5½ hours. Conditions for seeing the night skies are very much restricted during the month.

Recent Earthquakes

A STRONG earthquake was reported on May 23 to have occurred in Colombia, South America. The town of Girardot, some sixty miles south-west of Bogota, is stated to have been partly destroyed, and shortly afterwards the island of Gorgona, in Buenaventura Bay, was submerged by a huge wave. This part of South America is particularly liable to experience earthquake shocks. Many of these from 1763 until 1936 have been described by J. Emilio Ramirez, S.J., and one reported by the British Association Seismological Committee in 1907 broke submarine cables off the mouth of the Esmeralda River on January 31, 1906.

The Ecuador earthquake of May 14 was beautifully recorded on the E-W Milne-Shaw seismogram obtained by Rev. J. P. Rowland, S.J., at Stonyhurst College Observatory. The *P* wave was impulsive at 02h. 25m. 50s. U.T. and a full suite of pulses followed. The readings are in agreement with the statements in NATURE of May 23, p. 578.

Announcements

SIR HENRY H. DALE, president of the Royal Society, will retire from the post of director of the National Institute for Medical Research on September 30. To succeed him the Medical Research Council has appointed Prof. C. R. Harington, who is at present professor of chemical pathology in the University of London and director of the Graham Medical Research Laboratories in University College Hospital Medical School.

DR. C. G. Darwin, director of the National Physical Laboratory, has been appointed scientific adviser to the Army Council.

THE following officers of the Royal Society of South Africa have recently been elected: *President*, Prof. A. Brown; *Hon. Treasurer*, Prof. R. W. James; *Hon. General Secretary*, Dr. A. J. H. Goodwin; *Hon. Editor of Transactions*, Dr. A. L. du Toit; *Hon. Librarian*, Prof. E. Newbery.

THE following appointments in the Colonial Service have recently been made: Mr. C. E. J. Biggs (senior agricultural officer, Uganda), deputy director of agriculture, Tanganyika; Mr. A. E. Pound, (inspector of produce, Nigeria), agricultural officer, Kenya.

THE population of Peru, according to the last official census, taken in 1940, is 7,023,111 inhabitants (*Bol. Of. San. Panamericana*, January). The female population forms 50·58 per cent, and the male 49·42 per cent. More than half the population, 52·89 per cent, are whites or mulattoes, and 45·86 per cent are Indians, while the Negroes constitute only 0·47 per cent.

IN "Belgium and the War" (Oxford Pamphlets on World Affairs, No. 56. 4*d*.), Prof. G. N. Clark describes the economics and politics of Belgium before the German invasion of May 1940, as well as the course of Belgian foreign policy in recent years. The latter part of the pamphlet describes the brief campaign of eighteen days and the reasons for the capitulation of the Belgian army; with, finally, an account of the occupation of Belgium, colonial resistance and of the issues which have made the Belgians carry on the struggle against the Axis Powers.

ERRATUM. In the letter "2-Aminofluorene as Growth Inhibitor for Bacteria and Rats" by F. Bielschowsky and Prof. H. N. Green in NATURE of May 9, p. 526, an error in the legend to the graph was overlooked. It should read: "broken line, feeding on 2-acetyl aminofluorenone; crossed line, 2-acetyl aminofluorene".

LETTERS TO THE EDITORS

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

Calculation of Steric Hindrance

IT seems possible to account for the steric effect of non-reacting groups on substitution rates on the lines of the following scheme, illustrated here by the example of the symmetrical substitution of *t*-butyl chloride by chlorine ions:

$$Cl^- + \begin{matrix} CH_3 & CH_3 \\ \diagdown & \diagup \\ & C \\ & | \\ & CH_3 \end{matrix} - Cl = \begin{matrix} CH_3 & CH_3 \\ \diagdown & \diagup \\ Cl - & C \\ & | \\ & CH_3 \end{matrix} + Cl^- \quad . \quad . \quad . \quad (1)$$

In the transition state, the four *t*-butyl carbons will be co-planar and the methyl groups will cause least obstruction if arranged in either of the two symmetrical positions one of which is shown in Fig. 1. This is represented in terms of a Fisher model in which the carbon atoms have the usual covalent radii of 0·77 A. and the van der Waals' radii of 1·5 A., while the corresponding values for the hydrogen atoms are 0·32 A. and 1·2 A. respectively. The valencies of the central carbon atom are co-planar, with an angle of 120° between them; the valencies of the other carbon atoms are at the tetrahedral angle. The position of the chlorine particles in the transition state will be such that the line joining their centres to that of the central carbon will be perpendicular to the plane of the carbon atoms. Further, the carbon chlorine internuclear distances will be equal. From the latest calculation of the transition state, this carbon chlorine distance has been found to be 2·3 A., which is practically equal to the sum of the covalent radius of carbon and the ionic radius of chlorine. These chlorine particles will have a van der Waals' radius of 1·8 A.

While a more detailed consideration, on which we will report elsewhere, shows that the presence of hydrogen atoms on the central carbon (as in the reaction $Cl^- + CH_3Cl$) does not obstruct the approach of the chlorine particles to the required distance, their replacement by methyl groups as in reaction (1) does cause an obstruction. The extent of this obstruction is indicated in Fig. 1, where the shaded sections show the areas over which penetration of the hydrogen atoms by the chlorine particle occurs. The distances between the centres of these obstructing hydrogen atoms and the centre of the chlorine particle can be calculated as 2·43 A., which is 0·57 A. less than the sum of the van der Waals' radii of hydrogen and chlorine. To carry out reaction (1) we have to perform six times this compression as corresponds to the penetration of the chlorine particles into the spheres of the three hydrogen atoms pointing forwards and the three hydrogen atoms pointing backwards in Fig. 1. The corresponding energy of compression has been calculated.

Fig. 1.

The difference between the covalent and van der Waals' radius of an atom is practically the same (0·8 A.) as that between the covalent and negative ion radius. Thus the sum of the covalent radius of carbon and the ionic radius of chlorine will be practically equal to the sum of the van der Waals' radius of carbon and the covalent radius of chlorine. Thus a fair representation of the transition state can be obtained with the Fisher models by setting to each convex side of the central carbon the flat surface of a chlorine atom. (For the central carbon with co-planar valencies a model of the benzene carbon may be used.) This is shown, in the absence of steric hindrance, in Fig. 2, where the chlorine particles *A* and *B* have the covalent radius 0·99 A. and the van der Waals' radius 1·8 A., while the corresponding values for the carbon atom *C* are 0·77 A. and 1·5 A. The distance between the centres *A*–*C* and *B*–*C* is the transition state distance 2·3 A.

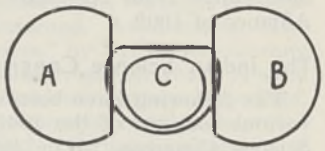


Fig. 2.

By replacing *t*-butyl by *s*-propyl or ethyl, the steric effect is much reduced; partly by the lessening of the number of points of compression and partly by the possibility of avoiding compression by a bending of the carbon chlorine bonds away from the larger groups. A very considerable steric hindrance can be predicted for the reactions of the neopentyl halides.

A. G. EVANS.
M. POLANYI.

The University,
Manchester.
May 7.

[1] Baughan and Polanyi, *Trans. Faraday Soc.*, **37**, 648 (1941).

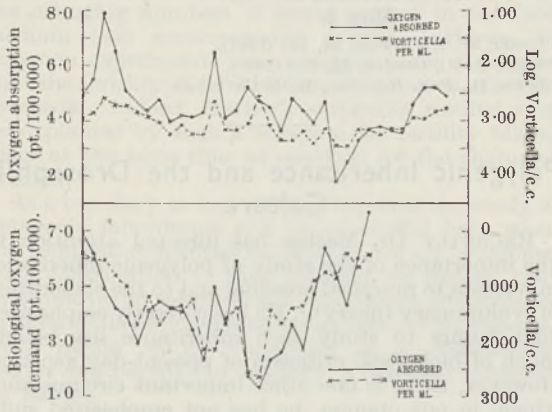
Vorticella as an Indicator Organism for Activated Sludge

IT has been recognized for a number of years that the type of protozoan fauna inhabiting activated sludge in a sewage purification plant of this type affords a useful indication of the condition of the sludge. In 1936, Ardern and Lockett[1] stated that they considered this test as the most useful in determining the activity of sludge and listed the common types associated with varying conditions. More recently, Barritt[2] has further enlarged their general findings. It has been concluded that the presence of ciliates and particularly the peritriches to the exclusion of other classes of Protozoa generally indicates a ripe active sludge. But the scope of the utility of this test has been limited by the fact that they were usually qualitative and therefore complementary only to the quantitative chemical analyses.

Preliminary observations of the activated sludge in the plant at Huddersfield indicated that the ciliates were so limited in variety as to afford a simplified case for determining quantitatively the fluctuations in their numbers and in particular of the Vorticella species in relation to the quality of the effluent produced. This limitation in species is probably due to the high percentage of chemical trade wastes in the sewage and is paralleled by a similar limitation of the macro-organisms in the percolating filters[3].

With the exception of Saturday and Sunday, daily counts of the Vorticella species in the channel liquor were made by dilution and centrifuging so that one tenth of a millilitre was fully examined. Correction

was made for the variation of activated sludge per unit of channel liquor since the Vorticellæ are only associated with the sludge particles. The chemical analyses were performed daily by other members of the staff. The three-minute oxygen absorption from acidified potassium permanganate and the biological oxygen demand over five days have been chosen as indicators of the quality of the effluent[4].



From preliminary results obtained it was apparent that the condition of the sludge as judged by the chemical analyses fluctuated somewhat irregularly with a frequency occupying three to four weeks. Two typical periods have been examined statistically, the first extending from September 22 to November 7, 1941, and the second from November 28, 1941, to January 1, 1942. During these periods the Vorticella species varied in abundance from 400 to 5,000 per millilitre. The statistical analysis shows that for both periods the degree of correlation between the oxygen absorption test and the Vorticella abundance is very high and negative (first period, $n = 32, r = -0{\cdot}7703$; second period, $n = 23$, $r = -0{\cdot}6925$). A similar result has been obtained for the relation between biological oxygen demand and Vorticella abundance (first period, $n = 25$, $r = -0{\cdot}7661$; second period, $n = 15$, $r = -0{\cdot}8380$). These correlation coefficients are of such an order as to place almost beyond dispute the relation between the chemical analyses and the biological assay[5].

The results are of importance (1) because they prove that a definite relation exists between the quality of the effluent and the number of Vorticellæ; this is particularly interesting in the case of the biological oxygen demand test since this analysis takes five days to complete; (2) because they show distinct promise for obtaining a more accurate estimation of the condition of the sludge by utilizing a property of the sludge itself and not its product. Furthermore, a method such as this would eliminate the fluctuations in strength and character of the sewage which renders the estimation of sludge condition by the usual chemical analyses often misleading. Vorticella is a particularly useful organism to employ as an indicator since it is easy to identify even by the non-professional biologist, and also their sessile habit renders them easily and quickly counted. After practice the complete estimation can be performed in thirty minutes.

The observations are being continued to discover whether winter cooling of the sewage has any effect on the relation and also to try to establish definite quantitative evaluations for standardizing the quality of the activated sludge. Any active part which Vorticella and other Protozoa take in the purification of sewage remains to be determined.

I wish to acknowledge the assistance of the members of the staff and also the permission of Dr. H. H. Goldthorpe, manager of the Corporation Sewage Works Department, to publish these results.

T. B. REYNOLDSON.

Biochemical Laboratory,
Huddersfield Corporation
Sewage Works Department,
Deighton, Huddersfield.
May 4.

[1] Ardern, A., and Lockett, W. T., *Proc. Inst. Sew. Purif.*, 1 (1936).
[2] Barritt, N. W., *Ann. Appl. Biol.*, 27, 151 (1940).
[3] Reynoldson, T. B., *Proc. Inst. Sew. Purif.*, 1941 (in the press).
[4] "Methods of Chemical Analysis as applied to Sewage and Sewage Effluents" (H.M. Stationery Office, 1929).
[5] Chambers, E. G., "Statistical Calculation for Beginners" (Cambridge Univ. Press, 1940).

Rheological Properties of Secretions from the Cervix of Pregnant and Non-pregnant Cows

IT has already been observed[1] that the flow-curves for bovine cervical secretions tested in an emptying tube viscometer[2] show a curvature which exhibits cyclic variations closely related to changes in the œstrous cycle. We have since found that, considering only the lower part (first 33 per cent) of the flow-curve, in which elastic fore-effect preponderates, curves plotting log $(L^2 - l^2)$ against log t (which are generally remarkably linear[3]) show greater slopes for cows known to be pregnant (three months or more) than for non-pregnant animals. (L is the initial length of the column and l the length after time t.) The slopes (γ) vary from a value of about 0·6 near œstrus to about 1·0 or a little more at some other point in the cycle and reach values sometimes higher than 2·0 in pregnancy.

Of the first fifty cows tested, twenty-seven were at least three months in pregnancy and all these gave γ greater than 1·0 (normally on the means of two tests). Of the remaining twenty-three non-pregnant animals only one maintained a value of γ greater than 1·0 for more than a day or two. This was a cow which had recently calved and which gave a value of γ greater than 1·0 for about a week, but at the first œstrus, γ fell to a normal value.

Samples of mucus have generally not deteriorated when kept at normal room temperature for about two days, but the technique for preparing them for the test, by homogenization and dilution, requires rather careful control. The values of γ are not seriously affected, however, by quite large changes in viscosity produced by dilution with distilled water, though γ tends to fall with such dilution. The arbitrary choice of pressure of extrusion has little effect, though optimum conditions for such factors make for greater accuracy and reproducibility.

We are investigating the changes which take place in γ during the œstrous cycle and in the earlier stages of pregnancy to establish when γ first begins significantly to exceed the maximum value reached during the œstrous cycle, presumably at the luteal phase. Since the high value of γ might depend on the presence of a corpus luteum and since it is of interest to ascertain whether a high value of γ is diagnostic of early pregnancy (there being at present no satisfactory test applicable to bovines) it is neces-

sary to investigate the behaviour of γ during periods of anœstrus due to retention of the corpus luteum, and this we propose to do.

One of us (A.T.C.) is indebted to the Agricultural Research Council for a grant to undertake these experiments.

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Breakdown of Self-Incompatibility by α-Naphthalene Acetamide

SELF-incompatible Petunia, Tagetes, *Trifolium repens* and *Brassica oleracea* have been made self-compatible by spraying the flowering plants with a solution of α-naphthalene acetamide[1]. This new technique has many possibilities to the plant breeder, but without a more complete study of how it works these possibilities cannot be developed properly. Eyster states that "α naphthalene acetamide neutralizes the effects of an ovarian secretion which diffuses into the style and inhibits or greatly retards the growth of pollen tubes". Since there is evidence that incompatibility is due to an immunological reaction between highly specific antigens and antibodies[2,3], it is improbable that α-naphthalene acetamide should be a simple haptene to the incompatibility antibodies of four different genera of plants.

In *Prunus avium*, I find that α-naphthalene acetamide does not increase the rate of incompatible or compatible pollen tube growth, but it does have a profound action on the formation of the abscission layer at the base of the style. Therefore it allows a longer time for the incompatible tubes to reach the ovary. The abscission layer forms two days earlier in untreated and unpollinated or incompatibly pollinated flowers than in flowers treated with α-naphthalene acetamide or pollinated with compatible pollen (see accompanying table). We see, therefore, in this case that the action of the α-naphthalene acetamide is not to 'neutralize' the incompatibility substances but to supply or replace the anti-abscission hormone which is normally produced by compatible pollen tubes or by the ovule immediately after fertilization.

LENGTH OF POLLEN TUBES AFTER FOUR DAYS AND THE NUMBER OF DAYS TO FORM THE ABSCISSION LAYER IN *Prunus avium* VAR. BEDFORD PROLIFIC

Pollen	No treatment		Water		Naphthalene acetamide	
	mm.	days	mm.	days	mm.	days
Crossed *Compatible*	13*	6	13	5	13	7
Selfed *Incompatible*	7·1	4	6·8	3	6·6	6
None	0	4	0	4	0	6

* The 13 mm. incompatible pollinations is an approximation because the tubes at this time were in the ovary.

Since the α-naphthalene acetamide delays abscission for two days, its use may not be confined to removing the bar to self-fertilization but it may decrease inter-specific sterility in plants, especially those with many-seeded fruits. In *Prunus avium*, unlike Petunia, no fruits were obtained after treatment and self-pollination; it is therefore probable that only plants which have a weak incompatibility reaction will be self-fertile after treatment.

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May 2.

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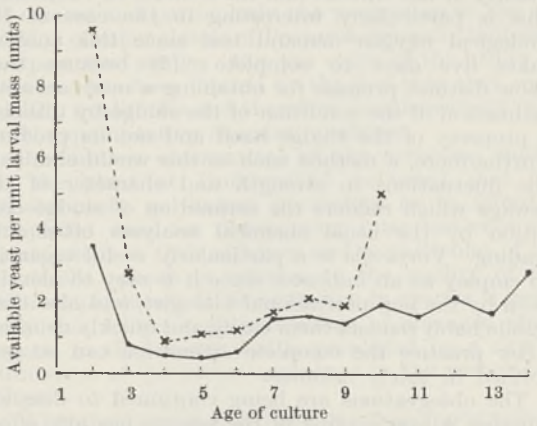
Polygenic Inheritance and the Drosophila Culture

RECENTLY Dr. Mather has directed attention to the importance of the study of polygenic inheritance in relation to practical breeding and to the elaboration of evolutionary theory[1,2]. He has correctly emphasized that failure to study such inheritance lies behind much of biologists' criticism of present-day genetics. However, there is one other important circumstance which, in our opinion, he has not emphasized sufficiently. It is the relation of environment to heredity; the problem of nature and nurture.

In the present context the influence of environment on the expression of heredity has a twofold importance. First, since polygenes "have individual effects which are small compared with non-heritable fluctuations"[2], it follows that their phenotypic expression (or exhibition) is easily modified by environmental changes or differences. Consequently one of the technical difficulties which prevented geneticists from working in this field was the problem of estimating the separate effects of polygenes and environment on the resulting phenotypes. Present statistical methods, as Hogben has pointed out[3], do not always adequately overcome these difficulties. This almost certainly led the "Drosophilists" to concentrate on the study of "unit characters", etc., and to neglect the less easily handled genes or groups of genes the expression of which is easily modified by environment.

Secondly, we have shown that the normal Drosophila culture is not an ideal environment for such studies[4]. As such cultures develop, the *quality* of the yeasts present (the larval food) changes in a more



DAILY CHANGES OF THE QUANTITY OF YEAST AVAILABLE PER UNIT MASS IN DROSOPHILA CULTURES CONTAINING ONE PAIR OF FLIES (UPPER CURVE) AND THREE PAIRS OF FLIES (LOWER CURVE).

or less definite way. This change by itself modifies the phenotypic expression of the variable mutant 'Antennaless'. The *quantity* of yeast available per unit larval mass also changes in these cultures (see graph above). These two major variables will almost certainly affect the exhibition of polygenes. But these environmental changes do not follow the same course in all circumstances[4]. In particular, they are influenced very significantly by the changing numbers of larvæ present in the food medium (see accompanying graph). Hence, in selection experiments care must be taken to ensure that the fertility of females is not altered as selection proceeds. Indeed, Mather's surprising results[1] *may* be explained by such a selection for fertility taking place at the same time as selection for the character studied.

As a corollary to this we may say that the study of polygenic inheritance will be successful only when the technical difficulties outlined above are overcome. As a contribution to their solution we suggest that experiments on selection and inheritance of polygenes in Drosophila be conducted using sterile culture media Such media reduce variability to a considerable degree and permit the handling of constant members of larvæ[4].

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Absorption of Minimal Doses of β-Carotene by Vitamin A-Deficient Rats

WIDE differences between the theoretically expected and experimentally obtained potencies of pure vitamin A as compared with β-carotene have led to a considerable amount of speculation[1,2] on the possible manner of conversion of carotene into vitamin A *in vivo*. While there is no direct evidence in support of the postulated unsymmetrical fission of the provitamins, we felt that it might be of interest to study the extent of absorption of β-carotene by rats under the conditions of biological assay.

In the course of these experiments, it was observed that analysis of the fæces of rats maintained on a carotenoid-free diet gives an apparent carotene excretion value of 0·2–0·4 μgm. per rat per day. Examination in a visual spectrophotometer showed this to be due to a non-carotene pigment possessing only a general absorption. By chromatographic adsorption analysis on columns of Brockman's alumina it was possible to separate the carotene from the associated impurity and estimate it quantitatively. The identity of the excreted carotene and the non-carotene nature of the other pigment were confirmed by spectrophotometric data and growth experiments on rats.

Some experimental results are summarized in the accompanying table.

Coconut oil content of diet (per cent)	Level of dosage μgm. β-carotene per rat per day	Amount of β-carotene ingested (μgm.)	Apparent carotene excretion (μgm.)	On separation			β-carotene excretion (per cent)
				Non-carotene (μgm. equiv.)	β-carotene found (μgm.)	β-carotene calculated (μgm.)*	
3	1	224·5	114·9	27·3	28·7	31·9	14·0
,,	2	448·9	159·0	40·4	49·8	55·3	12·3
10	1	204·0	117·0	36·0	22·8	25·3	12·6
,,	2	544·0	190·5	59·4	59·5	66·1	12·0

* Chromatographic analysis of known mixtures has shown the carotene recovery to be about 90 per cent, and these values are calculated on this basis.

The figures presented in this table represent the total amounts for each group of 6–7 rats over an experimental period of 5–6 weeks.

It should be mentioned, however, that in order to get sufficient quantities of the pigments, it was necessary to collect the fæces of each group of rats for 10–14 days and preserve the same in the refrigerator before analysis could be performed. During this interval, a part of the carotene might have undergone destruction and therefore it is probable that the actual excretions were considerably higher than these figures would indicate.

In contrast to the behaviour of carotene, which may be due to its hydrocarbon nature, vitamin A is known to be quantitatively absorbed at far higher levels of intake; at any rate, no excretion could be detected[3,4]. It is therefore suggested that the incomplete absorption of β-carotene might be the major factor responsible for the observed discrepancies; after absorption, perhaps β-carotene is as efficient as vitamin A at the levels of the biological assay.

In a note[5] which reached us during the final stages of this investigation, Wald *et al.* arrive at a similar conclusion based on the results of absorption studies on human subjects at higher levels of intake.

Further work is in progress and full details will be published elsewhere.

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Chemical Composition of Mitochondria

IN 1908 Regaud[1] suggested that mitochondria were "*corps lipoïdes*", and the following year[2] he pointed out the general resemblance between the myelin of nerve fibres and the substance of mitochondria in their reactions to histological fixation and staining. The theory that mitochondria contain a relatively large amount of lipines held its ground for a quarter of a century.

In 1934 Bensley and Hoerr[3] succeeded in actually separating the mitochondria of the liver of the cavy from the rest of the cell, and produced cakes of nearly pure mitochondrial substance in considerable quantity. Roughly a third of this substance is soluble in fat-solvents[4], and it was naturally anticipated that a large proportion of this would consist of lipines. On the addition of acetone, however, a very small precipitate

was formed, and it was concluded that only about 4 per cent of the material of mitochondria consists of lipines, the rest of the fatty material being true fat.

Bensley's conclusions differ so widely from those of previous students of the same subject that one looks for a possibility of reconciliation. May it not be that lipines are present in the ether-soluble fraction of mitochondrial substance in considerable amount, but largely resist precipitation by acetone? Ciaccio[5] has especially stressed the solubility of lipines in acetone when other fatty or fat-soluble substances are also present, and Kaufmann and Lehmann[6] have shown that if 2·1 gm. of oleic acid be added to 45 c.c. of acetone covering 2 gm. of lecithin, about half the lecithin goes into solution.

It would be most helpful if those who are expert in the technique of isolating mitochondrial material in quantity from cavy liver could be persuaded to apply tests for lipines to the large fraction of fatty material that is not precipitated by acetone.

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May 4.

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Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

WE regret that, as Dr. E. J. Bowen has pointed out[1], the important paper of Bowen and Williams[2] on the photo-oxidation of aromatic hydrocarbons has indeed escaped our notice, but we hope that our previous communication[3] has served a useful purpose in directing attention to the occurrence of the phenomenon in the visible fluorescence of cancerogenic hydrocarbons where it has not hitherto been described. This reaction is not only of practical importance for analytical fluorescence measurements, but also of theoretical interest as a possible initial stage in the metabolic oxidation of these substances.

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May 12.

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Determination of Water in Soils

THE usual method for determination of water in soils (that is, heating to 110° C.) is almost always unsatisfactory owing to decomposition and slow oxidation of organic matter; moreover the determination takes a long time to complete.

A series of experiments have therefore been carried out using the method described by Lowndes[1], using a Dean and Stark's tube. The sample is thus distilled under xylene or toluene (b.p. 137° and 110·7°), the water which comes over being weighed or its volume read off. The determination is completed in 2–4 hours and losses due to oxidation are avoided.

It will be seen that the results for a well-cultivated loamy garden soil are consistent among themselves and that the results with toluene agree with those obtained with xylene. With samples of chalk it was possible to apply a check by oven-drying, showing that the method is working satisfactorily.

Results with a dark clay loam

Sample	Appt. no.	Liquid used	Water (% dry wt.)	Average %
IV	3	Xylene	8·5	8·3
	6	,,	8·3	
	5	,,	8·0	
VIII	3	Xylene	21·2	21·2 (with xylene)
	6	,,	21·2	
	8	Toluene	21·7	21·8 (with toluene)
	4	,,	21·9	
I, *a*	9	Xylene	33·5	33·6
	5	,,	33·8	
	3	,,	33·6	
V	3	Xylene	56·3	55·8 (with xylene)
	6	,,	55·3	
	8	Toluene	56·4	55·9 (with toluene)
	5	,,	55·3	

Results with chalk (using xylene)

Appt. no.	Water (% dry wt.)	% water (by oven drying at 110°)
1	23·8	24·8
2	23·5	24·4
2	22·2	22·4
2	13·2	13·5
3	7·2	7·0

These results have not been corrected for the small amount of water left on the walls of the apparatus, which amounts to about 0·1 gm. but varies with the construction of the tube.

Further work is in progress on the application of this method to the investigation of soil moisture, but as there seems to be no doubt of its suitability and obvious advantages for most purposes, it was felt that the above preliminary results were worth putting on record.

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[1] NATURE, **148**, 594 (1941).

Molecular Sodium Hydride in Interstellar Space

IN a recent article[1] describing results obtained with the coudé spectrograph of the Mount Wilson Observatory, W. S. Adams gives some details of the identification of a number of interstellar lines with absorption lines of various molecules in their lowest possible energy states. Among others he mentions a line at λ 3934·3 provisionally assigned to NaH by McKellar[2].

Now the hydrides of the alkali metals are characterized by spectra containing band systems of rather

unusual intensity distribution. For the molecule RbH an approximate calculation of the relative intensities of the bands of the system in emission has been made by Gaydon and Pearse[3]. The results may be applied to absorption by molecules in the lowest state by assuming an initial distribution of all the molecules in the level of the lower electronic state for which $v'' = 0$, instead of a Maxwell distribution among the vibrational levels of the upper electronic state. The factor ν^4 is also changed to ν for absorption, but this is relatively unimportant in its effect on the results. This has been done in the course of an investigation of the spectrum of the NaH molecule by R. C. Pankhurst with the results shown in the accompanying table.

v',v''	λ	I_o	I_c
0,0	—	—	0
1,0	—	—	0
2,0	—	—	0
3,0	—	—	1
4,0	4230·6	0	3
5,0	4169·0	2	7
6,0	4108·4	5	16
7,0	4049·0	7	27
8,0	3990·9	9	42
9,0	3934·3	10	50
10,0	3879·4	10	50
11,0	3826·0	9	—
12,0	3774·3	9	—
13,0	3724·5	9	—

Here v',v'' are the vibrational quantum numbers of the upper and lower levels, λ is the wave-length given by Hori[4] for the $R(0)$ line of the band as observed in absorption, I_o is his corresponding band intensity, while I_c is the value of the intensity obtained by calculation. It will be noticed that the experimental and calculated values agree on the general course of the intensity from vanishingly small values near the origin of the system rising steadily to a flat maximum in the $(v', 0)$ progression. Without laying too much stress on the actual numerical values, which are based on an arbitrary scale of 50 for the maximum in the calculated relative intensities, I_c, and are eye-estimates on a scale of 10 for the maximum in I_o, it may be noted in favour of the assignment that the transition observed, namely (9,0), is in the region of the maximum, but since in this region the intensities of neighbouring bands are so nearly the same, it would seem that they also should be obtained. If this could be done the probability of the identification being correct would be greatly strengthened.

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May 6.

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Reflexion from Paper

I HAVE observed a curious optical effect which I have not seen described anywhere. If an open book is illuminated fairly strongly from one side, for example, from over one shoulder, the general colour of the white paper is different for the two eyes when one or the other is closed. The effect has been tried with several subjects with the same result. When the light comes over the left shoulder and the left eye is open the pages have a bluish tinge ; when the right eye is open and the left closed the tinge is reddish. If the light comes over the right shoulder the above effects are reversed. If the light is centrally placed above and behind the head there is no difference.

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I THINK the effect Mr. Burke describes is due to selective specular reflexion from the paper. Many near-white papers are slightly more glossy in red light than they are in blue ; that is, the specularly reflected light contains relatively more red and less blue than does the incident light. If the incident light comes over the left shoulder, the right eye will be rather nearer the angle of specular reflexion than the left, consequently the light reaching the right eye will be a little richer in red.

The effect can be observed in more pronounced form with many glossy coated ('art') papers, if they are illuminated and viewed at an angle of about 70° to the normal : the diffuse image of the light source appears distinctly orange or reddish compared with the source itself.

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History of the British Thermal Unit

THE date of the phrase "British thermal unit" can be pushed back by fifteen years ; it occurs in W. J. M. Rankine, "Manual of the Steam Engine" (1859), p. 300 ; but here, as in the 1875 quotation given by Dr. Powell[1], it is a descriptive phrase and not a technical term ; Rankine is in fact contrasting the British thermal unit and the French thermal unit.

It occurs, however, as a technical term in 1889 in De V. Wood, "Thermodynamics", 3rd ed. (New York), p. 3 ("The British Thermal Unit (B.T.U.)"). (I have not been able to consult earlier editions of this book.) H. Evers, "Steam" (1889), p. 4, speaks simply of "A Unit of Heat" ; M. H. Wright, "Heat" (1893), p. 79, says : "In England the unit of heat or thermal unit is . . ." ; W. S. Hutton, "Steam-boiler Construction" (1891), p. 4, speaks of "The British thermal unit".

It would seem likely that it was in the United States that it was first found necessary to incorporate the word British in the name of the unit, and that the phrase then recrossed the Atlantic as a technical term, and reached British physicists by way of British engineers.

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[1] NATURE, May 9, p. 525.

POST-WAR PLANNING IN RADIO TELECOMMUNICATION

THE meeting of the Wireless Section of the Institution of Electrical Engineers on May 6 was devoted to a discussion on "Post-War Planning in Radio Telecommunication", which was opened by Sir Stanley Angwin, engineer-in-chief of the Post Office, and a member of the committee of the Institution studying the possibilities of post-war planning in electrical engineering in general. While it is true to remark that all possible efforts on the part of radio engineers and physicists should be devoted to ensuring that the present conflict will lead to a victorious issue for the Allies, it is equally wise to observe that those with experience and responsibility should divert a little of their time to the consideration of the problems which will most certainly arise at the termination of the War.

Sir Stanley's opening remarks were concerned chiefly with the probable developments in post-war telecommunications—line, cable and radio—for conducting the normal peace-time business of the world, while, in addition, he outlined the probable future of broadcasting, television and the application of radio technique to various spheres, in particular, navigation. It is already clear that radio telegraphy and telephony on one hand, and the submarine cable and land line on the other, are complementary services, and their respective applications are decided by matters of distance and geography, as well as by technical considerations. In both this field and the similarly extensive field of broadcasting, it will be necessary after the War to resume consideration, on a world-wide basis, of the equitable division of radio frequency channels among the various services requiring them. The putting into effect of the most recent plan for the distribution of the frequencies or wave-lengths of European broadcasting stations, was interrupted by the outbreak of war; but in any event a considerable revision of this plan will probably be necessary on a return to normal conditions.

The design and development of broadcasting transmitters and receivers will need to be reviewed in the light of advances of technique and knowledge, and a certain amount of standardization may become necessary. In the field of television the technique of the service, and in particular the mode of presentation of the picture in the receiver, must be reviewed in some detail. With the view of relieving the radio channels of all unnecessary traffic, it is likely that more serious attention will be required to the scope offered by the use of land-lines for the distribution and relaying of broadcasting and television programmes. Finally, Sir Stanley Angwin referred to the problems which will have to be faced in connexion with the return to industry of staffs at present in the Services or in Government establishments. The radio and telecommunications industry will also have to deal with the technical matters connected with the reopening of overseas markets, if we are to take a proper position in world trade.

In continuation of the discussion, Dr. R. L. Smith-Rose referred to various problems likely to be encountered in connexion with fundamental research and development, the technical standardization of equipment and components, the re-allocation of personnel at present engaged on radio work, to the recognition of the radio-physicist as well as the properly qualified radio electrical engineer, and finally to the matter of post-war publication.

In the field of research, it will be found that while the radio wave spectrum has been considerably extended during the War, much of the ground will have been hurriedly and only very superficially explored, and there will remain a good deal of work in the examination and consolidation of principles and technique before it will be possible to make the best use of the frequency bands then available. It will probably be found necessary to extend the range of research, both fundamental and applied, in order to find room and allocations for the greatly increased number of services which will be awaiting application. In connexion with this matter, it will be necessary to give renewed attention to the technical merits of wired broadcasting, single side-band transmission, and the possibilities of the very short wave bands for relays and short-distance radio links. With the extended use of the very short wave-lengths, the subject of interference and its suppression will be brought into the limelight again, particularly as many of the purposes to which radio technique has been applied during the War are not conducive to freedom from interference.

If the radio industry is to develop satisfactorily on an extended basis at the end of hostilities, it is likely that a considerable amount of standardization of valves, components and equipment will be necessary, while there will be ample work for those whose duties include the preparation of specifications and test schedules. In the latter connexion, it will be desirable at a very early stage to lay down a statement or code of safety precautions to be followed in dealing with the very high voltages found nowadays in radio receivers and cathode ray tube apparatus. During present conditions much of this gear has been produced hurriedly, and without the precautions which have hitherto been considered essential by the fully trained and experienced electrical engineer.

With regard to the question of personnel and staffs, Dr. Smith-Rose believes that while many at present attracted to radio work in the various Services will return to their different peace-time occupations, many—especially the younger members—will attempt to stay to make a career in some branch of the radio industry. This influx of personnel will present a problem for the Institution of Electrical Engineers itself to deal with, for while many of these radio workers will possess adequate academic qualifications in science, and some practical experience, they can scarcely be classed as fully qualified electrical engineers according to the Institution's standards. Furthermore, many of those who return to their normal occupations in science, art or business are likely to wish to retain an interest in radio as a hobby, and the Post Office authorities might well be thinking over their future attitude towards the post-war radio amateur. The universities will also have to recognize a continuous need for properly educated recruits to a stable and growing profession, and it will be clearly desirable that a well-arranged graduate course in communication engineering should rank on an equal footing in the future with electrical engineering.

Another matter that may well receive consideration in advance by institutions and societies, as well as by the technical periodical Press, concerns the method of handling the vast volume of publications that will suddenly become available when the existing barriers of secrecy are removed. Indeed the quantity of radio literature that will pour out under post-war

conditions may demand a considerable extension in our present methods of systematic arrangement, abstracting and indexing. In this connexion, two useful suggestions were made later in the discussion, by Mr. D. A. Bell and Dr. L. E. C. Hughes. The first was to the effect that it would prove very desirable to institute some kind of critical reports of progress in the various phases of radio technique, perhaps on the lines of the series of annual reports already issued by the Physical Society; while the second directed attention to the desirability, if not of the necessity, of using micro-film technique for the recording of published papers.

Messrs. V. Z. de Ferranti and C. E. Strong outlined the difficulties which are likely to confront a radio industry suddenly called upon to make a change-over from the carrying out of war contracts to Service specifications, to the re-establishment of a peace-time industry on a stable basis. It is clear that the present radio industry has not been planned on a sufficiently large scale, and it was suggested that this experience should be borne in mind in the future. At the termination of the present War, it is probable that the whole radio industry will require an interval in its production programme while the design and development of the new peace-time equipment is carried out. Some considerable foresight will be needed here to retain groups of staff and workers intact over a comparatively slack period before the industrial machine gets into its new stride.

Mr. J. A. Smale said that he anticipated many developments in the field of point-to-point radio telegraphic communications, including the use of printing telegraphs and coded messages. To a large extent the standards of transmission have been relaxed during the War, and it will be necessary to recover these if all the available channels are to be used in the most efficient manner. Mr. A. D. Blumlein expressed the somewhat comforting opinion that the methods of distributing television programmes used in 1939 were about right, and, apart from minor improvements, would need only slight revision to resume broadcast operation.

The probable directions in which the broadcast receiver industry is likely to resume activities were examined in some detail by Dr. R. C. G. Williams, who believes there is the possibility of some Government control of the industry as an outcome of a reconsideration of the political side of broadcasting. Both he and other speakers envisage the possibility of the use of an improved projection type of cathode ray tube for obtaining better picture reproduction in domestic receiving equipment.

After further contributions by other speakers, the discussion was brought to a close by Mr. H. Bishop, chairman of the Wireless Section of the Institution. It is desirable, he said, to plan a bold policy of expansion in the whole field of telecommunications, and this will of necessity involve dealing on a national basis with all the problems which have been brought forward, and particularly those of staff, education, and research and development. He referred to the difference in standards in television in the United States and in Great Britain, and agreed that our own system could quickly be ready for the resumption of a satisfactory public service. He also referred to the desirability of encouraging increased co-ordination in the field of post-war research, and expressed the hope that many secret devices developed under war conditions will be released for a peace-time application in due course for commercial purposes.

THE FUTURE OF TECHNICAL EDUCATION*

By H. J. CULL

IN common with all sections of the community, technical teachers find the progress of the War marked by increasing demands upon them. Apart from special courses, the average experience appears to be of a large increase in the part-time day classes of the colleges and the maintenance of evening or the substituted week-end classes at something approaching their normal level. To cater for these with, in many cases, depleted staffs has called for sacrifices of many of our cherished ideas as to conditions of service—changes in hours of duty per week, sizes of classes and suitability of accommodation for classes —which will demand the watchful care of the Association if they are to be regarded as temporary expedients and not precedents.

Education and the Future

Prominent in our thoughts in spite of many preoccupations is the discussion which has been in progress during the year on educational post-war reconstruction. Inspired in the first place by an official invitation by the Board of Education, the executive of the Association of Teachers in Technical Institutions, as well as similar groups within other major educational associations, has given consideration to this matter. Official pronouncements by succeeding presidents of the Board of Education, as well as provisions already on the statute book awaiting the announcement of "appointed dates" and also the war-time developments of activities among young people, make certain steps in reconstruction almost self-evident. It would appear, for example, that after the age of eleven plus, all schools should be secondary in character, equal in status, and administered by one department of the Board of Education. The main interest here of the Association is to secure the continuance as individual entities of those schools which have so fully justified themselves during recent years, namely, the junior technical schools. These schools, giving a broad general education; with a scientific approach to an industry as a whole; working in close association with the industry of the district; and provided with the equipment and the qualified staff to give the industrial bias, have achieved a success which cannot be questioned. The one handicap which has always been present and has had to be overcome has been the suggestion of inferiority due to the later age of entry when compared with other types of schools. If this be removed by the general reconstruction, we have no fear that the schools will produce youths who will be other than a credit to themselves and any society in which they are partners. Pioneers in this type of school are convinced of their value from the point of view of the student—not alone of the industry which they join. The realistic approach to the studies means much to certain types of young people, and that is the real justification for wanting to preserve the schools and extend the experiment.

We are watching a development of adolescent education in two distinct directions at the moment. Firms are releasing for part-time day education employees in larger numbers than ever before.

* Substance of the presidential address delivered before the Association of Teachers in Technical Institutions on May 23.

Tribute must be paid to those firms who have thus met the difficulties of the youths in continuing their technical studies. It is believed that this war-time experience will persuade many firms of the value of this education, to their employees and to themselves, and that it will grow on a voluntary basis from year to year. Nevertheless we feel that part-time release should be made obligatory from the statutory age for full-time education, up to the age of eighteen. Much of such part-time work would be vocational in character and would be centred around the technical college.

Youth service is being officially sponsored in Great Britain for the first time. If part-time release for educational work is part of the reconstruction scheme, there must grow up in most districts a new type of school, already tried in a few areas, namely, the day continuation schools. This new youth service would in many cases seem to fuse with the work of the day continuation school. At the moment, the youth activity is bound to be war-biased, but one can hope that the aim of the combined day continuation school and youth activity will be to develop that complete personality inherent in us all—involving physical well-being; a developed mind able to appreciate and express; and a spiritual entity able to appreciate beauty in many directions and to take part in its perpetuation. So we find a further problem facing us on the technical side. Our organization of the vocational needs must be such as will not debar the youth of our colleges from a goodly share in physical and humanitarian activities.

Full-time Technical Education

In general reconstruction, too, the technical teachers would expect to realize some of those projects for which they have pressed for many years. For example, technical colleges have a contribution to make to a developing society by a more widely developed system of full-time courses. These might be attended by students coming direct from other types of schools, but perhaps more frequently by suitable partly trained students securing release from industry for a period to complete a course of training. Many pronouncements are made in these days that university students benefit greatly if they preface their university studies by some period in employment. This would probably be even more true of full-time work in technical colleges. Associated with this is the whole question of scholarships for these senior students in the colleges, which we have claimed as deserving of official attention for some years now. Regional co-ordination of the senior colleges is a further point which will need consideration in the complete scheme.

As we plan now for a post-war community we are largely groping in the dark. We do not know much of the conditions in which we shall find ourselves. For this reason we should refrain from being closely fettered by decisions. We believe victory will bring us a greater measure of freedom to develop as individuals and as members of an international commonwealth. The great aim should be that we as teachers shall be ready to seize our opportunities on behalf of the youth of the country and bring to them better fruition than ever before. Led by a president of the Board of Education of full cabinet rank and able to make demands as a right to a full share of the country's resources for education, we should be alive to every possibility of advance along the lines we have set. Perfect buildings, staffs large enough and well enough trained for the perfect schools, equipment worthy of the standard set will probably be acquired only slowly. But war-time training of youths has produced results which have not reflected the difficulties under which it has been carried out. Under peace conditions we need not wait for the perfect surroundings before starting to train youth to make the most of their personalities.

Building and Agriculture

Turning to more immediate problems, we find evidence of much that demands careful thought. The Board of Education has indicated the need for the development of junior technical schools for the building industry. No departments of our colleges have suffered more in the depletion of their work during war-time than those of building. Yet imagination does not need much scope to see the immediate importance of this industry after the War. The Association welcomes the suggested encouragement of these schools. It visualizes them as being schools of the type mentioned previously, presenting an approach-view of the industry as a whole. Such a training would lead to a definite apprenticeship and form part of the apprenticeship training. There is time to plan this as a complete scheme and a permanent one, and it should not develop as a rough preparation for immediate post-war needs only. The industry and the senior college building departments must be important partners in the plan.

Another aspect of technical education has been recently considered: that affecting agriculture. Though of course provided with its own unique difficulties, the needs of this industry for a scientific background to its studies is as great as any other.

SCIENCE AND THE WAR EFFORT

A "SCIENCE for Victory" Conference, organized by the Southern Area Committee of the Association of Scientific Workers, was held at University College, Southampton, on May 17. The meeting attracted scientific and technical workers from a wide area of southern England. Mr. Alexander Orba (instructor in radio at University College) presided at the afternoon session, and opened the Conference; he said that this was the first representative gathering of scientific and technical workers to be held in the Southampton area, to discuss the organization of their affairs and represented an important step forward in the part to be played by scientific men in the life of such an industrial area.

The opening speaker was Mr. H. W. Steele-Bodger, past president of the National Veterinary Medical Association, who spoke of the part veterinary science can play in the war effort by increasing the production of such foodstuffs as meat and milk. He emphasized that agriculture is really the basic and fundamental science and must be kept alive and flourishing if the people are to be fed. A Survey Committee of the National Veterinary Medical Association produced a comprehensive scheme for the control of diseases of livestock, and after years of patient effort had persuaded the Ministry of Agriculture to adopt it. As a result, he was confident that milk production would be very materially increased by the winter of 1943. In general, however, such progress is hampered by

ignorance of veterinary science, even in the highset quarters, and by conservatism and lack of co-operation among the farming community.

Mr. C. F. Carr, editor of the *Southern Daily Echo*, gave a short talk on "Science and the Press", in which he expressed the view that unless the newspaper industry is prepared to encourage research directed towards speeding up and improving its own productive processes, it will soon be completely out-done by broadcasting. He hoped they would get down to this and also that the Press might be to a much greater extent the vehicle for disseminating scientific knowledge to the public.

Dr. Harry Barron, head of the Plastics Department of Pirelli-General Cable Works Ltd., spoke on the subject of synthetic rubber. He explained how vital rubber is, not only to the war machine, but also to industry as a whole ; no longer can oil and steel be regarded as the only criteria of a nation's ability to make war. Since the loss of natural rubber supplies in the Far East, Great Britain may have difficulty in lasting out this year on existing stocks. The U.S.S.R. and Germany both built synthetic rubber industries years ago ; the United States started some time ago to build up such an industry ; but in Great Britain, owing to the continual obstruction of powerful vested interests, no start has been made even now. Not even the essential raw material—carbide—is available, as we have no carbide industry. The American industry will not be in a position for a year or two to supply us with quantities large enough ; 50,000 tons a year has been glibly talked about, but the total production this year is unlikely to exceed 40,000 tons. We need to be most economical in the use of rubber, and to save every scrap for reclamation. Dr. Barron thought we should set about solving the problem immediately by building quite small pilot plants, in order to gain experience in the processes and to train the technicians needed.

The evening session was presided over by Dr. Barron, who read out a letter from the Association of Scientific Workers to branches in the radio and electrical industries, asking for information about the misuse, wastage or under-employment of technical resources, about which a Committee of the War Cabinet has asked for investigations to be made.

The first speaker was Mr. C. E. G. Bailey, of the Mullard Radio Valve Co. He spoke on "Radio Research and the War", and began by describing the peace-time condition of the industry, in which, except for television development carried on almost exclusively by the large firms, technicians were mostly engaged in thinking out sales points, such as fancy tuning scales and push-button circuits. Little real research was done. At the same time, the few Government establishments maintained were hampered by inter-Services rivalry and by the difficulty of obtaining the best scientific brains, owing to humdrum conditions of work. The crisis of war has made plain the need—previously seen only vaguely—for the industry to change from the spirit of commercial competition to one of technical co-operation if real progress is to be made. Even at this eleventh hour, co-operation between the Services, between firms and between Services and firms, and the proper allocation of jobs, are only just being organized on a reasonable scale.

Turning to the subject of post-war reconstruction, Mr. Bailey said that this is a two-edged term. It is usually interpreted by employers as meaning that they must carve a niche for themselves in the post-war markets, so as to "avoid dismissing their employees". However, we must not employ technicians now in designing broadcast receivers on the old competitive lines, when their services are so vitally needed for war work.

In the subsequent discussion, one speaker suggested that the Association of Scientific Workers should be ready to put forward a general plan for the post-war industry, which would indicate future lines of research and ensure that ample work is available.

The final contribution was by Mr. Alexandra Orba, of University College, Southampton, on "Technical Education". He outlined a plan for education designed to produce the technicians required for immediate war-time needs as rapidly and efficiently as possible, and at the same time to lay the foundation for a more satisfactory educational system after the War. We shall then have a larger number of people with technical knowledge than ever before, and we must take full advantage of this to build up a different attitude towards science and its cultural value. We must see that the vocational training given is related to the needs of society at the time and the estimated future needs ; we must train staffs for all grades of work in industry, for executive and administrative posts as well as technical ones.

There was considerable discussion following this address, and a resolution "That the Board of Education be urged to give consideration to the need for teaching all school children something of the organization and processes of modern industry" was carried.

The Conference served a useful purpose in focusing attention in the area on the need for the application of scientific effort both immediately and for the future, and a number of resolutions arising out of the papers which had been discussed were passed.

LONDON SCIENTIFIC FILM SOCIETY

THE London Scientific Film Society gave a demonstration of films on May 16 at the Imperial Institute cinema. Dr. Julian Huxley introduced the film "Galapagos" and led a discussion on it afterwards. The film was made by the Dartington Hall Film Unit under the direction of Mr. William Hunter and Mr. David Lack and was photographed by Mr. Richard Leacock. It illustrates the comparatively free adaptive evolution of new types, in absence of competition, from original single colonizations on a group of oceanic islands. The extent of the differences from the mainland forms depends on the time that elapses since the colonization. In such cases, where the pressure of natural selection is light, the animals are not as well equipped to fill their environmental niches as are mainland forms. For example, there is a member of the gull tribe, the close ancestors of which are water birds, which nests in the trees although it still retains webbed feet ; and the finches have evolved a range of species to exploit the available food supplies, although the shape of their beak, unlike those of most mainland birds, does not always give a precise indication of the food habits of the bird.

Dr. Huxley also pointed out that there is a tendency to gigantism in absence of competitors, as shown on the Galapagos by the giant tortoises and iguanas, and that animals can extend to unusual habitats, as

shown here by the unique sea lizard and the red land crabs.

The film is well photographed, but it is to be regretted that there are no pictures of the mainland birds from which the island forms evolved and that the captions are scarcely sufficient to explain the purpose of the film. It was pointed out that the absence of sufficient funds explained some of the unavoidable deficiencies of the film and why it was only available on 16 mm. silent film.

In the discussion which followed it was asked whether any steps are being taken to preserve such valuable films, which show animals that are fast becoming extinct. It was explained that the National Film Library of the British Film Institute has as one of its aims the preservation of films which illustrate the development of the cinema and of social history, but that it does not collect films specially for their scientific or technical content. The Scientific Films Committee of the Association of Scientific Workers (on whose recommendations the programmes of the London Scientific Film Society are largely made) has recently made a plea to the National Film Library for the preservation of scientific films and has made out a list of those that it considers should be obtained now. "Galapagos" is one of them.

Other films shown by the Society at this meeting were: "Propeller Making", "This is Colour" (an Imperial Chemical Industries film in Technicolor about dyes), "A Few Ounces a Day" and an excellent film epic recently arrived from the United States of the building of the Boulder Dam in Colorado.

FORTHCOMING EVENTS

Saturday, May 30

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Problems of Collective Feeding in War-time".

Monday, June 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Geographical Films.

Friday, June 5

GEOLOGISTS' ASSOCIATION (in the Rooms of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m. —Prof. Frank Debenham: "Shelly Drift in the Antarctic".

APPOINTMENTS VACANT

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

HEAD OF DEPARTMENT OF THE JUNIOR TECHNICAL SCHOOL FOR BUILDING in the Bournemouth Municipal College—The Director of Education, Town Hall, Bournemouth (June 4).

LECTURESHIP IN CLINICAL PATHOLOGY—The Secretary, University College, Cork (June 6).

UNIVERSITY CHAIR OF BIOCHEMISTRY tenable at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 8).

LECTURER IN PHARMACEUTICAL SUBJECTS—The Principal, Leicester College of Technology and Commerce, The Newarke, Leicester (June 13).

ASSISTANT MISTRESS TO TEACH BIOLOGY AND SUBSIDIARY CHEMISTRY —The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (June 13).

CHEMIST to assist in an investigation on the production of organic fertilisers—Prof. H. A. D. Neville, The University, Reading.

MECHANICAL ENGINEER FOR MINE ON THE GOLD COAST engaged on production of essential war material—The Secretary, Ministry of Labour and National Service, Central Register (Ref. O.M.C. 968), Public Trustee Office, Sardinia Street, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Society for the Protection of Birds. Fifty-first Annual Report, January 1st to December 31st, 1941; with Proceedings of Annual Meeting, 1942. Pp. 40. (London: Royal Society for the Protection of Birds.) [45

Annual Report of the Oundle School Natural History Society. Pp. 24. (Oundle: Oundle School.) [45

Reports on Progress in Physics. Vol. 8 (1941). General Editor W. B. Mann. Pp. iv+372. (London: Physical Society.) 25*s.* net. [55

Sheffield City Libraries. Research Bulletin No. 6: Machining of Metals. Pp. 46. (Sheffield: Central Library.) [55

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 24: The Limestone Coal Group of the Glasgow District. By Dr. M. Macgregor; with Note on Palæontology of Principal Mussel-bands, by Dr. J. Weir and Dr. D. Leitch. Pp. 22. (London: Geological Survey and Museum.) 1*s.* 1*d.* [55

Proceedings of the Royal Society of Edinburgh, Section B (Biology). Vol. 61, Part 2, No. 17: A Study of the Cytoplasmic Inclusions during the Spermatogenesis of the Mouse. By Dr. R. A. R. Gresson. Pp. 197–210 (2 plates). 1*s.* 3*d.* Vol. 61, Part 2, No. 18: Variation in *Gryphæa incurva* (Sow.) from the Lower Lias of Loch Aline, Argyll. By Rhona M. Maclennan and Dr. A. E. Trueman. Pp. 211–232. 1*s.* 9*d.* (Edinburgh and London: Oliver and Boyd.) [115

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 13: Limestones of Scotland, Area 3: East-Central Scotland. By D. Haldane and Dr. J. B. Simpson; with Analyses by Dr. A. Muir and H. G. M. Hardie. Pp. 30. (London: Geological Survey and Museum.) 1*s.* 5*d.* [135

Annual Report for 1941 of the Research Departments of the College of the Pharmaceutical Society. Pp. 36. (London: Pharmaceutical Society.) [145

Burton-on-Trent Natural History and Archæological Society. Local Records for 1941. Pp. 25. (Burton-on-Trent: Natural History and Archæological Society.) 1*s.* [145

Other Countries

University of Illinois: Engineering Experiment Station. Circular Series No. 42: Papers presented at the Twenty-eighth Annual Conference on Highway Engineering held at the University of Illinois, March 5–7, 1941. Pp. 91. 50 cents. Bulletin Series No. 333: The Suitability of Stabilized Soil for Building Construction. By Edwin L. Hansen. Pp. 40. 45 cents. Bulletin Series No. 329: A Study of the Collapsing Pressure of Thin-Walled Cylinders. By Rolland George Sturm. Pp. 80. 80 cents. (Urbana, Ill.: University of Illinois.) [115

Bernice P. Bishop Museum. Bulletin 170: Land Utilization in American Samoa. By John Wesley Coulter. Pp. 48+2 plates. Bulletin 171: Report of the Director for 1940. By Peter H. Buck (Te Rangi Hiroa). Pp. 33. (Honolulu: Bernice P. Bishop Museum.) [115

U.S. Department of Agriculture. Farmers' Bulletin No. 1885: Treatment of White Pines infected with Blister Rust. By J. F. Martin and G. F. Gravatt. Pp. ii+28. 10 cents. Miscellaneous Publication No. 468: Raspberry Fruitworms and related Species. By H. S. Barber. Pp. 32. 10 cents. Technical Bulletin No. 801: Insecticidal Efficiency of some Oils of Plant Origin. By A. W. Cressman and Lynn H. Dawsey. Pp. 16. 5 cents. (Washington, D.C.: Government Printing Office.) [115

Occasional Papers of the Bernice P. Bishop Museum. Vol. 16, No. 9: Encyrtidæ of the Marquesas and Society Islands (Hymenoptera Chalcidoidea). By P. H. Timberlake. Pp. 215–230. Vol. 16, No. 10: Psammocharidæ from the Solomon Islands, Prince of Wales Island, and New Caledonia. By Nathan Banks. Vol. 16, No. 11: The Hippoboscidæ of Oceania (Diptera). By Joseph C. Bequaert. Pp. 247–292. Vol. 16, No. 12: Viability of Coconut Seeds after Floating in the Sea. By Charles Howard Edmondson. Pp. 293–304. Vol. 16, No. 13: The Isopod Crustacea of the Hawaiian Islands, 2: Asellota. By Milton A. Miller. Pp. 305–320. Vol. 16, No. 15: Miscellaneous Notes on Hawaiian Plants, 2. By F. Raymond Fosberg. Pp. 337–348. Vol. 16, No. 16: The Genus Araucaricola in Fiji (Coleoptera, Tenebrionidæ). By Elwood C. Zimmerman. Pp. 349–356. (Honolulu: Bernice P. Bishop Museum.) [115

Field Museum of Natural History. Anthropological Series, Vol. 33, No. 2: Kinship System of the Seminole. By Alexander Spoehr. (Publication 513.) Pp. 29–114. (Chicago: Field Museum of Natural History.) 50 cents. [135

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 143: Production of Dried Grapes in Murray Valley Irrigation Settlements, 1: Viticulture. By A. V. Lyon and D. V. Walters. Pp. 48. Pamphlet No. 112: Building-Frames; Timbers and Sizes. (Division of Forest Products, Technical Paper No. 36.) By A. J. Thomas and Ian Langlands. Pp. 45. (Melbourne: Government Printer.) [145

Catalogues

Ilford Kryptoscreen X-Ray Paper. Pp. 6. (London: Ilford, Ltd.)

Catalogue of Books on Botany and Gardening with some items of Natural History. (No. 285.) Pp. 36. (Oxford: Dulau's Department, B. H. Blackwell, Ltd.)

Sulphonamide-*P* B.D.H. (Sulphanilamide) Pastes. Pp. 2. (London: British Drug Houses, Ltd.)

A Catalogue of Books and Periodicals on Botany, Agriculture, Forestry, Fruit-Culture, Gardens and Gardening, Herbals. (No. 598.) Pp. 64. (London: Bernard Quaritch, Ltd.)

Catalogue of a Private Library and Books from other Sources Recently Purchased. (Catalogue No. 660.) Pp. 94. (London: Francis Edwards, Ltd.)

Books on Science and its Applications and other New Acquisitions. (Catalogue 66.) Pp. 48. (London: E. P. Goldschmidt and Co., Ltd.