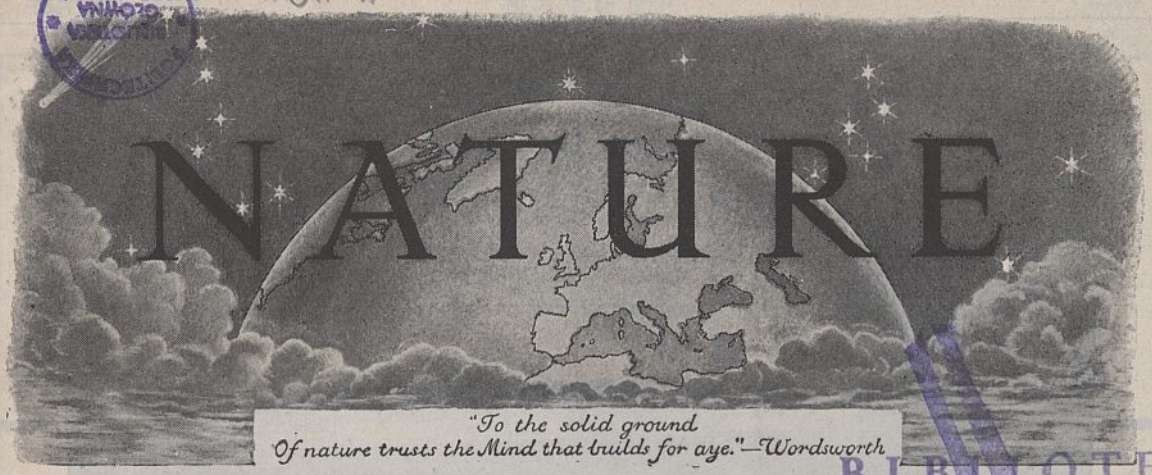

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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NATURE

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TRAINING OF CIVIL SERVANTS

UNIVERSITY OR STAFF COLLEGE?

IN the House of Commons the Chancellor of the Exchequer was recently asked if he had yet appointed a committee to examine the question of the training of Civil servants. The reply was in the affirmative. A committee of nine members has been set up under the chairmanship of the Financial Secretary to the Treasury. Its terms of reference are "to examine the general question of the training of Civil servants, including the question whether a staff college should be established, and, if so, the particular form and character which that college should take".

No one will attempt to deny that the time is opportune for an examination of the general question of the training of Civil servants. Nor, indeed, will anybody attempt to deny that their work and reputation have made them a body of whom this nation can be justly proud. Nevertheless the work of government must be conditioned by the evolution of social and industrial events, and the trend of those events, especially under the impact of scientific discovery, is producing groupings and complexities undreamed of when the lines of Civil Service selection were first determined. It is now very clear that the Civil Service is no longer the preserve of those who have received what is called 'a classical education'. There may once have been an excellent case for an aloof remoteness from the rather sordid details of a busy world as a qualification for government. There also may have been reasons for selecting candidates for government work only from our older universities. But that was before the internal combustion engine and the radio destroyed old boundaries and crushed mankind together on a shrinking planet, thus forcing it to work out new ideas of integration or to perish from stupidity or truculence. Scientific government has become inevitable. It is true that, even before the War, the man of science had entered government service. The Admiralty and the Ministries of Health and Agriculture showed clear enough proof of that. But the process had only just started, and its pace has been immeasurably quickened by war. It must continue to accelerate if the reconstructed world of peace is to come within any distance of the notions men treasure about it.

So, as we have said, the time is opportune for an examination of the general question of the training of Civil servants. We therefore welcome the Chancellor of the Exchequer's announcement, and we have tried to look hopefully at the terms of reference which are to guide the Committee he has set up. At first sight they seem quite innocuous. But, after looking at them a little closely, we begin to wonder at the prominence which is given in those terms to the question of a staff college. They seem to come a little near begging the whole question. There are many ideas which might be included where the general question of training is involved; and it is not unreasonable to ask why the staff college should be mentioned specially. We do not doubt that there may be good and sufficient reasons which so far have escaped us, but we cannot be blamed for

recording the impression that the special mention of the staff college may incline the Committee in its favour.

Perhaps, in this connexion, we, too, are not entirely guiltless of having what may be called prejudices. If that be the case, we can at least hope they will be carefully studied by the Committee in order that they may either be finally discarded as prejudices or accepted as ideas not to be ignored if the future Civil Service is to have the proper training for its great task.

Our first point is that a staff college, *if it be the only means of entry into the service*, may do exactly the thing which must be avoided. It will tend to narrow entry and to produce the kind of outlook which has been deplored in connexion with other professions. The gathering together of people intended for a particular vocation must always tend to be unfortunate. Already, in the case of teachers, the weaknesses of training colleges, as they have hitherto been conceived, are standing out clearly under the searchlight of critical examination. The same may be said for students whose training has been secured in a theological college. We believe that professional people gain enormously if, during the period of their qualifying studies, they are able to mix with men and women whose professional aims vary widely. For that reason we hope Civil servants will receive their main training in the universities or in institutions of similar rank where men and women following all kinds of courses may absorb something which is called, vaguely perhaps, general education, as well as studies of more specific and specialized type. Indeed, so far as those branches of the service are concerned which must more and more be staffed by chemists, physicists, biologists and the like, we fail to see how any other course is possible. This same point was emphasized by the Yugoslav Minister of Education at the recent conference of the Association of University Professors and Lecturers of Allied Countries in Great Britain (see NATURE, April 24, p. 466).

There is, perhaps, an even greater danger in the formation of a staff college for Civil servants such as may be under consideration. It is not merely that entrants will miss the wider and healthier contacts with other students. It is also that a staff college may have an unhappy effect on the universities themselves. That danger was brought out by Prof. Paul Vaucher at the above-mentioned conference. "Napoleon had created side by side with the universities," he said, "several professional high schools for the recruiting of his officers and civil servants. They attracted an important part of that *élite* that would have gone to the universities and were indeed so successful that they indirectly affected the methods for training used within the universities themselves. It did not in fact limit or narrow down the extent of learning, but it did in a way reduce the opportunities for disinterested and independent research." This, apparently, was the result of allowing exhaustive competitions to take the part of regular examinations.

Those dangers, it is true, might be avoided, and it is also true that the methods of training in our universities are themselves under close examination because it is said they did not enable the universities to contribute, as they should have contributed, to the swiftly moving and bewildered world of pre-1939. But if university methods are to be changed, it should come from other sources than a staff college set up for special and specific purposes.

We reiterate the point made above. There may have been reasons for giving the question of a staff college the prominence it received in the Committee's terms of reference, but until we know more about them, and until we are assured that the staff college is not to take the place of training already provided in the universities, we cannot help fearing that the very suggestion of a staff college in that context comes perilously near to begging the whole question.

CONSERVATION OF SCIENTIFIC AND TECHNICAL PERIODICALS

THE Association of Special Libraries and Information Bureaux has rendered a real service to scholarship and research by directing attention to the probable post-war demands for sets of scientific and technical periodicals. The pamphlet "Salvage or Storage" which the Association has just issued could scarcely be bettered as a concise statement of the position. Scientific workers are fully aware of the potential demand for complete sets of the publications of learned societies, professional institutions and research organizations, to which the statement confines its attention, to replace those destroyed or damaged in scientific and professional institutions in Great Britain. While, however, the need for restoring the shattered academic life in enemy occupied countries is recognized, the implications of this, in view of the deliberate Nazi campaign against learning, are far from being appreciated.

This demand, as the ASLIB memorandum points out, will be large and very difficult to meet. Not only will files for the war years be very imperfect or missing altogether; in addition, valuable stocks of earlier holdings will have vanished, and restitution, even if possible from Germany, which may be doubtful, is only a partial solution. Great tracts of Europe will require re-educating if we are to hope to exterminate the lust for military domination, and a vital part of this re-education will consist in an ample supply of the literary and scientific output of the free nations. The neutral countries themselves have also suffered inevitable interruptions and losses in the supply of scientific and technical literature originating from both Axis and Allied nations. Even if rehabilitation is restricted to the larger reference libraries, the demand is bound to be great.

The conditions which create this demand, however, at the same time reduce the stocks from which the demand must be met. Under the regulations of the Paper Control in Great Britain, publishing organizations may not use per quarter more than 19·5 per cent of the weight of paper used by them in the corresponding quarter of 1939, subject to special allowances for specific purposes. Not only has this led to reductions in format and in number

of pages, but also of the number of copies of each issue. Scientific workers are increasingly aware of the difficulties experienced in obtaining replacement copies of even current issues which may have been lost in the post or in other ways, and there is frequently difficulty in placing a fresh subscription. Especially for technical and scientific works, the home demand has increased, so that, although sometimes offset by the drop in overseas subscriptions, the net result is the reduction of reserve stocks even to vanishing point. When it is realized that losses through enemy action have sometimes been serious and that the drives for salvage have persuaded many private owners to send their copies for re-pulping, the anxiety regarding the future expressed in this pamphlet will readily be understood.

It should be unnecessary to emphasize to scientific workers the primary importance to the research worker and scholar of complete sets of all periodicals issued by learned societies, etc., being available in a reasonable number of the larger reference libraries. It is impossible to distinguish one set of publications as being of permanent value while another can be safely discarded. The publications of certain relatively obscure local organizations have on more than one occasion proved of value in the war effort.

Storage and dispersal problems alone would preclude the issue of a national appeal for the preservation of all holdings of periodicals issued by learned societies, research organizations, etc. A central depository is obviously undesirable, and the Central Committee for the Recovery of Books and Manuscripts of ASLIB is working upon the principle of dispersal in regard to books, but for periodicals a strong central organization and efficient records are almost impracticable under war conditions. To meet this difficulty the ASLIB memorandum suggests that learned societies, professional institutions and research organizations which do not possess good reserve stocks, or which cannot disperse these to safeguard them against enemy action, should ask all their members to retain their own copies, in order that those not wanted for permanent filing may be called in after the War to complete the stocks of British and foreign libraries.

It should not be difficult for societies to keep a card index of subscribers who undertake to co-operate in this way, so that future stocks can be roughly assessed. Where subscribers cannot for various reasons retain the periodicals in their own custody, it is suggested that they should notify the following, in the order named, and offer these organizations the opportunity of storing the periodicals against future needs : the publishing organization ; the local public or county library ; the Science Library ; the Library Association ; the National Central Library ; or ASLIB. Unless the periodical is very rare, damaged or dirty copies should be sent for salvage. These suggestions relate to British publications. The wartime issues of foreign publications of learned societies should only be discarded after expert advice. The memorandum should be sure of a ready response from all scientific workers, who may well be grateful for a timely and lucid statement on the situation.

EDUCATIONAL PRINCIPLES

Education for a World Adrift

By Sir Richard Livingstone. (Current Problems, No. 17.) Pp. xvi+158. (Cambridge : At the University Press, 1943.) 3*s*. 6*d*. net.

THE educational storms that have raged over Great Britain during the last generation or so have usually been connected with the machinery of education. There have been few who have been content and far-seeing enough to sit back and look steadily at the whole canvas of education and to contemplate its objectives. For this there are several reasons. Not many people are prepared to set out clearly defined aims in education, while those that do often present such a narrow outlook that their argument frequently returns to problems of machinery. Fortunately, with a new Education Bill in the offing, there are indications that educationists are becoming disturbed more by shortcomings in the fundamentals of education than by the mechanics of administration. Adequate, smooth-running machinery is necessary to make the products we need and seek. Much more important is it to know what kind of product we wish to make. There is little use in transforming immature beings into mature members of civilized society unless we ourselves are clear what we mean by maturity and civilization.

Credit, therefore, must be given to Sir Richard Livingstone for his courage in facing up to the real issues of education and for his resolve at this stage in refusing to be drawn into discussions about the operation of the various processes in education. Buildings, playing-fields, school meals, nursery schools, etc., are all of greatest importance. But these are incidentals and not so important as what is being taught and what we wish to procure inside the schools.

Three things, says Livingstone, are essential. The knowledge necessary to living must be imparted. People must be taught to use their brains. Most important of all, people must have placed before them a clear set of standards and values and must be prepared to live by them. It is mainly with this problem that his book deals.

In an analysis of the present age, the author states his beliefs as follows. This, he declares, might be called the Age of Science, or the Age of Social Revolution, or the Age without Standards. He is concerned with it in the latter aspect. "The nineteenth century had a soul, a spirit ; what soul, what spirit, has ours ? The child of the Victorian age was born into a world of stable traditions and clear standards and was shaped from birth in their strong moulds. The child of to-day is born into a world whose traditions and standards are weakened, a world with inherited good habits, but no ruling philosophy of life."

The philosophy of the nineteenth century, according to Livingstone, was based on Christianity, reinforced, "to a far greater degree than is generally realized, by the clear and noble ideals of Hellenism, through the classical education received by the governing classes. It would be difficult to find any leaders of the age whose outlook on life was uninfluenced, if not formed, by one of these." In discussing the apparent absence of a purposive philosophy in our time, the author suggests that only by a return to the Christian and Hellenistic philosophies will this and future generations be able to produce men and women capable of living a fuller and richer life. That, in essence, is the theme of this book.

As a means of regaining these lost spiritual values, Sir Richard reiterates some points which he has discussed in an earlier work, "The Future in Education". To counteract the spiritual flatness and lack of values in young lives we should ensure that visions of greatness in human life and character be set before them. This can be done by teaching literature and history, the Bible and the Greek classics (in translation) being chiefly used as source-books. So that young people shall not be influenced by stories of cruelty and treachery and wickedness, it is important that their reading-matter be carefully chosen and that the "first-rate" is set before them as worthy of emulation. Unfortunately, even a casual reading of Sir Richard's prescription of set books and authors reveals a tragic lack of acquaintance with the common people for whom the medicine is being prepared. The suggestions might profitably be used for the very small section of the population who are attracted towards the "cultural", but would contribute little to the life of the majority. This unawareness of the people is paralleled by some peculiar misinformation which is supplied about the parade ground. "Mere character training in the narrow sense could be carried out by a drill-sergeant; courage, endurance, fair-play, discipline, could be learnt on a parade ground and the work would need a far less highly qualified staff than those of a school."

The intrinsic weakness of this and other books on education by the same author are bound up with this point. His philosophy offers a great deal to those who are wont to look at truth from the angle of the humanities and the heights of classic aloofness. In bridging the gap—artificial but very real—between the cultural and the vocational, the abstract and the practical, it does little except, perhaps, widen the cleavage.

This can readily be seen in Livingstone's attitude to science. No frontal attack is made on science, yet it would be difficult to find another work in which science is so magnanimously disparaged, and so "back-handedly" praised. "During the last war the salvation of the world was assigned to science. Now we are disillusioned. Science, like medicine, is an integral part of civilized life. It is difficult for human beings to maintain health without doctors but medicine is not health. It is difficult for a civilization to be sound without science, but science is not civilization, and few people can suppose that salvation is its business." Scientific men, the author goes on to say, frequently go beyond the limits of their subject; science is non-moral and unconnected with standards of value. The man of science might well retaliate that his governing principle—the search for objective truth—is in itself a moral principle which must be honoured in the observance and not the breach. The difficulty seems to be in Livingstone's assumption of an absolute scale of values. Science would argue that moral and ethical and spiritual values are by no means the same at different times and at different levels of civilization. Scientific discoveries have often been responsible for overthrowing outworn principles which have been established and sustained by inadequate knowledge. The treatment of criminals, prisoners, paupers, the insane, mentally defectives and the under-nourished has been considerably modified by scientific investigations, while we are all familiar with instances of how religious outlook has been modified by changes which in origin were quite unrelated to religion.

Reverting to Sir Richard's main premise. Is he right in saying this is an "Age without Standards"? Is the nation which rose to arms in 1939 in defence of the "Four Freedoms", which includes freedom of worship, devoid of spiritual values? Because those outward forms of religion which met the spiritual needs of some Victorians are disappearing, is it just to assume that the spiritual quality of our people has been lowered? And is it too much to hope that men of liberal education may yet realize that the last hundred years has produced a challenge to traditional and dogmatic habits of thought that cannot be brushed aside? Instead of readily assimilable and comforting beliefs in design and purpose, men and women are seeking truth—absolute truth—even if it brings the house of dogma crashing about their ears.

A serious criticism of the structure of this book is the misuse of quotations. In an essay of this nature, the argument can often be driven home more surely by quoting an extract from another writer. In many cases here the argument becomes little more than a method of linking up quotations. These are almost entirely lengthy excerpts from the classics and are not always apposite. T. H. HAWKINS.

POPULATION OF BRISTOL

The Population of Bristol

By H. A. Shannon and E. Grebenik. (National Institute of Economic and Social Research, Occasional Papers 2.) Pp. 92. (Cambridge: At the University Press, 1943.) 7*s*. 6*d*. net.

THIS is the second of the 'occasional' papers issued under the auspices of the National Institute of Economic and Social Research. It includes an introduction by Prof. Hamilton Whyte, a section by Mr. H. A. Shannon dealing mainly with migration into and out of Bristol, and a reprint of the important paper contributed by Mr. E. Grebenik to the *Journal of the Royal Statistical Society* in 1940 on "Some Aspects of Population in Bristol", which the author himself in a final short chapter puts into less technical language.

In the last analysis the people constitute the real wealth of any country: they are the prime agents in making all material wealth effective by turning raw materials into riches. It follows that studies of trends in the quantity and character of the population are extraordinarily valuable. This particular study has additional interest because few attempts have been made to discuss in such detail the population of a comparatively small and compact area. The only criticism one might offer relates to the price of the publication, if it is to be widely read. It is high, in view of the fact that the pamphlet contains only 57 pages of new matter; and of the total no fewer than 24 pages are taken up with tables, concerning the employment and origin of migrants, which in these days of paper shortage could with a little ingenuity have been advantageously compressed.

Mr. Shannon's contribution starts with a survey of the population changes from the beginning of the nineteenth century. Those who live in great cities get the impression that England is sadly overcrowded. Such impressions are corrected on reading "the city [that is, Bristol] . . . is seen greatly to have outstripped its surrounding county fringe [namely, Gloucester and Somerset less Bristol] from at least 1821. . . . It is barely an exaggeration to say that that county fringe has remained stationary for the last hundred years." The truth is that people in

general prefer company—or the amenities which living in the neighbourhood of large groups brings—to solitude.

Bristol, as defined by its 1935 boundaries, registered in the seventy years 1861–1931 a total increase of some 225,000. Of this total, the *net* increase due to migration is estimated to have been trifling, of the order of 2,000 only. The growth of population was due almost entirely "to the fertility and natural increase of Bristolians". While the net gain by migration to the city, as a whole, has been slight, there has been—as in most other large centres of population—a steady stream of migrants from the inner to the outer areas of the city, fostered by slum clearance and the development of new housing estates nearer the open country.

The effect of re-armament on the figures is clear: the wider fringe of Bristol, in the region of the Filton aircraft works, which before had been substantially rural in character, showed a jump in the electoral roll from round about 20,000 in 1931 to nearly 30,000 by 1938. In fact, if for this purpose an immigrant is defined as a person who holds an insurance book issued outside Bristol, the figures show that 30 per cent of the adult male immigrants into the borough have entered the aircraft industry, which is now the city's leading industry. This, with building and the distributive trades, accounted for more than one half the adult male immigrants. Distribution, hotel and club service, and food manufacture accounted for two out of every three women immigrants. Such concentration of both male and female labour, in view of the large assortment of trades which Bristol offers, does not presage well for the future when peace returns. It is in large part due to war conditions, and it can no doubt be multiplied many times if other parts of the country are considered. The problem is clearly one that needs to be attacked on a national scale.

In keeping with the results of similar investigations elsewhere, the majority of the migrants come from nearby areas, but the tentative suggestion is made that this seems to be less true of skilled than of unskilled immigrants. Another point of interest is that the immigrants generally experience a higher degree of unemployment when comparison is made with the native stock. Moreover, this difference is consistent: it holds for both males and females, and for each age-group tested.

Mr. Grebenik has summarized the results of his researches lucidly and concisely, and some of his conclusions are worth recording. Neglecting migration, and assuming the fertility- and mortality-rates of 1937 to remain constant, he estimates that in 65 years time Bristol will have only about 273,000 inhabitants as compared with 415,000 at present. The number of children under fifteen years of age will then actually be less than the number of old people. They will account for not more than 15 per cent of the population, while old people of 65 years and more will account for 20 per cent. This will mean a diminished demand for schools and teachers, maternity and child welfare clinics, but greater pressure on social services catering for the aged.

Among the most striking figures quoted are those showing the average age of mothers in different occupational groups at the birth of their first babies. It was found to be 28·0 years in the middle class, 26·2 among skilled artisans, and 24·5 among unskilled workers. Again, the proportion of children of high parity orders (that is, the proportion of seventh, eighth, ninth . . . children) discovered among the middle class was only 1·2 per cent; among skilled artisans it was 2·1 per cent; while among unskilled workers it rose to 13·8 per cent. On the other hand, the proportion of first children born was 52·1 per cent among the middle class, 47·2 among skilled artisans, and 25·0 among the unskilled.

Such records as these, throwing light on both the general decline in fertility and its differential incidence, should open the eyes of all who read to the nature and gravity of the population problem, and to its reactions on trade and employment, the social services, the provision of necessaries and amenities, and indeed every aspect of the life of the community.

D. CARADOG JONES.

ARCHÆOLOGY AND MODERN MAN

What Happened in History

By Prof. V. Gordon Childe. (Pelican Books. A. 108.) Pp. 256. (Harmondsworth and New York: Penguin Books, Ltd., 1942.) 9*d*.

PROF. V. GORDON CHILDE is one of the foremost prehistorians. He has travelled widely and done much work of great importance to the specialist; he has, as it were, personally added many bricks to the edifice of prehistoric knowledge. But he has also long realized that prehistory and early history form a continuum, and that, by standing back and contemplating the whole, many general conclusions can be arrived at with regard to the rise and fall of civilizations. Too often volumes purporting to give such cultural résumés come unavoidably from the pens of 'scissors and paste' authors who do very good work but cannot, of course, write with any personal authority.

For this reason a special welcome must be accorded to Prof. Childe's fascinating little book now under review. In it he discusses the changes in material well-being and mental outlook that have taken place throughout the ages up to the break-up of the Roman Empire. He gives us a brief survey of what he describes as Palæolithic and Mesolithic savagery, of Neolithic barbarism, of the rise of the Metal Age cultures and so on until a climax was reached as a result of the Old World unity made possible by the exploits of Alexander the Great. Finally, there is a stimulating chapter with the author's views about the decline and fall of the ancient world. At this point one naturally recalls T. R. Glover's treatment of the subject in his "The Ancient World", but the present work, of course, deals with an infinitely longer time-span of human effort.

Naturally, Prof. Childe has had to select and compress his background material to a cruelly hampering degree, and has consequently had to make a certain number of dogmatic statements, some of which may perhaps be open to challenge in detail by other specialists; but this is inevitable. Again, in the nature of the case he has had, as it were, to view humanity as one whole, advancing or retreating along the same road, even if not always at the same time. Perhaps not quite for the same reason, the external causes for changes in human ways of life and outlook—climatic changes and the like—are not much discussed: man makes himself is the creed adopted. But the conclusion that history is two-dimensional, or as Prof. Childe says on the last page "the upward

curve resolves itself into a series of troughs and crests", with each crest reaching to a new high level and no trough as deep as the one before, is one that is not always sufficiently appreciated nowadays. Personally I have long believed that this is one of the fundamental lessons that can be derived from the general study of human progress: history may indeed repeat itself, but the repetition is not merely circular; it is spiral. It is indeed three-dimensional.

In a general connexion, on p. 21, the author throws out a suggestion that "cultures are tending to merge into culture", which will perhaps fill some people with foreboding—the cultural temperature resulting from such a merger would probably be a tepidity of the Laodicean kind! On the other hand, of course, the "limitless multitude of Neolithic cultures" referred to on p. 56 must have constituted an equally unsatisfactory background for human advancement. Nevertheless, it has always seemed to me that this was a tremendously important moment in cultural evolution: that the discoveries which led to the rise of the Neolithic civilization were perhaps the most fundamentally important ones ever made by humanity. Community life as we know it, with all the social and moral problems it involves of the regulation of human behaviour, dates from the discoveries of agriculture and the domestication of animals.

Very interesting indeed to us to-day is Prof. Childe's implication in his last chapter that the later Roman emperors introduced Nazism in an effort to escape the oncoming decline and death of civilization. It is perhaps not *quite* so satisfactorily explained exactly why the ancient world was dying, unless we accept the natural idea of old age. Civilizations are not unlike individuals. They are born as a result of culture contacts and, unless killed, survive for a span before disappearing. But, as the author's optimistic creed indicates, they do hand on a something which is taken over by their successors—the next great civilization to arise.

This more than worth-while book contains many facts—the background material for the study; but it is primarily intended to stimulate thought and to help the reader to understand the general story of human development and, may be, to draw lessons which will help when our own civilization, now in danger of collapse, is once again in process of reconstruction.

M. C. BURKITT.

THE STORY OF MAGNITOGORSK

Behind the Urals

An American Worker in Russia's City of Steel. By John Scott. Pp. 224. (London: Martin Secker and Warburg, Ltd., 1942.) 7*s*. 6*d*. net.

THE cause of world freedom owes much to the amazing development of mineral resources and heavy industries in the Soviet Union since the inception of the first Five-Year Plan. In the late 'twenties, thanks to the sagacity and foresight of their leaders, the Russians embarked on a vast scheme of industrialization in the Urals and Western Siberia, far distant from the nearest frontiers, in the face of appalling difficulties. Since the old industrial centre of the Ukraine has been overrun, these newly developed regions have indeed become a stronghold of Russia's unconquerable resistance.

For more than five years John Scott, an adventurous young American engineer, shared the life of the Russian workers while helping to build blast furnaces and operate the coke and chemical plants of Magnitogorsk, on the eastern slopes of the Ural Mountains. His remarkable story, written with stark realism, tells of the triumphs and privations of those who struggled to change Magnitogorsk from a squalid village of Kirghiz and Bashkir herders into one of the world's largest metallurgical plants, with a production of about 3 million tons of steel a year. Even more impressive than the documented statistics which bespeak the progress of material achievements is the illuminating account of daily life in Magnitogorsk, of the patriotic enthusiasm, the intense striving after education, the confusion and disorders, the unquestioning obedience to the dicta of the Communist Party, and of the purge which struck the city in 1937.

The author is neither a dilettante nor a partisan propagandist; he actually dwelt and toiled as a Russian, and although his writing is imbued with the spirit and atmosphere of the Revolution, it is none the less a sane and balanced study of the benefits and shortcomings of socialism as it recently functioned in Magnitogorsk.

If this extraordinary book attains the wide circulation it deserves, it should help to promote better Anglo-Russian understanding. Especially should it be read by those who have not ceased to wonder how the peoples of the Soviet Union have so successfully withstood the armed might of Nazi Germany.

DAVID WILLIAMS.

ORGANIC REACTIONS IN LIQUID SYSTEMS

Mechanism and Chemical Kinetics of Organic Reactions in Liquid Systems

A General Discussion held by the Faraday Society, September 1941. Pp. ii+601–806. (London and Edinburgh: Gurney and Jackson, 1942.) 15*s*. net.

THIS volume contains fourteen papers on various aspects of the mechanism and kinetics of organic reactions in liquid systems, together with reports of discussions on them at a meeting of the Faraday Society in September 1941 (see NATURE, Jan. 31, 1941, p. 126). The topics included various kinds of substitution reactions, elimination reactions, hydrolysis, addition and condensation, prototropic changes, anionotropic changes, substitution reactions, free radicals, Cannizzaro reaction, and ring closure. A wide and important field was thus covered.

The main emphasis was laid on the electronic theory and modern interpretation of the processes discussed, and as the papers are in the nature of monographs by leading workers in the fields, and have full bibliographies, the interesting and valuable character of the book will be appreciated. Modern organic chemistry is making full use of recent advances in physical chemistry, and in the theory of atomic structure and bond formation which has been worked out in theoretical physics. Some idea of the great advances in the understanding of organic reactions which this new knowledge has made possible can be gathered from the work reported here, and both chemists and physicists should find the volume both stimulating and useful.

The Faraday Society General Discussions are well known and appreciated as valuable contributions to the advancement of knowledge, and the present volume well maintains the high standard set in previous General Discussions.

NEWS AND VIEWS FROM THE SCIENTIFIC FRONT*

By SIR RICHARD GREGORY, BART., F.R.S.

IN the middle of last century, contemporary thought was no more ready to receive, or able to understand, Darwin's scientific evidence as to man's place in Nature than philosophers and theologians of Galileo's time were willing to be convinced of the truth of his observations and the rational conclusions derived from them. When the "Origin of Species" was published the review copy sent to *The Times* was handed to a member of the staff who was responsible for notices of literary works generally. He was an excellent journalist but as innocent of science as a child, so he exercised editorial functions and asked a friend to suggest someone who could write a review which he could adopt with a few introductory remarks of his own. Fortunately, T. H. Huxley undertook to do this, and his fine article on Darwin's book appeared in *The Times* unsigned in the usual way. It was not until later that he permitted it to be known that he was the author of the review.

At that time the *Saturday Review* devoted a fortnightly column to scientific subjects, and this led Huxley to believe that a quarterly magazine surveying advances of science in a systematic way was wanted, particularly on account of the poor state of natural history journalism. He therefore became chiefly responsible for the launching of the *Natural History Review* in January 1861 and continued as its overworked and unpaid editor for two years. He then ceased to contribute to the magazine, but the publisher, Mr. John Murray, decided to carry on with paid contributors and editors instead of volunteers. As, however, the enterprise was never sound financially, there was little hope for it under the new scheme and the magazine came to an end in 1865.

The promise of success of a quarterly review for general scientific readers, whether devoted to the biological or the physical sciences or to both, is no better to-day than it was then. Most scientific and technical societies provide facilities for keeping their members in touch with advances in their own professional spheres, but their vocabularies are usually so highly specialized that they are unintelligible without preliminary acquaintance with their meaning. After the *Natural History Review* had failed to find a sufficient circulation to maintain its publication in quarterly issues, a weekly periodical of a less specialized kind, *The Reader*, was started and Huxley took an active part in conducting it, until it also came to an end after a life of three or four years only.

J. Norman Lockyer, who was the science editor of *The Reader* during its existence, as well as a contributor to the *Saturday Review* and other non-professional periodicals, was led by his experience to the conclusion that a weekly journal of science of a more comprehensive scope than any previously published was needed by both scientific and general readers. He was at that time scientific adviser to the Macmillan firm of publishers, and the head of it, Mr. Alexander Macmillan, believing that the interests of science and of the British people would be advanced by such a journal, warmly supported plans for its establishment. All the leading contemporary men of science promised active co-operation in Lockyer's scheme, the result being that the first number of NATURE appeared on November 4, 1869, with Messrs. Macmillan as the publishers [see also NATURE of February 27, p. 231].

In that period public attention was being directed to scientific subjects in the general Press and other periodicals. A weekly *International Review of Scientific Lectures*, published in Paris, was devoted to public lectures delivered by leading scientific authorities in the chief countries of the world, thus enabling general readers, as well as men of science, to become acquainted with the advances being made. A few weeks before NATURE was published, Mr. John Murray began the issue of the *Academy*, "a monthly record of literature, learning, science and art". Prof. Huxley and Sir John Lubbock were among the scientific contributors to the first number. Though the *Academy* gave particular prominence to scientific subjects, and included in its second number several papers by Helmholtz, Mayer, Virchow and other men of science read at a meeting of the German Association of Naturalists at Innsbruck, as well as summaries of other communications, it did not become a rival to NATURE, as was feared it might do, and friendly relations were always maintained between the two editors.

What Lockyer desired to do was to promote public interest in science and its achievements, whether through the general Press, lectures, or in any other useful way. The more contacts he could find between science and the public mind, the better he was pleased. With Huxley and Tyndall he combined scientific authority with literary power, and represented, therefore, the most effective type of connecting link between science and the citizen, whether through articles or in popular lectures. It was to assert the rights of science to an honoured place in national service, as well as its responsibilities to the development of natural resources, both intellectual and material, that NATURE was founded.

The establishment of a weekly periodical to promote public understanding of science, and at the same time to provide a forum for natural philosophers, was a notable event in the history of journalism. It is true that, nearly forty years earlier, the British Association was founded with much the same intentions, but as it met in full session only once annually, accounts of its activities in the periodical Press were limited to a few issues.

The attitude of the public Press, when the founders of the Association charged themselves with the obligations "to obtain more general attention for the objects of Science" and held annual meetings in different parts of the country for this purpose as well as for the discussion of scientific advances, was the reverse of encouraging. It was represented in contemporary journalism by Dickens' articles in *Bentley's Miscellany*, afterwards published as the "Mudfog Papers". These contributions were caricatures of the proceedings of the first and second meetings of the Association and of the men of science who took part in them. Less crude, but just as derisive, views as to the meaning of science and its service to the community prevailed in literary circles generally. *The Times* ridiculed the Association and its objects at the beginning and continued to do so for a number of years afterwards. It and other journals of the time, like *The Age* and *John Bull*, regarded the entrance of science into public life as an intrusion,

* Substance of an address at the Conference on Science and the Citizen held under the auspices of the British Association Division for the Social and International Relations of Science in London on March 20–21.

and its efforts to extend the understanding of it as evidence of a desire for self-advertisement.

By the middle of the century, however, contempt had changed to condescension, and the public mind was ready to give sympathetic consideration to the utterances and publications of what had been described as a "hodge-podge of philosophers" by such a cultured representative of higher learning as John Keble of Oxford. Even though the tone of literary scholars and leaders of the Press towards scientific work and thought continued to be supercilious, the new humanism made a strong appeal to many progressive minds, and leading organs of the Press introduced its chords into their harmony of news.

When NATURE made its first appearance, the period of opposition to organized science and its public relationships had been left behind. From being regarded as presumptively vociferous, the natural sciences came into positions of authority among the progressive elements of human thought and action. The Great Exhibition of 1851 and the second International Exhibition held eleven years later had given new outlooks to industrial science and its profitable development. Labour asserted its rights to a place in the economic field by the formation in 1864 of the International Working Men's Association, which afterwards became "The International". To guardians of traditional learning and social privileges, both science and labour represented revolutionary movements which had to be admitted into the fields of public affairs even though their motives and purposes did not approach the conventional standards of Victorian respectability. The common cause was to secure freedom of thought and action and the advancement of human welfare.

The periodical Press took critical or helpful attitudes towards these claims, each reflecting the views of most of its readers and some using a lens instead of a mirror to examine them. In order to exist, a journal, like a human being, must have a good circulation as well as a heart to keep the living stream in full flow. In journalism many hopeful hearts have believed that a large body of the public was waiting to respond to their strong and steady throbbing, but have been doomed to disappointment. Sooner or later, the public, general or special, gets the kind of journal it wants, and decides whether or no its publication is worth while financially. From a business point of view, lack of sufficient support is more often due to being in advance of the times than lagging behind them.

In the 'sixties of last century scientific forces formed the spearhead of cultural movement; but though their main advances compelled attention they broke up an established system of defence and received, therefore, little support from other elements in the front line. In the absence of accurate and intelligible accounts of operations in scientific fields, neither the public nor its leaders could arrive at a right understanding of their meaning or justly judge the value of the resources of the new territory of natural knowledge. There was need for the organization of scientific intelligence and also for the expression of scientific opinion upon educational and other public problems then under discussion. The time had come for performance to be related to progressive policy and science to exert its influence in the realm of the Fourth Estate. It was with the object of presenting news of advances in the expanding field of natural knowledge and of expressing the views of leaders in the scientific services on contacts of such knowledge with current questions in which it was an important factor, that NATURE was founded.

The entrance of scientific 'usurpers' into the fields of public policy and established learning met with a hostile reception, but it was welcomed by enlightened leaders in other cultural groups. The moment was opportune to make their advances and influence known to all who cared to give attention to them, even though the promise of support was relatively small. Confidence in a cause has to be sustained if success is to be achieved, and it was needed to found and maintain a weekly scientific journal in the third quarter of the nineteenth century, when education in science had a very minor place in the schools. At that time interest as well as enterprise were required to establish a periodical of this kind. Fortunately, Mr. Alexander Macmillan, who was then the head of the great house of publishers bearing his name, possessed these qualities and maintained his faith in the mission of science without consideration of financial profits to be derived from the publication of its weekly message. It was not until towards the end of his life in 1896 that NATURE became self-supporting, though from the beginning the journal was esteemed as the accredited organ of scientific fact and opinion.

One of the reasons for the long-delayed fulfilment of early promise was the increase of specialization among scientific workers. In the quarter of a century following 1869, nearly fifty separate societies were founded, each dealing with a particular department of science or technology, all of them issuing publications of a special kind, and some having their own journals. It became difficult to keep in close contact with developments in even a single field of operations, and more so for workers in other fields to understand the terms in which advances were described. The forces in the front line lost touch with one another, but each continually entered new territory and established strong positions in it. The common purpose of the pioneer corps was to clear away the tangled growth which obscured most of the features of Nature and to explore what was beneath it. The object of the technical services which occupied the territories acquired was to examine the resources in them and apply discoveries to useful ends.

Among the journals in existence before NATURE made its first appearance were the *Lancet*, *British Medical Journal*, *Chemist and Druggist*, *Electrician*, *Engineer*, *Engineering*, *Gardeners' Chronicle*, *English Mechanics* (now *Mechanics*), and *Pharmaceutical Journal*. A journal which aimed at recording notable movements along the whole line of advance of pure and applied science in terms intelligible to all of them as well as to non-professional readers with wide interests had to undertake the duties of an intelligence department with the policy of a general staff.

For more than fifty years, the general staff responsible for the conduct and contents of NATURE consisted of two officers—an editor and an assistant editor. Correspondents from all parts of the world made the journal a centre of scientific news and views from the very beginning of its foundation. The increase in numbers of scientific and industrial research centres led to a greatly increased volume of original communications from them. The result was that NATURE became a kind of clearing-house at which scientific drafts were presented and their exchange values adjusted. In a single year before the present War, nearly one thousand letters from original

investigators appeared in the correspondence columns of the journal. One sixth of these letters were from scientific centres outside the British Isles, and thirty different countries were represented by their writers. The journal thus came to be recognized as a world medium in which early announcements could be made of new scientific observations and conclusions.

By providing the means of expansion of old industries and creating new, science has transformed conditions of civilized life and influenced the whole social structure. In Darwin's days beams from strong scientific searchlights revealed weak parts of ancient bulwarks which were believed to be impregnable. The beams came from a lighthouse and were not produced for purposes of aggressive action by new forces but for the guidance of mariners in mysterious seas. They were, however, so dazzling in their effects that they were resented as a danger to established principles of navigation instead of being welcomed. The conflict which then arose was between champions of new and old ways of looking upon human life in its philosophic and spiritual aspects. Later, the cry of danger was again raised against science because poison gases, high explosives and bombs from aeroplanes were among its fruits. The War of 1914–18 brought this attitude towards science into prominence, and the view was expressed by responsible leaders of thought that a halt should be called to further advance of knowledge because of the dehumanizing results which might be derived from them. By this time, however, there was a sufficient body of responsible opinion to assert the right of science not only to liberty of thought and action in its own fields, but also to be a component part of the executive staffs in control of the disposition of its forces.

The campaign with these objects in view as well as to establish closer contacts between science and other formative elements in the social structure was opened in NATURE of October 21, 1915, with a leading article on "Science in National Affairs". Every week since then the journal has had the temerity to express opinions upon current affairs in which scientific methods and services are involved. Without entering the field of party politics there has never been a lack of important public problems requiring scientific knowledge as well as wisdom for their right solution.

The result of the revival of the scientific movement has been to give the social and international relations of science both shape and policy. In 1938, the British Association established an autonomous Division of its constitution to promote these objects, which were among its original purposes. There are still many people who regard men of science as members of a kind of monastic order content to carry on their studies in cloistered seclusion, whether their lives and work are of service to others or not. The history of science is rich in examples of men of this type, pursuing knowledge for its own sake without thought of recognition in this world or reward in another. They are the saints of science and are revered as such by all who esteem truth and the high endeavour its pursuit entails. To these natural philosophers, the impressive fabric of science owes the main features of its design and execution; and no tribute is too great to be paid to them.

Science is, however, a gospel of righteous principles however much they may be departed from in practice. It has the duty not only of preparing messages but also the mission of interpreting their meaning to all who will give attention to them. In the history of civilization there has never been an epoch in which understanding of the spirit and service of science was more necessary for the public and its leaders than now. A century ago wide public interest was aroused in scientific subjects through descriptive lectures with experimental and other illustrations, but there is far less demand in these days for the expositions which were then so popular. The cinema and broadcasting can now perform this informative function much more effectively than peripatetic lecturers. What the public is ready to take active interest in to-day is the impact of science upon social conditions, and its relations to life and labour. These are subjects upon which any individual citizen affected by them can have his own opinion and is at liberty to express it. The function of science at a public conference or meeting is to present the results of impartial inquiry into any such subject for which a meeting is convened and to provide whatever further information is available relating to it.

The British Association, through its Division for the Social and International Relations of Science, could most appropriately organize such public conferences at suitable centres anywhere in Great Britain, and by doing so would greatly assist in the extension of knowledge of contacts between the natural and the social sciences. It could do at home what the British Council is doing for science and other fields of culture abroad, but to undertake such an educational enterprise successfully would require much greater financial support than the Association is at present able to provide. If this Conference on "Science and the Citizen" should lead to the establishment of a kind of public university extension movement, with particular reference to science and social values, it would mark the beginning of a new era of constructive co-ordination of progressive scientific knowledge with changing social needs.

THE CONCEPT OF ENERGY

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IN an earlier article entitled "Modern Science and Thomas Hobbes"[1], I remarked that it was especially the law of conservation of energy which inclined thinkers of the nineteenth century to a rigid determinism. The concept of energy gained such great prestige during the latter half of that century that it seemed as if physics were as much preoccupied with energy as the chemists were with matter. Although that era is gone and the historian of the relativity theory will have to show how the two fields became less completely demarcated, the old categories of thought still remain, and for many purposes perhaps they always will. In any event the concept of energy in classical physics holds much the same central position that the atomic theory holds in chemistry—but there are no comparable historical studies.

One hundred years ago, Sir William Robert Grove gave a course of lectures at the London Institution, later published (in 1846) under the title "On the Correlation of Physical Forces". In these lectures Grove pointed, for the first time, to the interconversion of various physical 'forces' and argued the existence of some underlying identity; in essence he gave a formulation of the general law of conservation of energy. The full importance of Joule's paper of

1843 was understood by Grove, for it is clear that he was exploring the same problem. But even if it is true that, as F. W. Hobson remarked, "the notion of Matter is one formed by common sense, but the conception of energy has been created by Science for its own special purposes", it would be wrong to suppose that the concept sprang suddenly into use in the nineteenth century. Writing of physical science in 1838, Osborne Reynolds said: "The terms 'energy' and 'work' did not exist in the language of science in their present significance"; on the contrary, although the product mv^2 was accepted as a mechanical quantity, the idea of work or motion against resistance "expressed as a product of the distance, multiplied by the mean resistance overcome, although it was known to express the half of the change in the vis viva which takes place in a body moving against resistance, had never been recognized in the schools of mechanical philosophy as a fundamental measure of mechanical action, either as 'work' or by any other name"[2]. Nevertheless, the importance of measuring motion against resistance was increasingly recognized by engineers, who were applying the steam engine to more and more industrial uses. So early as 1759, Smeaton, in a paper published by the Royal Society, compared the relative powers of undershot and overshot water wheels—the application of kinetic as against potential energy—but the steam engine was the chief source of quantitative investigations. With the development of machinery it became an urgent matter to have some method of specifying the power required. Watt settled the unit of power to be employed, but the great question of how much power might be obtained, theoretically, from the steam engine was first successfully tackled by Sadi Carnot. In 1824 he wrote: "Everywhere where there is a difference of temperature, everywhere where there can be a restoration of equilibrium, there can also be a production of motive power. . . . Conversely, everywhere where this power can be consumed, it is possible to produce a difference of temperature. . . ." From a theoretical calculation of the ratio of the specific heats of air he went on to obtain a value for the mechanical equivalent of heat. That this was erroneous matters less than the important advance begun by Carnot, for he had grasped the important truth known as the First Law of Thermodynamics, and this law in the form $dQ = dU + dW$ is only a special case of the law of conservation of energy.

Joule also, of course, had the outlook of the engineer rather than that of the theoretical physicist. Before him Julius Mayer, following a line of thought started by Gay Lussac and Séguin as well as Carnot, had speculated on some form of conservation hypothesis; but as Joule himself remarked, there were no such proofs "as were sufficient to cause it to be admitted into Science without further enquiry". These proofs his own painstaking experiments amply supplied. Even if he had "nothing but hundredths of a degree" with which to prove his case, Joule convinced even if he did not rouse the scientific world. Kelvin and Helmholtz between them, in the years immediately following 1847, explored the theoretical problems connected with the law of conservation of energy, and Rankine, Clausius and Kelvin developed the dynamical theory of heat. Thomas Young introduced the term 'energy' so early as 1801, pointing out with respect to the product mv^2 that "many of the sensible effects of motion, and even the advantage of any mechanical power, however it may be employed, are usually proportional to this product". Rankine introduced the term 'potential energy' and Coriolis (1844) and Poncelet (1874) both made use of the term 'work'.

Looking back over this period, one is struck with the attempts of many physicists to get at the physical nature of energy, much as the chemists sought to discover some ultimate key to the nature of matter. To these the quantitative relationships appeared inadequate. But it had to be admitted, as Fleming then wrote, that "We have no experience of Energy apart from Matter of some kind, nor of Matter altogether devoid of Energy . . . The moment . . . that we pass beyond these merely quantitative ideas and proceed to ask further questions about the nature of Energy and Matter we find ourselves in the presence of inscrutable mysteries . . ." These physicists forgot that the concept of energy arose from preoccupation with the idea that there are permanent elements in Nature; its formulation was from the first mathematical and rested on the study of isolated systems.

Energy is essentially a European concept. So far as one can tell, the Greeks came no nearer to it than to recognize some sort of resistance to motion that had to be overcome. Aristotle's influence was behind a purposive or teleological view of Nature which depicted events as drawn towards their ends. There have been recrudescences of the teleological view ever since the seventeenth century, when it seemed to have been finally banished, but in mechanics the only noteworthy example is Maupertuis's formulation of the Law of Least Action. It proved difficult to find a method of expressing the determinism of events, however, and Jordanus and da Vinci, for example, early students of mechanics, had only hazy ideas of force and perhaps of work. But even for da Vinci in the fifteenth century perpetual motion was an absurd illusion. Stevin in 1606 assumed the impossibility of perpetual motion in mechanics, but he did not extend the assumption to all other fields. Even so acute a thinker as Huygens admitted that it might be possible in some field although not in mechanics.

In looking for the origination of the mathematical concept of energy, one's hopes are raised by a perusal of Galileo's work. Since he established the equations

$$v = gt,$$
$$s = \tfrac{1}{2} gt^2,$$
$$\text{and } gs = \tfrac{1}{2} v^2,$$

it is easy, by multiplying each of these by m, to obtain (in the usual symbols)

$$mv = mgt = Pt \quad . \quad . \quad . \quad (1)$$
$$ms = \tfrac{1}{2} mgt^2 = \tfrac{1}{2} Pt^2 \quad . \quad . \quad (2)$$
$$\text{and } mgs = \tfrac{1}{2} mv^2 \quad . \quad . \quad . \quad . \quad (3)$$

Mach pointed out that this derivation makes the last equation appear more remote, less fundamental, than the other two. This may well have been the view of the men of science of the seventeenth century. It is significant that Descartes used matter and motion alone in his cosmic theory—the first original synthetic account since Aristotle. The chief point of Descartes's work in this connexion was his conviction that something causal is conserved. Since his cosmology was a kind of extended kinetics, he had no use for any form of potential energy: the universe was conceived somewhat after the manner of a quantity of gas in a thermally isolated vessel. But the concepts

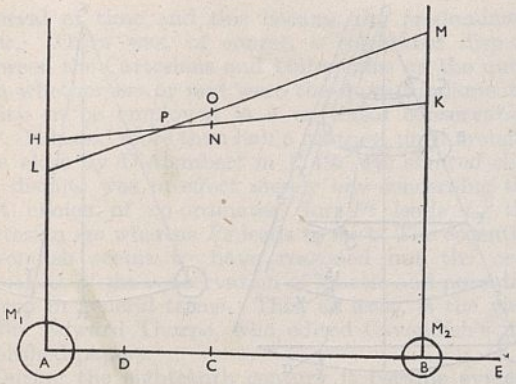

Fig. 1.

Descartes introduced were not defined satisfactorily, and his treatment of the fundamental subject of elastic collision was hopelessly erroneous.

Huygens (1629–95) was the first man of science whose investigations seriously advanced the idea of energy in mechanical systems. His work requires more detailed study because he followed Galileo rather than Descartes in seeking to render a small region of fact quantitatively intelligible and not to make all facts derivative from one central philosophy. In 1652 he commenced work on the study of horizontal direct impact. Unfortunately, his complete work only appeared posthumously. Using experiment much as Galileo had done, he built up a series of propositions which embraced a correct treatment of the conservation of momentum and of kinetic energy for this limited form of motion. Beginning with Galileo's concept of inertia, Huygens made the assumption that for bodies of perfect elasticity, equal masses meeting in a straight line with equal and opposed velocities recoiled with those velocities unchanged in magnitude but reversed in direction. He was then able to show that for unequal masses, in the case where the masses are inversely as their velocities, that is

$$\frac{m_1}{m_2} = \frac{v_2}{v_1},$$

each mass again rebounded with its velocity reversed. In deducing this theoretically he had to add to his preliminary assumptions the important principle that the centre of gravity of a system of bodies cannot rise as a result of any motion of the bodies under gravity. This was an assumption which Huygens regarded as self-evident and one which he made use of throughout almost all his work in mechanics. That its theoretical value was unknown to English men of science is evident from the surprise of Wren, Wallis and others, who witnessed experiments on impact using the ballistic pendulum in Huygens' rooms in London in 1661 and found that Huygens had a method of calculating the heights to which the pendulum bobs would ascend after collision.

In the particular theorem referred to, Huygens used the figure shown in Fig. 1.

The mass m_1 has a velocity $v_1 = AC$ and m_2 has $v_2 = BC$. After rebound, suppose m_1 possesses a velocity $v_1' = CD$, less than CA. Then m_2 must, by the conservation of momentum, possess $v_2' = CE$, for $DC + CE = AC + CB$ (the relative speeds of approach and separation being equal, as Huygens knew). The vertical descents required to give m_1 and m_2 their original speeds were HA and KB respectively, such that

$$\frac{HA}{KB} = \frac{AC^2}{CB^2}.$$

After impact these become AL and BM, such that,

$$\frac{AL}{AH} = \frac{CD^2}{CA^2} \quad \text{and} \quad \frac{MB}{KB} = \frac{CE^2}{CB^2}.$$

When first elevated, m_1 and m_2 have their common centre of gravity at N. After impact this becomes O (assuming the new velocities), for $m_1.AC = m_2.CB$

$$\text{and } \frac{HN}{NK} = \frac{AC}{CB} = \frac{LO}{OM}.$$

It is easy to show[3] that O must be higher than N. This contradicts Huygens' fundamental principle; hence, he argued, the speeds of approach and separation must be equal for m_1 and m_2. From this point Huygens' work shows a clear development culminating in the recognition of the conservation of energy within mechanical systems. The first step comes in a later theorem on impact, where he showed that Σmv^2 is constant: by using the square of the velocity the difficulty of taking account of signs vanishes. Huygens himself regarded the quantity mv^2 (called the *vis viva* by Leibniz) as more fundamental than the quantity of motion mv.

A closer approach to an equation for energy was, however, made in his work on the centre of oscillation of a compound pendulum. Here Huygens began by considering the simplest case of an inflexible weightless bar carrying the weights D at the lower end and E at some other point (Fig. 2). If the weights and their distances from the axis of oscillation are given, where is the centre of oscillation? Huygens' first method[4] of attacking this problem was to suppose the pendulum to be withdrawn to the position ABC. On swinging back to the lowest point, E and D are supposed to meet the respectively equal masses G and F. By the laws of impact the collision will immobilize the pendulum and the masses G and F then move with the speeds belonging to E and D at the instant of collision. In calculating the heights which G and F can attain, all that Huygens assumed was his fundamental principle that the centre of gravity does not ascend higher than it was when the pendulum was in the position ABC.

In his published work Huygens abandoned the device of the impact against equal masses which are unconnected and simply supposed the masses to be freed at some point in their paths. In the general case where there are masses A, B, C, . . . on the linear pendulum, distant e, f, g, . . . from the axis D, and these can ascend separately through the

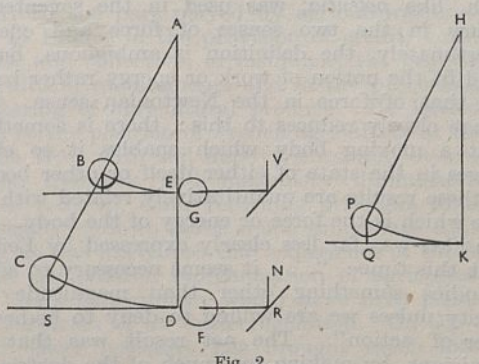

Fig. 2.

heights α, β, γ, . . . then the centre of gravity (distant d from D) must ascend a distance z and the centre of oscillation (distant x from D) a distance y. It seemed to Huygens that he might assume the equality of the swings of a compound pendulum.

By similar triangles, $\frac{x}{d} = \frac{y}{z}$ or $z = \frac{yd}{x}$.

Using $v^2 = 2gs$ we get:

$$\frac{x^2}{e^2} = \frac{y}{\alpha}.$$

Hence $\alpha = \frac{ye^2}{x^2}$; and similarly, $\beta = \frac{yf^2}{x^2}$, $\gamma = \frac{yg^2}{x^2}$.

The work done is $A\alpha + B\beta + C\gamma + \ldots$

or $$\frac{Ae^2y + Bf^2y + Cg^2y + \ldots}{x^2}.$$

But this is also given by $(A + B + C + \ldots)\frac{yd}{x}$.

Whence
$$x = \frac{Ae^2 + Bf^2 + Cg^2 + \ldots}{Ad + Bd + Cd + \ldots} = \frac{Ae^2 + Bf^2 + Cg^2 + \ldots}{(a + b + c + \ldots)d} = \frac{\Sigma mr^2}{\Sigma mr}.$$

All this—except the term work—is to be found in Huygens' great "Horologium Oscillatorium" of 1673[5]. It is clear that Huygens has in effect combined his fundamental principle with Galileo's relation that the velocity acquired in descent under gravity varies as the square root of the height. The speeds of suspended particles at any point in the path were then compared with the corresponding heights of descent, a procedure which really amounts, in combination with the conservation of *vis viva*, to the application of the law of conservation of energy in mechanics. It is possible from this starting point to obtain an equation showing the constancy of the sum of the kinetic and potential energies for an isolated system, namely, $T + V = H$, in the form given by Lagrange.

If any doubt remained as to the importance of Huygens' contribution to the subject of energy it must surely be dispelled by his own clear statement of his ideas. For in his MS. of 1693, two years before his death, there appears the following passage (translated from the Latin): "In all movements of bodies whatsoever, no force is lost or disappears without producing a subsequent effect for the production of which the same amount of force is needed as that which has been lost. By force I mean the power of raising a weight. Thus, a double force is that which is capable of raising the same weight twice as high"[6]. The word for force in this passage is *vis*, a word which, like *potentia*, was used in the seventeenth century in the two senses of force and energy. Unfortunately, the definition is ambiguous, but it would fit the notion of work or energy rather better than that of force in the Newtonian sense. The passage clearly reduces to this: there is something about a moving body which enables it to effect changes in the state of either itself or other bodies, and these results are quantitatively related with the cause which is the force or energy of the body. The same idea was far less clearly expressed by Leibniz about this time: ". . . it seems necessary to admit in bodies something other than magnitude and velocity unless we are willing to deny to bodies all power of action". The net result was that the Leibnizians, by making too much of the doctrine of

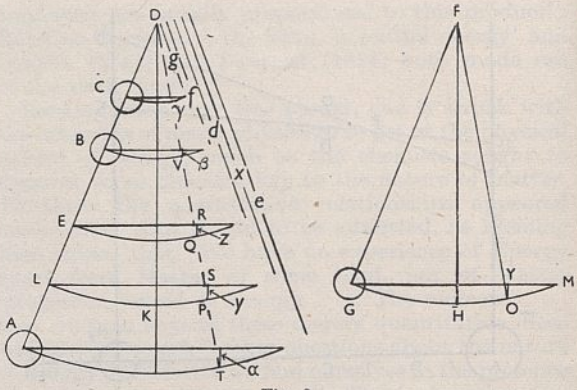

Fig. 3.

the conservation of *vis viva* (really established by Huygens), caused a good deal of metaphysical fog to gather about the whole subject. Fortunately, Daniell Bernoulli perceived whence this metaphysical fog had come. Returning to Huygens' point of view, he formulated the principle of the conservation of *vis viva* as that of an "equality between the actual fall and the potential rise".

Leibniz had, on the whole, a disappointing influence. His own preference was for a world-system based on a principle of conservation of force, which latter quantity he proposed to estimate through the product mv^2. ". . . there is always a perfect equation between the full cause and the entire effect", he wrote, ". . . each complete effect is equivalent to its cause". Then, as if forestalling the retorts of later readers, he admitted "this axiom is altogether metaphysical"! It was, however, justified in his opinion on account of its use in "reducing forces to a geometrical calculus".

When we turn to Newtonian mechanics, there is in this field no great clarification comparable with Newton's treatment of other concepts. There is a passage in the "Principia" dealing with machines which states: ". . . if we estimate the action of the agent from its force and velocity conjunctly, and likewise the reaction of the impediment conjunctly from the velocities of its several parts, and from the forces of resistance arising from attrition, cohesion, weight and acceleration of those parts, the action and reaction in the use of all sorts of machines will be found always equal to one another". Tait considered that this might be reduced to the statement: work done on the machine is equal to potential energy stored up, or work done is equal to increase in kinetic energy when no energy is stored up. The general impression of Newton's writings is, however, definitely against Tait's view that Newton should be credited with a great part of the responsibility for the principle of the conservation of energy. Elsewhere Newton commented apropos the Cartesian theory: ". . . motion is much more apt to be lost than to be got". Newton did not regard the cosmic machine as perfect, and supposed that an ethereal medium supplied the necessary increments of motion to replace that lost.

It was very unfortunate that Newton and Huygens did not collaborate and that, on the contrary, profound differences of view lay between them and their followers[7]. The concept of work performed might, through Huygens' clear example, have become fundamental in mechanics long before it did. Instead, Newton used the idea of force applied for a given

interval of time and this became the predominant view. There was, of course, a celebrated dispute between the Cartesians and Leibnizians on the question whether mv or mv^2 were the more fundamental entity to be employed in a universal conservation law. It lasted more than half a century, until brought to a close by D'Alembert in 1743. He showed that the dispute was in effect merely one concerning the best choice of co-ordinates, for Pt leads to the Cartesian mv whereas Ps leads to mv^2. The eccentric Cavendish seems to have reasoned out the consequences of the conservation of kinetic and potential energy in general terms. This, at least, is the view of Sir Edward Thorpe, who edited Cavendish's unpublished papers.

During the eighteenth century it became evident that physics could not be unified on kinetics; the identities of mechanics had to be traced in other phenomena. In 1787 Rumford (Benjamin Thompson) showed that there was no significant change in weight when water turned to ice; the hypothesis of the material nature of heat (and light) had soon to be given up. Text-books of physics commonly deal with these matters, though, so far as I know, they never give any experimental details for Davy's melting of ice by friction, an experiment which, on the face of it, has few claims to serious consideration[8].

[1] NATURE, **149**, 688 (1942)
[2] "Memoir of James Prescott Joule", 17 (1892).
[3] "Oeuvres Complètes", **16**, 50–64.
[4] "Oeuvres Complètes", **16**, 414.
[5] "Oeuvres Complètes", **18**, 259.
[6] "Oeuvres Complètes", **18**, 554.
[7] NATURE, **146**, 511 (1940).
[8] Andrade, E. N. da C., NATURE, **135**, 359 (1935).

CO-OPERATIVE SYSTEMS IN EUROPEAN AGRICULTURE

A YEAR ago the Division for the Social and International Relations of Science of the British Association held a conference on post-war European agriculture, which formed one of a series of conferences on post-war reconstruction. Since then a good deal of work has been done on the problems of agricultural reconstruction both by the governments of Allied countries in London and by inter-allied bodies like the Leith-Ross Committee. It has become clear that important as will be the material help which can be brought into the liberated countries from outside—the seeds, implements, fertilizers, even livestock, which will be required to restore their impoverished farms—the effectiveness of such aid will depend, both in the period of relief and the longer period of reconstruction, on the effectiveness of internal organization and the extent to which agriculture is integrated technically, economically and socially.

It was with this consideration in mind that the British Association called a second conference on April 16 and 17, 1943, to discuss the most widespread of the methods of agricultural integration in Europe, the co-operative system. The conference was welcomed by Sir Richard Gregory on behalf of the British Association. Sir John Russell, in his opening address, recalled how speakers at the previous conference, confronted with the agricultural alternatives of national self-sufficiency or a high standard of living, and of large or small farms, had, almost without exception, declared for the small farm and a high standard of living, especially of nutrition. The present conference accepted, and would have to deal with, the consequences of that decision. The disadvantage of the small farm is the overwhelmingly hard labour it demands, which bears particularly heavily upon the women. The small farm lacks machinery to lighten that toil, it lacks the capital needed to carry the farmer through the long cycle of agricultural production, and it is frequently burdened with debt. Methods of marketing are primitive and wasteful. It is the testimony of practical men that co-operation has provided a remedy for these evils. It has in addition given a technical training to the small farmer, raising his standards of cultivation and putting him in touch with modern knowledge.

The first session was devoted to the experience of Western Europe, beginning with the British Isles. Mr. Hewitt, himself a farmer and the chairman of a farmers' co-operative society in the west of England, took the co-operative supply of agricultural requirements as his main theme. He showed the large part which agricultural co-operative societies play in the handling of requirements such as seeds and feeding stuffs, grown by one set of farmers and used by another, and instanced, in particular, the distribution of the famous Aberystwyth strains of grasses and clovers and of 'once grown' seed potatoes. He looked forward to the end of the War and the urgent call from the devastated countries of Europe for agricultural requirements and supplies of all kinds, which it would be the great privilege and very pleasant duty of British farmers to meet with abundant supplies of the best qualities of seeds, seed corn and seed potatoes.

The application of co-operation to the problems of the Scottish crofters, the nearest approach to a peasantry to be found in the United Kingdom, was described by Mr. C. J. M. Cadzow, secretary of the Scottish Agricultural Organisation Society. He described how, following on the widespread failure of the crofters' potato crop in 1938, his Society had undertaken the distribution of seeds and fertilizers through the clerks to seven hundred grazing or township committees. All requirements were those recommended by the agricultural colleges as suitable to the district concerned. The Society had also arranged for the sale of the crofters' wool. The co-operative movement in Ireland, the remarkable pioneer work of Horace Plunkett and his associates guided by the formula "Better farming, better business, better living", and the world-wide influence of the movement, great out of proportion to its material achievements, were described by Miss Margaret Digby.

M. André Dulin, of the French National Committee, described the part played by agricultural co-operation in France in the provision of credit, both individual and collective, in insurance, the provision of agricultural requirements and in the processing and marketing of agricultural produce. He looked forward to the position of French agriculture at the end of the War, with soil impoverished and overrun by weeds, livestock and machinery diminished and labour reduced, since returning prisoners would be physically unfit to make much immediate contribution. It was likely also that experience of the failure of all the boasted reorganization of agriculture by the Vichy Government would have bred pessimism and suspicion of all State regulation. On the other hand, sheer necessity has brought much informal co-operation in the use of implements and transport

facilities. The hope of the future lay in the professional reorganization of agriculture on the lines of voluntary co-operation.

M. Borremans, agricultural attaché to the Belgian Embassy, concluded the session with a sketch of agricultural co-operation in Belgium under the leadership of the well-known Boerenbond Belge, with its simultaneous concern for technical advance and instruction, social welfare and economic prosperity.

The second session was devoted to the northern countries lying about the North Sea and the Baltic, all having in common a strong dairy element in their co-operative economy. The chair was taken by Dr. C. R. Fay, reader in economic history in the University of Cambridge. Agriculture in these countries, he said, is based on the family farm, but it is not a peasant economy ; it is the family farm, commercialized, mechanized and specialized, and the conditions of its success are two : State guardianship of the land unit, which can neither be merged in the large estate nor fragmented into the dwarf holding, and co-operative economics. Adjustment to an export market is not the secret of Scandinavian success in co-operative organization. It must be sought rather in the high intelligence of the participants, based on high education, in democratic feeling, and in the integrated and dynamic character of the movement. All this can be seen not only in the countries represented at the conference, but also in Finland and Iceland.

Mr. P. A. Moltesen, agricultural attaché to the Danish Legation, described the spontaneous origin of Danish co-operation and its specialized character, with one function for each type of society, and its corollary, multiple membership by each farmer, and the final linking of all societies in a national federation which exerts considerable influence upon the economic policy of the country. Mr. S. Krolikowski (Poland) spoke of co-operation as the means by which the peasant farm can effect the difficult transition between self-sufficiency and participation in a capitalistic economy, and can combine individual land ownership and cultivation with collective action in purchase, manufacture and sale. Co-operation, again, is the best channel of technical instruction for the farmer and the means of stimulating him to adopt more scientific methods. Before the War, 50,000 students were accommodated in co-operative schools. During the War, though their educational work has ceased, there is reason to believe that the agricultural trading co-operatives are still in use and developing, since they were too strong for the enemy to destroy without an adverse effect on the production-level. After the War their part would grow still more, in the organization of food supplies and the replanning of agricultural economy. Mr. Fjelstad, minister in the Norwegian Cabinet, sketched the development of co-operation in Norway both in farming and forestry, where co-operative insurance and the organization of a fireguard service have saved considerable national assets from destruction. He described how the already developed co-operative dairy system enabled the Norwegian milk marketing board to be organized from the bottom up and not, as in Great Britain, from the top downwards. Mr. Gerritzen, agricultural attaché to the Netherlands Embassy, spoke of the many-sided co-operative organization of his country, the part it has played in the development of the famous market garden industry of the Netherlands, and its bold and successful entry into the beet sugar industry. In the discussion, other speakers referred to the co-operative movements of the Baltic States and Iceland.

A further session of the Conference was devoted to a somewhat different aspect of the immediate post-war problem, the emergency distribution of food. In this the farmers and their organization have a part to play, since every country must rely fundamentally on the food which can be produced within its own borders. But in the first few months of liberation every European country will be dependent on emergency supplies hurried into its towns and industrial areas—sometimes even into its rural areas—from overseas. These supplies will have to be distributed, as will those delivered from the country as soon as normal transport has begun to work. Distribution in such emergency conditions may not be easy to improvise and the normal channels of trade may be blocked or unsuitable. In these circumstances, the existence of a consumers' co-operative movement, whether catering mainly for the industrial population, as in Great Britain, or of a rural character as in many Continental countries, may well be of the highest value to the relief administrator or newly restored national government. It has the machinery of distribution, it serves public ends and enjoys the confidence of its members.

Mr. J. McFadyen, of the Co-operative Wholesale Society, opened the session with an account of the experience of the British co-operative movement in distributing foodstuffs in periods and areas of heavy bombing. He described the way in which neighbouring societies have come to one another's assistance. In one case where all the bakeries of a city were temporarily put out of action, nearly two thirds of the necessary supplies were sent in from the co-operative bakeries of other towns and distributed both to co-operative members and others. Repairs to co-operative premises anywhere were the immediate concern of a central C.W.S. building department. Dispersal of essential stocks is made easy by the wide network of co-operative societies and the mutual understanding which exists between them. This account of actual and recent experience was followed by a survey from Mr. R. A. Palmer, acting chairman of the International Co-operative Alliance, of the actual resources in productive and distributive machinery, as well as in membership, of the co-operative movements in Europe, resources which, in spite of the restrictive and in some cases even destructive action of the occupying enemy authorities, will, it is hoped, be available to those who have to administer the distribution of food in the first difficult weeks after liberation.

Precisely how difficult those weeks may be was made plain in an address by Mr. J. Kwapinsky, Minister of Social Welfare in the Polish Government, who described the appallingly low level of rations which have been in force in Poland for a long time past : rations of 600–800 calories daily for the Polish Christian population and of less than 300 calories for the Jewish populations, in both cases below minimum physiological need. Relief of the town populations of Poland would have to be given with all possible speed. The enemy has destroyed private trade, and controls food distribution largely through the pre-war co-operative system, which is dominated but not destroyed. The supervision of food distribution in the post-war period will have to be transferred to the revived Polish local authorities, but for actual distribution in emergency circumstances, the co-

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operatives would be the most elastic system with the necessary commercial knowledge and storage and transport facilities. On their commercial efficiency in collecting home-grown food, in which agricultural co-operatives would also play their part, would depend in large measure the successful mastery of the 'black market'. On the efficient distribution of food from abroad would depend the speed of agricultural reconstruction, since no reconstruction could be attempted until such phenomena as the reckless slaughter of livestock for food has ceased. These conclusions were reinforced on the administrative side by Mr. R. Kreisky, speaking for Czechoslovakia, and on the nutritional aspect of the problem by Dr. Magnus Pyke of the British Ministry of Food, who described the very interesting inquiry into nutritional conditions in an industrial suburb of Madrid, carried out by the Rockefeller Foundation in the summer of 1941. This, while access to occupied Europe was impossible, provided the best indication of the sort of conditions which are likely to be found among the liberated peoples. The main conclusion was that the fundamental condition was a shortage of calories rather than deficiency of any particular constituent. The diet was pitiably scanty but not grossly unbalanced.

At its last session, the conference returned to the agricultural and productive, rather than the distributive, aspect of co-operative organization, and considered the experience of countries in Eastern Europe, Czechoslovakia, Yugoslavia, Greece and the Soviet Union. Dr. Bicanic (Yugoslavia) looked beyond the organization of co-operation on the 'classic' pattern of local and voluntary association, already developed with a varying measure of success in the different regions of Yugoslavia before the War. He envisaged a type of co-operation which would embrace the entire village community, deriving from the old Slav principle of the 'Zadruga', or family group, which is still a living force. Such a village co-operative would not be a collective in the Russian sense, but it would carry out a complex of services usually divided among separate co-operative societies, local authorities or individuals, or in many rural communities wholly neglected. A movement in this direction was developing spontaneously before the War; the post-war task would be to foster and extend it. Mr. Hodza (Czechoslovakia) showed how the strength of the co-operative movement had been built up by voluntary effort in the days of Austrian and Hungarian rule, and how under the Republic it was able to take a leading place in national economy. Mr. Polychroniades (Greece) looked to the reconstruction of Greek agriculture and the raising of the peasants' standard of living through a much more extensive application of co-operative methods. Dr. Barou concluded the review of European experience with an account of the wholly different application of the co-operative principle in the Soviet Union, where collective ownership of land and collective application of labour have replaced the individual peasant farm and, with the increased size of the unit and the State control of banking and commerce, the ordinary economic functions of the co-operative have disappeared.

The final impression left by the Conference was of the strength, ubiquity and diversity of the co-operative movement in Europe, and of the extent to which it is, and will doubtless remain, the principal instrument of raising both the technique of European farming and the social conditions of the peasant.

THE IMPERIAL INSTITUTE

JUBILEE OF OPENING BY QUEEN VICTORIA

By DR. H. A. TEMPANY, C.M.G., C.B.E.

ON May 10 the Imperial Institute will have reached the fiftieth anniversary of its opening by Queen Victoria. In normal times such an event would doubtless have been marked by some public ceremony appropriate to the occasion, which possesses, in certain respects, a unique historical interest. Under war-time conditions this is precluded, of course, but at least the event warrants some examination in brief retrospect of the history of the Institute and the part which it has come to play in public affairs to-day.

The genesis of the Institute occurred in 1887, when its foundation as a memorial of the golden jubilee of Queen Victoria was undertaken. Its first president was the then Prince of Wales, afterwards Edward VII, under whose direct guidance the Institute was organized. It is, therefore, a relic of the zenith of the Victorian era, those spacious days when the political skies appeared serene and unclouded and there was scarcely more than a hint of the grievous troubles which were to assail the world during the ensuing half-century.

The general objects which the Institute was founded to fulfil were to promote the development of the British Empire and to foster relationships between its numerous component territories and the mother country. Specifically, it was intended to promote the development and utilization of the resources of the Empire, to foster new forms of production as well as the processing and marketing of Empire products, to collect and disseminate information concerning the Empire, its peoples and its products, and later it was instructed to advise on the availability and utilization of its raw materials for Imperial defence. Concurrently it was intended that it should collect samples and specimens of Empire products, and establish and maintain exhibition galleries open to the public, which would serve as an indication and a reminder of the character of the Empire and of the vast resources which it contained. It was also envisaged that the Institute should serve as a link between the various parts of the Empire and a focus and a meeting-place from which would emanate new projects and schemes in connexion with Imperial development.

The concept had at that time a certain novel grandeur, and, associated as it was with the immense and now almost legendary affection, esteem and veneration in which Queen Victoria was held, it made an immediate popular appeal; as a result the large sum—for those days—of £400,000 was raised from official and private sources to launch the project. Of this sum £250,000 was devoted to erecting the impressive building in South Kensington, in which it has ever since been housed; the remaining £150,000 was constituted into an endowment fund.

The first director was Sir Frederick Abel; he was succeeded in 1903 by Prof. (afterwards Sir Wyndham) Dunstan, who retired in 1925 and was succeeded by Sir William Furse. The present director, Sir Harry Lindsay, succeeded Sir William Furse in 1934.

After its inauguration the wave of enthusiasm evaporated, while the available revenue from the endowment fund and other sources proved inadequate

to enable it to fulfil its functions. Consequently it had to face financial difficulties. In 1900 a part of the building was made over to the University of London, which has continued to occupy it until the present time.

In 1905 the Institute was placed under the control of the Colonial Office and so remained until 1925, when its position was reviewed and it was given its present constitution under the Imperial Institute Act of 1925.

Under this the Institute is vested in a statutory Board of Trustees, while its governance is entrusted to a Board of Governors, of which the president is the Secretary of the Department of Overseas Trade, and membership comprises representatives of the Dominions and India and of the Treasury, the Board of Trade, the Colonial Office, the Ministry of Agriculture and Fisheries, the Department of Scientific and Industrial Research as well as of the Royal Society and certain other scientific and commercial bodies.

At the time of its reconstitution, the Institute absorbed the Imperial Mineral Resources Bureau, which had been previously operated as a separate organization. The revenues of the Institute are now derived from the endowment fund, from grants made by the United Kingdom Treasury and by the Governments of the Dominions, India, Burma and the Colonies and Mandated Territories as well as from fees and rentals. The total income and expenditure balance at about £48,000 per annum. The bulk of the income is now contributed by Empire Governments.

The history of the Institute has thus been somewhat chequered; it was only after a rather prolonged initial period that it settled down to the fully efficient discharge of its functions. These nowadays comprise, on one hand, laboratory investigation of Empire raw materials, and the collection and dissemination of technical and commercial information concerning the raw and semi-manufactured products of the Empire, and on the other, the maintenance of its exhibition galleries and the related educational services designed to provide instruction to the general public concerning the British Empire, its peoples, its products and its general character.

In regard to the former, the Institute has during the fifty years of its existence succeeded in building up an information service which is almost certainly unrivalled in its own particular sphere. It is organized in two departments, a plant and animal products department and a mineral resources department, each under the charge of a scientific officer; each department is provided with a technically trained staff, all of whom have the standing of graduates of a British university or possess equivalent qualifications. The staffs in both cases are again subdivided into an intelligence section and a laboratory section. The former is concerned with the collection, recording and dissemination of information, and with replying to the great number of technical inquiries which flow to the Institute from all parts of the Empire, the latter with the examination and technical trial of materials submitted to the Institute. A careful and extensive card-index system epitomizes the sources of information about raw materials of all kinds. The Institute is, under its constitution, debarred from undertaking fundamental research, but is expected to investigate and report upon materials submitted to it. As many of the products submitted are novel in character and as at times their examination may call for the development of new technical methods, the distinction between investigation and research may, it is anticipated, at times present not inconsiderable difficulties.

The work of the departments is assisted by two advisory councils, one dealing with plant and animal products, the other with mineral products; while associated with them are fifteen consultative committees each dealing with a special product or group of products, the membership of which is composed of scientific, technical and commercial authorities on the particular subject with which each committee is concerned. The set-up thus provided is well adapted to provide an efficient advisory service, and it can be truthfully said that, at any rate of recent years, no query on a subject falling within the scope of the Institute's functions has been received to which an answer has not been returned embodying the latest available information.

The results of more important inquiries are published in the quarterly *Bulletin* of the Institute, while an extensive series of monographs on a wide range of subjects is also issued. Special mention should also be made of the annual statistical summary of the mineral industry of the Empire and foreign countries issued by the Institute, which enjoys an international reputation.

The library of the Institute also deserves special mention; it contains more than 75,000 volumes, including all technical journals relating to its work; its facilities are freely available to workers.

On the publicity side, the Exhibition Galleries of the Institute are noteworthy, for, in addition to providing a range of exhibits and samples which illustrate with a wealth of detail the products and resources of Empire countries, by means of photographs and admirably devised and mounted dioramas they enable the inquiring visitor to obtain a reasonably accurate impression of conditions in many parts of the British Commonwealth. Associated with this is a library of Empire films and lantern slides, which are available for loan to schools and other institutions, while arrangements exist for the provision of lecturers to deliver discourses on a wide range of subjects connected with the Empire. The attack which the Institute has been able to make on the widespread ignorance in the United Kingdom concerning conditions in the Dominions, India and the Colonial Dependencies indeed represents one of its major achievements. During 1942, for example, more than 4,400 films and 836 sets of lantern slides were issued to borrowers for display at a great variety of schools, adult organizations, hospitals, army, navy and air force units and many others. Nevertheless, considerable though this achievement has been, it needs to be multiplied to a great extent before the position can be considered as entirely satisfactory.

During the War, the activities of the Institute have of necessity been diverted to some extent from their normal channels. A number of members of the technical staff have been temporarily transferred to the Ministry of Supply and other temporary war-time organizations of Government, while twenty-two of the technical and general staff are serving with the Armed Forces. To those that have been left has devolved the duty of maintaining its activities, which have not appreciably diminished, although there has been some shift in the nature of the inquiries received, many of them being concerned with finding alternative sources of supply of commodities

which have been cut off as a result of war conditions. Until recently, also, the Exhibition Galleries have been closed to the general public, although facilities have been accorded for visits by organized parties, of which there have been many applications. On the other hand, the demands for loans of films, lantern slides and the provision of lecturers have, as might be expected, increased.

After fifty years, one is entitled to ask how far can the Institute claim to have fulfilled the objects with which it was founded. Certainly in some respects it has not entirely fulfilled them; thus it has never been able to play the predominant part as a centre for the organization of intra-Imperial activities which was originally foreseen for it. No doubt this is partly the result of the preoccupation of those responsible for its destinies in its early days with the immediate difficulties of finance and management. It is true that the Institute has attracted to itself a number of related activities which although they are operated as independent units still come within its general ambit; as examples may be mentioned the office of the Trade Commissioner for Burma and the investigational work carried out by the London Advisory Committee for Rubber Research. It is also true that a much larger number of new developments have come into being, covering a wider field, which are operated independently of the Institute; examples of these are the Imperial Agricultural Bureaux and the Imperial Economic Committee; the Dominions, India and many of the Colonial Dependencies have also set up information agencies and bureaux which operate independently of the Institute. There is free and friendly collaboration between the Institute and all these organizations, but it seems reasonable to suppose that the original intention, when the Institute was first envisaged, was that all activities of this nature should come within the ægis of the Institute.

It is a matter for speculation whether the course which events have actually taken may not in the long run have been preferable to that originally envisaged, and in any event the position is now firmly established.

On the other hand, the Institute has unquestionably amply fulfilled the role which was laid down for it as a centre for the investigation of raw materials and the collection and dissemination of information concerning the products of the Empire, while its publicity and educational work within the limits of the resources available could scarcely be bettered, although there is probably scope for their considerable further extension provided the necessary finance could be provided.

On balance, therefore, it must be admitted that the Institute has gone far towards achieving the expectations which were entertained when it was founded; it occupies a unique position and renders services of great value in many directions which would otherwise be unprovided. It may indeed be said that, as it stands to-day, it is a not unworthy memorial of the great Queen whose golden jubilee it was designed to commemorate. It is to be hoped that during the next fifty years its progress will continue unimpeded, and that in the post-war era there will occur the further expansion of its activities and utility for which abundant opportunity exists.

OBITUARIES

Mr. E. Heron-Allen, F.R.S.

EDWARD HERON-ALLEN, who was born in London on December 17, 1861, was educated at Harrow, where his natural aptitude for microscope work was roused. Necessity, however, led him to study law, and in 1884 he was admitted a solicitor. He followed his profession very successfully for some years, but his inclinations lay in other directions and were always asserting themselves. Ultimately he was in a position to follow them completely, and thenceforth the Foraminifera received his main attention.

Heron-Allen had, however, already published a "Prolegomena towards the Study of the Chalk Foraminifera . . ." in 1894, but from about 1908 onwards for the next twenty-five years the results of his researches flowed fairly regularly. Throughout the greater part of that time, Heron-Allen's work was done in close association with Mr. Arthur Earland. Their papers covered not only British foraminiferal faunas (for example, Selsey, the North Sea, west of Scotland, Clare Island, Plymouth) but also those of far distant parts of the world, such as the Kerimba Archipelago and areas visited by the *Terra Nova* and *Discovery* expeditions. Nor were older faunas ignored, and publications on the Foraminifera of the Eocene of Biarritz (1919) and the Miocene of Moorabool, Victoria, Australia (1924) ensued. The room in the Zoological Department of the British Museum (Natural History) allotted to the two partners became the store-house of a magnificent collection of Foraminifera, to which Heron-Allen added other historic collections. It also housed a unique library concerning the group, a library which contains rare works and original MSS. and drawings of Foraminifera. Heron-Allen generously presented these to the Museum some years ago. He was elected a fellow of the Royal Society in 1919, was a member of numerous other societies, and during 1916–18 was president of the Royal Microscopical Society.

Although most of his work was on systematics, Heron-Allen was interested in other aspects of the Foraminifera, and he read a paper on their bionomics to the Royal Society in 1915. For him the Foraminifera were essentially living creatures, and he epitomized this in a favourite lecture of his (and he was a fascinating lecturer) on purpose and intelligence in the Foraminifera. In his approach to systematics Heron-Allen was a faithful disciple of H. B. Brady, and his classification of the Foraminifera was based on the one used in that author's memorable *Challenger* Report. If, for a long time, he was impatient of the many new genera and species erected by oil-palæontologists, it was because so many of them, especially at first, were the product of immature work and scant knowledge of variation within even well-known and abundant species. He was also initially sceptical of the claims by oil-palæontologists of the value of the Foraminifera in the search for oil, though, when the basis of their work was explained to him, his attitude became much more sympathetic to them and to the changes in foraminiferal nomenclature that have been made.

But Heron-Allen was a man of great vitality which expended itself in more than one way. For many years he lived at Selsey and he wrote on its geology, archæology and history; for example, "Selsey Bill: Historic and Pre-Historic", published in 1911. He was no mean horticulturalist, and in 1928 was president of the National Auricula Society. The violin was a life-long attraction, and so early as 1882 he had published an essay on violin-making. Witty, cultured and well read, Heron-Allen was an entertaining conversationalist, and he frequently pointed his remarks by an apt quotation from one of the many languages, classical and modern, which he knew. Of these, Persian held pride of place, and in 1898 he published a literal translation of the Bodleian MS. of the "Rubáiyat of Omar Khayyám", and in 1899 what was really a defence of the accuracy of Fitzgerald's well-known poetical translation. His many-sided character even found a place for palmistry and circus-riding while on a visit (1886–89) to America! He was district commissioner of Boy Scouts for South-west Sussex during 1910–19, while in 1918 his talents were used in the Staff Intelligence Department of the War Office.

As a friend Heron-Allen was staunch and generous, embarrassingly so sometimes; as an opponent, he was tough and unyielding. He typified in his person and character much of the late Victorian era, and he was a connoisseur in all that he took up. He was twice married. The tragic death of his younger daughter some years ago, when she was on the threshold of a promising zoological career, was a blow from which he never really recovered. Pneumonia took toll of his strength in the autumn of 1941, but his gay, fighting spirit never gave in. He died at his home at Selsey on March 28, and is survived by his wife and one daughter.

H. DIGHTON THOMAS.

NEWS and VIEWS

Hydro-Electric Development in Scotland

THIS is an opportune time for any information about rainfall and run off in the area comprised in the Hydro-Electric Development (Scotland) Bill now before Parliament (see NATURE, Feb. 13, pp. 177 and 187). Before us we have two reports and a memorandum by Captain W. N. McClean, founder and director of the River Flow Records Organization. The first report is on "River Flow Records of the Ness Basin 1929–1942". It describes the measurements made on the rivers feeding into Loch Ness and on the River Ness which drains the Loch. The report shows that the author has had to carry out his work with very limited means for equipment, maintenance and labour—clearly much of the latter has been voluntary. As the local authorities of Inverness have now agreed to maintain the author's records of the Ness Basin, their value is obvious. The second report, published in January last, is on "The Water Resources of Loch Quoich". This Loch feeds Loch Garry, which in turn feeds Loch Oich—a small loch near Loch Ness on the Caledonian Canal. Capt. McClean regards Loch Quoich as one of the sources of possible water-power and one of the gems of Scottish scenery. From records over some twelve years, he has no doubt that 15,000 kilowatts continuously can be developed here without considerable cost in dam construction for storage.

In his memorandum, Capt. McClean emphasizes the need for an Inland Water Survey of Great Britain to obtain correct hydrological data. He is not satisfied that rainfall statistics suffice; also he pleads for water records to be removed from all sectional interests. "There are," he says, "certain figures in the year-book ["Surface Water Yearbook" of the Inland Water Survey Committee appointed in 1935 by the Ministry of Health] which are grossly and intentionally wrong, and they would seriously affect the figuring out of the capacity of Power Schemes in an important area of Scotland. Other figures are just missing, because it might be inconvenient to divulge them." Enough has been said to give an idea of Capt. W. N. McClean's work and of the views he has formed. From facts disclosed in the Cooper Report, it follows that, in face of indifference and discouragement, pioneers like Capt. McClean needed much faith to carry on in all the vagaries of Scottish weather.

Avalanche Research in Switzerland

DURING the War of 1914–18 the number of avalanche fatalities among the armies in alpine regions was very high; in the period between the two wars, the influx of winter visitors to the Alps was followed by an alarming increase in accidents due to inexperience in snow-craft. It became obvious that a proper study of snow and avalanches was needed. There followed the private research work of individuals in many parts of Central Europe, who in turn were succeeded by more elaborately organized groups. In 1934 the Swiss authorities inaugurated a small research laboratory on the Weissfluhjoch close to the upper end of one of the Davos funiculars at a height of 8,500 ft. Under the direction of Dr. H. Bader, a crystallographer, and Dr. M. Haefeli, a civil engineer, much valuable work was carried out ranging from the purely scientific to the severely practical. The former has given us a great deal of new knowledge of the structure and behaviour of ice crystals, such as their rearrangement into regular order under stress with its clearly defined metallurgical analogy. Among the latter were such tests as the reaction of different types of snow to varying meteorological conditions and the resulting tendency to increase or decrease avalanche danger. The drawing together of the many threads of research followed and the results, combined with the investigations of practical men in the mountains, have been of the greatest value in bringing about a closer understanding of, and so mitigating, avalanche dangers. An excellent publication of some 340 pages was produced in 1939 recounting the field and laboratory work up to the end of 1938, and subsequent publications have also appeared.

Originally the governing body of the Weissfluhjoch station was the Swiss Commission for Snow and Avalanche Research under the chairmanship of the head of the Federal Forestry Department and working

in conjunction with many Swiss men of science, chief of whom was Prof. P. Niggli, the mineralogist, of Zurich, and including many experts in cognate subjects such as Dr. Mörikofer, of the Meteorological Observatory at Davos. It was largely financed from unofficial sources. A recent press notice stated that the Swiss Government has opened a new research institute on the Weissfluhjoch, which we assume to be a development of the earlier laboratory, perhaps more on the lines of the research institute on the Jungfraujoch. Possibly it means the commencement of its existence as a separate department of the Ministry for the Interior, with more adequate funds for effective research than its semi-private forerunner had been able to command.

Metallographical Research in Sweden

A SPECIAL committee appointed by the Swedish Government to investigate the need for new research institutions has recently submitted a proposal for the establishment of a new institute for iron and steel research, called the Metallographical Institute. In common with the new Swedish Wood Research Institute and the Chemical Research Institute in their respective spheres, it will be a central institution for carrying out metallurgical research in close co-operation with the various iron and steel works in the country, the Swedish Ironmasters' Association, etc. The present Metallographical Institute in Stockholm will be incorporated in the new institution. In its proposals the committee points out that Sweden's export of iron and steel products is mainly dependent upon the country's ability to produce high-quality, so-called 'fine' steel and steel products. To keep these products up to the highest standard and yet to be able to produce them at competitive prices will demand unremitting research. It is proposed to erect the new institute near the Royal Technical University of Stockholm, and it will thus constitute a new addition to the 'City of Science' that has grown up around that institution in recent years. The building costs are estimated at about £70,000, and those for the equipment at £30,000. It is suggested that the State shall pay for the erection and maintenance costs of the buildings, while Swedish industry shall undertake to bear the expenses for the equipment and the research work.

Artificially Dried Grass

THE "Production of Artificially Dried Grass" is the title of Bulletin No. 8 by J. McNair and A. B. Fowler, published by the Hannah Dairy Research Institute. While it is realized that extension of grass drying is unlikely during the war period owing to the shortage of labour, machinery and fuel, the need for home-grown protein-rich feeding stuffs will continue after the War, so that if the problems involved in the various stages of the process are properly understood now, it will do much to ensure that future developments are on a sound basis. The report is, therefore, intended to be informative rather than conclusive, and the results, obtained from practical experience on a small (120 acres) dairy farm in Ayrshire, throw considerable light on the somewhat conflicting views now held as to the economic possibilities of the process. The greatest variations are found in the cost of producing the raw material. Apart from manurial treatment the weather is chiefly responsible for this. High-grade material needs to be cut young, and difficulty is experienced in maintaining good quality owing to the seasonal fluctuations in the growth-rate and the relatively high costs of cutting and collecting young herbage. A judicial use of fertilizers is, however, profitable particularly if arrangements are made for ensiling any surplus material.

The operation of the drying plant itself offers fewer difficulties than the production of suitable grass, though there is still a need for a capable drier and ancillary field equipment at a moderate price. Maintenance charges, however, on both cutting and drying machines have hitherto been underestimated, and before grass drying can be recommended for adoption as part of the normal operations on an average-sized farm, costs must be further reduced and the quality of the product improved. The position may best be summarized in the final words of the Bulletin, "that viewed in the light of possible future developments, the practicability of grass drying is still an open issue, and one vital to British agriculture".

Polish Science and Learning

WHEN eastern Europe has been devastated and its indigenous culture suppressed, it is particularly gratifying to find a band of refugee professors and lecturers combining to keep the stream of their learning from drying up. *Polish Science and Learning* (No. 2, February 1943, Oxford University Press) is the second of a series of booklets prepared by Polish scholars in Great Britain in collaboration with their British colleagues. An article by Charles Elton on "The Changing Realms of Animal Life" is contributed as "something new towards maintaining the concept of international co-operation in science after the war is over", and the same ideal lives in the messages from Sir James Colquhoun, Sir John Russell, and Prof. A. V. Hill. Articles by Poles (some of them, for reasons of security, writing pseudonymically) deal with "The Future of the Inland Waterways of Poland in the General Trans-European Network", "Problems of Economic Geology in Poland", "Marian Raciborski and the Advancement of Botany in Poland", "Development of Polish Hydrobiology" and "Polish Painting". The booklet strikes a sombre note with its obituary notices and list of losses among Polish scholars during the War, but the account of "Polish Educational Activities in Exile" rings with confidence in the future.

Health of American Troops Abroad

ACCORDING to an editorial article in the December issue of the *Statistical Bulletin*, the health of American troops in Great Britain and other places in the temperate zone has been maintained at an extraordinarily high level. On the other hand, a host of new problems is being found in the tropical and sub-tropical regions in the form of insect-borne diseases such as malaria, typhus, dysentery, yellow fever, plague and cholera. Of these, malaria is by far the most serious problem. Its control is difficult as there is no specific prophylactic method. The disease, however, can be checked by routine administration of quinine or synthetic drugs, especially atabrine. Intestinal disorders, including dysentery, are also a serious problem in the tropics. Preventive control requires strict adherence to sanitary methods and instruction of the men to protect themselves. Typhus is not confined to eastern and south-eastern Europe; North Africa is an important focus of the disease, as

is shown by the fact that severe epidemics have occurred recently from Morocco to Egypt. Immunization has been applied, but its value has still to be confirmed. The incidence of illness due to exposure to heat is far less among seasoned troops than among new arrivals. In conclusion, the article states that sickness- and death-rates among the American troops are appreciably lower than during the War of 1914–18, in the tropics as well as in other regions.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentres of three recent earthquakes. These determinations were based on instrumental data received from the seismological observatories at Weston, Mobile, Tucson, Georgetown, Chicago, Burlington, Fordham, Buffalo, Philadelphia, Tacubaya, Honolulu, Lincoln, Pasadena, St. Louis, San Juan, Sitka and Huancayo. The first earthquake was on January 24, and took place at 20h. 42·1m. U.T. from an epicentre near latitude 15° N., longitude 91° W. This is south-east of Sta. Cruz Quiche in Guatemala, Central America. The second shock occurred on January 27 at 2h. 45·2m. U.T. from an epicentre near latitude 52° N., longitude 180° W., which is in the North Pacific Ocean in the Aleutian Islands Archipelago between Rat Island and Tanaga Island. Both these earthquakes had a normal depth of focus. The third earthquake here detailed took place on January 30 at 5h. 33·0m. U.T. from an epicentre near latitude 2° S., longitude 80° W., which is very near to Guayaquil in Ecuador in South America. This earthquake had a depth of focus probably about 100 km., which is below normal, though not unexpected in the region in question. All these epicentres are in well-known seismic regions.

New Seismograph in Mexico

THE State Government of Puebla, Mexico, has acquired a Benioff vertical-component seismograph, to be installed at the National Astrophysical Observatory at Tonantzintla, State of Puebla. This instrument is now on the way to Mexico. This modern seismograph has been purchased from the National Research Council of Washington, D.C., through Dr. Harlow Shapley, director of the Harvard College Observatory, who made the necessary arrangements, in which the State Government of Puebla was represented by the Mexican Embassy in Washington. The instrument is identical with that installed in the Harvard Seismological Station; it is of the latest model available and is a valuable addition for scientific investigation in Mexico.

Health in Paris

ACCORDING to an article in the *Journal of the American Medical Association* (Jan. 22, 1943) no important epidemic has broken out in Paris since the beginning of the War except smallpox at the beginning of 1942, which was checked by intensive vaccination. Cases of scabies have increased from 1 to 70 per cent. Tuberculosis has doubled among 6–8-year old children and adolescents of 18–25. No general mortality figures have been published, but the annual rate of deaths at the Cochin Hospital has increased from 1,200 to 1,400. All Paris hospitals suffer from increasing transport difficulties.

The Nutrition Society

THE Nutrition Society has arranged a whole-day conference on "Nutrition in Infancy" to be held on May 22, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, beginning at 10.30 a.m., with Prof. L. G. Parsons in the chair. The following papers will be read: (1) "Nutritional Needs in Infancy" by Dr. H. M. M. Mackay; (2) "Recognition of Nutritional Disorders in Infancy" by Wing-Commander R. W. B. Ellis; (3) "Treatment of Nutritional Disorders in Infancy" by Dr. A. A. Moncrieff; (4) "Public Health Aspects" by Dr. J. C. Spence and Dr. H. E. Magee. The discussions after the four papers will be opened by Prof. Noah Morris, Dr. S. G. Graham, Dr. J. V. C. Braithwaite and Mr. F. le Gros Clark, respectively. Further details of the meeting can be obtained from the Hon. Secretary, Dr. Leslie Harris, Nutritional Laboratory, Milton Road, Cambridge.

Announcements

THE Lord President of the Council has appointed Dr. Charles S. Hanes to be director of food investigation in the Department of Scientific and Industrial Research. Dr. Hanes is at present serving with the food mission in North America, his services having been made available by the Department of Scientific and Industrial Research to the Ministry of Food for this purpose. The date from which he will take up his new post has not yet been fixed.

THE thirty-third annual May Lecture of the Institute of Metals will be delivered by Prof. G. P. Thomson, in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on May 19, at 6 p.m. Prof. Thomson will speak on "Electron Diffraction".

UNDER the terms of the James Scott Prize (1943) Prof. E. A. Milne delivered an address entitled "The Fundamental Concepts of Natural Philosophy" at the ordinary meeting of the Royal Society of Edinburgh on May 3.

The title of reader in medicine in the University of London has been conferred on Dr. Clifford Wilson, in respect of the post held by him at the London Hospital Medical College.

THE Chadwick Trustees are offering three prizes, of £100, £50 and £25 respectively (accompanied, if the trustees so decide, by a Chadwick Medal or Medals), for the best three essays, received before September 1, on architectural, engineering and administrative principles (relative to sanitation and hygiene) which should be observed in the replanning arrangements of war-devastated towns or areas. Further particulars can be obtained by sending a stamped, addressed envelope to the Clerk to the Chadwick Trustees, 204 Abbey House, Westminster, S.W.1.

ERRATUM.—Referring to the letter entitled "Mode of Chemical Action of X-Rays on a Non-Aqueous Solution" in NATURE of April 17, p. 448, Dr. E. Broda writes: "In expressing the analytical data in terms of amounts of persulphate, a factor 3·0 was overlooked; the figures in column 1 and 3 of the table should be divided by this factor. The result expressed in the last column (percentage decrease per unit dosage) remains, of course, unaffected.

LETTERS TO THE EDITORS

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

Autumn Sexual Behaviour and the Resident Habit of many British Birds

IT has been shown experimentally that the autumn migration urge of redstarts, *Phœnicurus phœnicurus* L., can be eliminated by injections of sex hormone[1], and evidence has been summarized and discussed[2] which indicates that the sexual behaviour and lack of southward migration in autumn in the British subspecies of the starling, *Sturnus vulgaris* L., are due to the partial recrudescence of the gonads at this season. In the Continental race of starling the summer regression of the gonads is more complete and there is no sign of gametogenesis in autumn. Consequently in this race interest in, and attachment to, the nesting places become sufficiently weakened to release the birds for the southward movement. The presence of sexual behaviour in autumn and an associated lack of southward migration have also been described[3] in the British robin, *Erithacus rubecula* L., and recently a survey of ornithological literature by Morley[4] has shown that such an association is present in many other British species at this time of year.

It seems reasonable to suppose that resident British birds are insular forms derived originally from the main Continental species. That is to say, they are derived from birds which were, and still are, migratory. In the milder climate of the British Isles migration is not a necessity for them, and, in fact, Britain is used as a wintering area by many of the Continental members of these species. The change to a non-migratory habit appears to have occurred independently in a large number of unrelated groups and species, being shown, for example, by most British crows (Corvidæ) and by several thrushes (Turdidæ) and tits (Paridæ). The very number so changing indicates the advantage to be gained by the elimination of long and exhausting journeys, and probably as many British species as the food supply will allow have abandoned the migration habit. Omnivores like the starling and the rook, *Corvus frugilegus* L., and seed-eaters like the chaffinch, *Fringilla cœlebs* L., are able to remain in Britain all the year round, although some species such as the long-tailed tit, *Aegithalus caudatus* L., and the goldcrest, *Regulus regulus* L., because of their small size, are so close to the borderline of danger that in exceptionally cold winters almost all may be frozen to death.

The mechanism by which this change of habit has apparently been achieved, at least in some species, is most interesting. It seems that the southward migration urge, which is either induced or allowed by a deficiency of sex hormone, has been overcome by the autumn activity of that part of the anterior pituitary gland which causes gonad growth and sex hormone secretion. It is a natural experiment comparable with Schildmacher's work on the redstart, and, of course, as sexual display is also induced by the presence of sex hormone, it explains the reason for the otherwise incongruous appearance of such display in autumn. Following his detailed study of the British robin, Lack (personal communication) has also arrived independently at a similar interpretation of the significance of this autumn sexual display. Because of gonad growth the attachment to the nesting sites, territories, or areas is sustained throughout the entire autumn and winter. At the approach of the breeding season, when gonad growth is greatly accelerated, sexual behaviour merely becomes more diverse and intense, and the connexion with the nesting places is further strengthened and particularized.

W. S. BULLOUGH.

Department of Zoology,
University of Leeds.
April 12.

[1] Schildmacher, H., *Vogelzug*, **4**, 21 (1933).
[2] Bullough, W. S., *Phil. Trans. Roy. Soc.*, B, **231**, 165 (1942).
[3] Lack, D., "The Life of the Robin" (in the press).
[4] Morley, A., *Ibis*, **85**, 132 (1943).

Innervation of Crustacean Muscles

THE physiology of the striated muscle of Crustacea is known to differ in several respects from that of the vertebrates ; as, for example, in the peripheral location of the inhibitory process, and the presence of separate motor fibres for slow and fast contractions. The interpretation of these peculiar properties requires a knowledge of the histology of the neuromuscular system, in order to compare and contrast it with the mode of innervation of vertebrate muscle. Van Harraveld[1] has put forward the view that each muscle fibre in the crustacean receives a great many endings from each of the different types of nerve fibre, motor and inhibitory, so that it is surrounded by a dense feltwork of axons, and has forty or more nervo endings on its surface. This view is reminiscent of that of Bethe[2] and Tonner[3], both of whom used a methylene blue staining method to demonstrate an extensive network of nerve axons in crustacean muscle. Unlike van Harraveld, however, they derived this network from a "sub-epithelial nerve plexus" and not directly from the central nervous system. On the other hand, D'Ancona[4], working in Cajal's laboratory, gave a very different histological picture of the peripheral nervous system ; he could only demonstrate one or two nerve endings on each nerve fibre, and no nerve network.

As it seems that van Harraveld's histological picture is coming to be generally accepted (see Gerard[5]), it seems desirable to record some preliminary work which led me to consider the possibility that his histological methods have led him to describe as nerve fibres structures which are, in fact, fibrils of connective tissue origin.

In the course of some work on the nervous system of the prawn, *Leander serratus*[6], specimens of the abdominal musculature and whole chelæ of the animal were fixed in various fluids, embedded in wax and cut in serial sections. The nerve axons in the material were stained by Bodian's protargol method.

I found that the protargol method, when applied to material fixed in a saturated solution of picric acid in sea water, demonstrated a fibrous network among the muscles, very similar in appearance to that described by van Harraveld. But in material fixed in a mixture of 80 per cent alcohol, formaldehyde and glacial acetic acid, the method showed no such network, but only a much more sparse system of fibrils, all of which could be traced back to main nerve trunks : no muscle fibre was ever seen to receive more than one or two endings from these nerve axons. Furthermore, I found it

possible to stain a fibrous network in this alcohol-fixed material by the use of a silver method which is specific for the reticulin fibrils of vertebrate connective tissue[7]. This network was identical in arrangement with that seen after protargol staining of picric acid material, and its connective tissue nature was demonstrated by its arrangement within the connective tissue sheaths of the main nerve trunks, as well as among the muscle fibres.

Thus a staining method which is specific for nerve axons in vertebrate material, that of Bodian after picric acid fixation, will stain connective tissue fibrils as well as nerve fibrils in Crustacea. It therefore seems likely that van Harraveld's ammoniacal silver method led him to make a similar confusion.

I have not been able to continue with this study since 1939, but the available evidence leads me to believe that the work of D'Ancona gives the most reliable histological picture of crustacean muscle innervation.

WILLIAM HOLMES.

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Oxford.
April 15.

[1] van Harraveld, A., *J. Comp. Neur.*, **70**, 267 (1939).
[2] Bethe, A., *Anat. Anz.*, **12**, 31 (1896).
[3] Tonner, F., *Zool. Jahrb. Abt. Phys.*, **53**, 101 (1933).
[4] D'Ancona, U., *Trab. Lab., Madrid*, **23**, 393 (1925).
[5] Gerard, R. W., *Ann. Rev. Physiol.*, **4**, 329 (1942).
[6] Holmes, W., *Phil. Trans. Roy. Soc.*, B, **231**, 293 (1942).
[7] Robb-Smith, A. H. T., *J. Path. Bact.*, **45**, 312 (1937).

Agar from South African Seaweeds

AGAR suitable for bacteriological purposes has been extracted from the following species: *Gelidium cartilagineum* (L.) Gaillon, *Gracilaria confervoides* (L.) Grev., *Suhria vittata* (L.) J. Ag.

Of these, *Gelidium cartilagineum* and *Gracilaria confervoides* were previously known sources of agar in other countries: the former in North America and the latter in Ceylon, China, North America and Australia. *Suhria vittata* has long been a source of edible jelly in South African households. This jelly is used in a similar way to that obtained from Irish moss (*Chondrus crispus*).

The various agars prepared were first tested at the Government Low Temperature Research Laboratory, Cape Town, as suitable media for the growth of *Staphylococcus albus*, *S. aureus*, *B. subtilis** and a thermophilic anærobe obtained from blown cans of a meat and vegetable ration. The agars were further tested at the Baragwanath Military Hospital and were found to be suitable media for the growth of *B. coli*, *B. dysenteriæ* Schmitz, *B. dysenteriæ* Flexner, *B. dysenteriæ* Sonne, Staphylococci and Streptococci. A number of the agars prepared, especially those from *Suhria vittata*, proved as good as the best Japanese agars.

Agar was also obtained from *Gelidium pristoides*. This agar was found to be a suitable medium for the growth of the various organisms mentioned above. The agar was, however, of inferior quality. It did not dissolve as easily, the jelly was not as firm (1·5 per cent agar) as the other agars tested, and it was somewhat opaque even after clearing with egg-white.

Preparations for the manufacture of bacteriological agar are well in hand. We are indebted to Mr. P. S. Malan, of Buchanan Ltd., for co-operation in tests relating to the preparation of bacteriological agar on a commercial scale. This aspect of the work has been chiefly concerned with *Gracilaria confervoides*. This species seems to be the most abundant source of agar, since although it is known from only two localities (Hout Bay and Langebaan) it occurs at those places in considerable amounts, especially at Langebaan. Although sub-littoral in habit, it grows in calm water and is rooted in sand. It is washed ashore in very considerable amounts after heavy seas and so harvesting is easy and cheap. A search is being made of additional localities for this species.

The other species listed are also sufficiently abundant on South African coasts to be at least of value as emergency sources of bacteriological agar. Unfortunately the harvesting of *Suhria vittata* in considerable amounts is difficult since it occurs chiefly as an epiphyte on the large kelp *Ecklonia maxima*, which grows in the sub-littoral off the west coast of South Africa. *Gelidium cartilagineum* and *G. pristoides* are chiefly found on the south coast of the Union. The former is uncovered only at low water of spring tides while the latter occurs at about mid-tide level[1].

A low yield of jelly was obtained from *Hypnea spicifera*, J. Ag., which proved to be a suitable medium for *Staphylococcus albus*, *S. aureus* and *B. subtilis*. It is unsuited for work with thermophilic bacteria, however, since it liquefies below 130° F. It has certain physical properties unlike those of agar. As compared with agar, nearly twice as much of the substance is needed to make a jelly.

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* For standard cultures of the first three species we are indebted to the Department of Bacteriology, Medical School, University of Cape Town.

[1] For details regarding distribution and abundance of the species discussed see Isaac, Wm. Edwyn, *J. South African Bot.*, 225 (1942).

Phagocytosis in the Appendix of the Rabbit

IN the recent article "Microbial Factors in the Digestive Assimilation of Starch and Cellulose in Herbivora"[1], attention has been directed to the determinant role taken by iodophile micro-organisms in these processes. During passage through the alimentary canal, the iodophile population is eliminated, and the suggestion has been advanced that in this way the products of microbial synthesis become available to the host animal.

Three factors have been distinguished which may operate to a variable extent in different herbivorous species, namely: (1) action of digestive enzymes of the host animal: (2) ingestion by ciliates of the rumen or cæcum; (3) bacterial autolysis.

Reconsideration of some claims advanced by earlier observers has in the meantime indicated that these factors may be supplemented in certain Herbivora by a true process of endocellular digestion. Thus Bizzozero and Ruffer, as cited by McEwen[2], had independently described an active phagocytosis of bacteria as occurring in the appendix vermiformis of rabbits. By the use of appropriate histological procedures, we have been able to substantiate this claim.

The agents concerned are large mononuclear cells present in great numbers in the lymph nodes and lymph papillæ of the submucosa.

In face of the conflicting views held in regard to the origin of such cells, it is convenient to retain the term macrophage introduced by Metchnikoff[3]. Examination of the macrophages both in organ smears and sections has demonstrated the presence in them, in addition to cell debris, of numerous bacteria. Moreover, the bacteria showed a strong blue reaction on treatment with iodine solution. Since such iodophile species comprise in rabbits[4] the bulk of the microbial population of the cæcum, the origin of the ingested micro-organisms becomes unequivocally clear.

Granulocytes appear to play no part in the observed phagocytosis, which may therefore be attributed to macrophage activity alone. The extent to which this process of endocellular digestion affords an effective contribution to the nutrition of the host animal or is to be regarded merely as a protective mechanism against bacterial infiltration is receiving further attention. The abundant development of lymph nodes in the rabbit's appendix, the numerous macrophages present and the actual size of the organ make it probable that very large numbers of micro-organisms can be dealt with in this way. It must be stressed, however, that this conclusion only refers to the particular herbivorous species under consideration. Thus, for example, in the guinea pig, both appendix and sacculus are lacking, the lymph nodes being confined to the small agminate glands distributed at intervals along the margin of the cæcum.

Again, in the human appendix itself, the development of the lymph nodes is, in comparison with the appendix of the rabbit, very restricted, and examination of smears and sections has revealed no clear evidence of macrophage activity.

In regard to the musculature of the wall, however, a contrasting situation is disclosed, a fact of interest in view of the role that has sometimes[2] been attributed to the human appendix in the regulation of colonic peristalsis. These considerations, among others, indicate that the functional significance of the appendix may vary in different animal species, devolving both on the general organization of the alimentary canal, and the characteristics of the microbial population[1,5,6] which it supports.

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April 2.

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Frictional Properties of Metallic Films

A RECENT communication by Schnurmann[1] has criticized the interpretation of earlier observations[2] on the frictional behaviour of thin films of soft metals on a copper surface made on the Bowden-Leben apparatus.

It is not an uncommon experience in frictional studies to find difficulty in correlating the results obtained on different machines. Factors, such as the rate of repair of lubricant films, surface oxidation and other contamination, frictional heating, and many others, may be of great importance and lead to discrepancies. In the absence, therefore, of a detailed account of Dr. Schnurmann's experimental method, it is not possible to attempt to interpret his observations in the light of earlier published work on the Bowden-Leben apparatus. It is obvious, however, that there is a wide difference between conditions in the type of machine he refers to and those in the Bowden-Leben machine. Dr. Schnurmann has measured the friction of a loaded steel ball rotating on a steel plate, under which conditions the ball presumably must rotate in one spot or around the same track. Since he finds that films of soft metals wiped on to the steel sliding surfaces do not decrease the friction, he implies that the earlier published work carried out on the Bowden-Leben machine, which uses quite different conditions and materials, was incorrectly interpreted.

The work to which Dr. Schnurmann refers dealt with frictional measurements using a hemispherical steel slider moving slowly over films of soft and low melting-point metals (lead, tin and cadmium) rubbed on to copper surfaces. Under these conditions the coefficient of friction was reduced considerably below the values for either metal separately, often to surprisingly low values; for example, $\mu = 0{\cdot}03$ for lead films. The view was taken that this decrease in friction coefficient resulted from the decrease in adhesive forces across the small area of contact, rather than from any reduction in the ploughing forces, that is, the forces involved in producing a groove in the lower surface. In actual practice, it may often be difficult to distinguish purely grooving effects from changes in the forces of adhesion accompanying the removal or deposition of contaminant films on the lower or upper surfaces, which take place during successive slides in the same track. However, Bowden, Moore and Tabor[3] have recently evaluated the approximate contributions of adhesion and ploughing forces to the friction of steel on indium. Even with such a soft metal as indium, the adhesion term for hemispherical sliders was shown to be roughly twice as large as the ploughing term. Unfortunately, such a quantitative treatment has not been carried out on the lead-copper alloys. However, there were mentioned in the original communication[2], and also in an earlier one[4], a few simple experimental observations which showed clearly that grooving effects were always small compared with the magnitude of the frictional changes accompanying the deposition and removal of surface films of various materials on copper, including films of lead, tin and cadmium. These will be briefly summarized:

(*a*) The frictional decreases due to these metal films were observed during the *first* slide, and the friction remained little changed by successive slides in the same track. Eventually, continued sliding in the same track penetrated the soft metal film and the friction *rose* to values approaching that for steel on copper. If these effects were due to changes in the ploughing or grooving contributions to the frictional forces, as Dr. Schnurmann appears to suggest, then one would expect to find a markedly higher frictional resistance during the initial slide in any track, and certainly no rise on further sliding in the same groove.

(*b*) The *increase* in friction accompanying the removal of the soft metal film in the groove, say, lead on copper, was easily demonstrated by addition of

oleic acid or even oxidized oil to the surfaces, when the friction became greater instead of less, or by wiping with dilute caustic soda solution. Such changes in the friction, due to the removal of the films of soft metal, varied in magnitude with the metals considered, but appeared to account for the greater part of the overall effect. They clearly illustrate that the grooving contribution to the friction, which must evidently be present to a certain extent, is small compared with the contribution of adhesive forces to the total friction.

Dr. Schnurmann seems to have misrepresented the results listed in Table 2 (ref. 2). The frictional data were intended to show that, while the value of μ was 0·3 for a steel hemisphere sliding very slowly on a lead-copper bearing alloy at 20° C. (even after a number of slides in the same track), μ became reduced to 0·08 after a number of slides in the same track at 100° C. This low value of μ in the same track remained unchanged on cooling. Since the reduction in μ brought about by sliding at high temperatures was to a much lower value than could be associated with grooving effects based on changes in mechanical properties, it was therefore considered to result from the wiping-out of the soft phase (lead) over the hard phase (copper). This was further supported by the previous data on the frictional properties of copper covered with a known lead film. In addition, removal of the lead film restored the low value of μ to near its initial value.

It was mentioned in the original communication[2] that if the film of soft metal was deposited on a hard backing, the film was easily broken through and little reduction in the value of μ below that of the unplated metal would result. It is therefore not at all surprising that Dr. Schnurmann found no decrease in the friction of a steel sphere rotating (presumably in the same area or track) on a steel flat initially plated with a soft metal. The soft metal would be wiped away and penetrated very rapidly under such high loads at the point of contact.

A certain amount of work (as yet unpublished) has been done on soft metal films on various metals at speeds up to 250 cm./sec., and in general the results bear out those obtained on the Bowden-Leben apparatus. However, the film of soft metal may have a short life for continued dry sliding in the same track or groove. In practice, in an actual bearing, the value of the soft metal phase may lie in its ability to prevent local seizures for short periods of time when the lubricant film happens to become penetrated in some way.

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Public Appreciation of Science

As a man in the street with no claim to be a scientist I read with interest the report in NATURE of April 3 of the conference convened by the British Association to consider ways and means for increasing public appreciation and understanding of science. The impression I gain from this and similar discussions is of a disposition to blame various forces extraneous to the scientific community for the failure of science to exert upon the public mind the influence which it should. So far as Great Britain is concerned, however, I suggest that a chief responsibility for the frustration of science, so far as it is determined by public ignorance, rests primarily on scientific men themselves.

In the United States of America they do things better. Science Service has been operating since 1921, and is now conducted by the Institution for the Popularization of Science. This is a non-profit corporation controlled by a Board of Trustees nominated by the chief scientific and technological organizations in the United States. It is a model, showing what scientific men can do when they cease blaming other people and open the doors which are already swinging on their hinges. In its weekly Science News Letter, the Institute turns out an up-to-date picture of the contemporary progress of science and technology. It has initiated, all over America, Science Clubs where the vast undeveloped potentialities of scientific curiosity and creativeness of the common person, and particularly of youth, is provided with opportunity and guidance. In its Things of Science service it makes available at low cost specimens of the new materials which science is bringing into being as the fabric of an emerging civilization. Through its annual Science Talent Search it is combing out the potential genius of American boys and girls and providing, in conjunction with the Westinghouse Corporation, scholarships to enable the potential Edisons and Faradays of the coming decades to develop what is in them. All this may be well known. British scientific people have nothing similar.

I write as an individual entitled to speak for nobody but myself and therefore with the greater freedom. To my unsubtle mind it seems that if British men of science really believed in science for the service of mankind and acted upon that belief, they would brush aside in this connexion the irrelevant political dividing lines which segregate the English-speaking peoples. Why, in short, should not British science organizations forthwith become affiliated with the American Institute for the Popularization of Science, receiving appropriate representation on its Board of Trustees, publishing a British edition of Science News Letter and organizing, as opportunities allow, the democratic facilities and opportunities which are indispensable in order that the new generations shall be equipped with the temper and technique of science.

The fundamental need of our age, as Mr. Wells has so magnificently shown, is synthesis of all the forces, political, economic, intellectual and moral, of the inhabitants of our planet. The temper, technique and aspirations of science are bound up inescapably with the idea of mankind as one community. If scientific men cannot unite, even where the barriers of language do not exist, to whom shall we turn to give a lead ?

Why should not scientific men of the Atlantic democracies mobilize in one organization now, to lay the intellectual and moral foundations of the new order which is the only alternative to misery, frustration, disaster ? Surely for every reason against, there are a hundred for.

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ESTIMATION OF VITAMIN A

THE second International Conference on Vitamin Standardisation provisionally fixed 1,600 as the value for the factor relating the results of spectrophotometric tests of vitamin A with the results of biological tests, expressed in international units.

In 1935 and 1937 the Vitamin A Sub-committee organized co-operative tests to make further determinations of the value of this factor[1,2]. The materials tested were a specimen of halibut liver oil, a concentrate derived from it, and the United States Pharmacopœia reference cod liver oil. The concentrate yielded a conversion factor of between 1,000 and 1,200; but it was unstable, and the deterioration was sufficient to account for the lowness of the value. The value of the conversion factor for the halibut liver oil was originally calculated to be 1,470[1] but later, at the time of the experiment on the U.S.P. reference oil, it was recalculated by improved statistical methods, and the values for the halibut liver oil and reference oil were then found to be 1,570 and 1,820, respectively. Since the difference between the logarithms of these two values was 2·1 times its standard error, the odds were about 30 to 1 against that difference being due to chance. As a result of these experiments, the recommendation was made to retain the provisional value of 1,600 as the best compromise and to await further data.

In 1939 it was planned to hold a third meeting of the International Standardisation Conference towards the end of the year, with the question of the value for the conversion factor as part of the agenda. The Vitamin A Sub-committee, as a further contribution to the settling of this difficult and practically very important problem, decided to make a co-operative test, similar to the two preceding ones, on one of the pure esters of vitamin A recently prepared in the laboratories of British Drug Houses, Ltd., by Mead[3]. The β-naphthoate, first described by Hamano[4], was selected and was placed at the disposal of the Vitamin A Sub-committee by the kindness of the British Drug Houses, Ltd., on behalf of whom Dr. T. H. Mead gave invaluable help in the preparation of a suitable and stable solution for feeding in the biological tests.

The experiment was planned on the same lines as the two preceding ones, being in its essence a comparison of the vitamin A potency of vitamin A β-naphthoate and of international standard β-carotene in biological tests with rats, spectrophotometric estimations being made at the end, as well as at the beginning, of the feeding tests, so that the stability of the test solutions could be controlled throughout. The biological tests were carried out in almost the same set of laboratories as before and the spectrophotometric tests were in the hands of Dr. R. A. Morton. A special dilution of the international β-carotene standard was prepared as before by the Department of Biological Standards at the National Institute for Medical Research.

The projected third meeting of the International Vitamin Standardisation Conference in 1939 could not take place, but the tests went on and were completed, not without difficulty, by most of the participants. The collected individual results were placed in the hands of Dr. J. O. Irwin who, besides working out the combined result, has made use of the material of this and the two preceding experiments for an exhaustive study of the accuracy of the biological test for vitamin A; it is hoped to publish this study shortly.

For the solution of vitamin A β-naphthoate used, the value obtained for $E\,\frac{1\text{ per cent}}{1\text{ cm.}}$ 325 mμ was 0·094*. Nine laboratories sent in results of biological tests. They ranged from 97 to 260 I.U. per gm. of the naphthoate solution. The weighted mean of the results, derived in all cases from tests of five weeks duration, was 166 I.U. per gm. The limits of error for this result ($P = 0·99$) were 89–112 per cent. The conversion factor for this experiment is, therefore, $166 \div 0·094 = 1770$, and lies between the values 1,570 and 1,820 obtained in the two previous experiments. The difference between the two extremes seemed earlier to be significant but, after inclusion of the most recent data leading to an intermediate value, it was concluded from consideration of the logarithms of the three values and of their standard errors that the three values did not differ significantly. This being the case, it is permissible to pool the results, and obtain a conversion factor of 1,740, with limits of error ($P = 0·99$) of 93–107 per cent.

Practical application of such a conversion factor to commercial oils and concentrates is, of course, conditional on the absence or elimination of irrelevant absorption at 325 mμ. This matter has been discussed by Morton[5]. It would appear that a single factor is still justified for all spectroscopically normal vitamin A preparations, oils or concentrates.

The very consistent evidence obtained in the United States for a conversion factor of 2,000 or more is most probably to be explained by the wide use of the U.S.P. reference cod liver oil as standard of reference, while in Great Britain the international standard preparation of β-carotene has been more generally used. The U.S.P. reference oil has always officially borne the value of 3,000 I.U. per gm., which was the value found in exhaustive tests against the 1931 mixed carotene standard. In the co-operative test carried out by the Vitamin A Sub-committee on this oil, comparison was made with the 1934 pure β-carotene standard, and the value found was 2,619 instead of 3,000 I.U. per gm. This discrepancy between the reputed value for the U.S.P. reference oil and that found in a test against pure β-carotene corresponds closely with the difference between the value for the conversion factor of 2,000 preferred in the United States and that of 1,740 found by the Vitamin A Sub-committee.

To what extent the discrepancy between the values of 2,619 and 3,000 I.U. per gm. for the U.S.P. reference oil arose through use of the imperfectly related 1931 and 1934 carotene international standards or through deterioration, for which there is spectroscopic evidence, cannot now be determined, nor is it important to do so. What is important is to find some satisfactory solution to the difficulty which has arisen from the use of two different conversion factors on

*The vitamin A β-naphthoate showed:

$E\,\frac{1\text{ per cent}}{1\text{ cm.}}$		
	693 mμ	167 (vitamin A_2 in small amount)
	617 mμ	3804
	325 mμ	1200 (cyclohexane)
	325 mμ (corr'd.)	1180 (cyclohexane)

and the solution in arachis oil was 0·00902 per cent wt./wt. or 0·0083 per cent wt./vol. The expected value for $E\,\frac{1\text{ per cent}}{1\text{ cm.}}$ 325 mμ was, therefore, 0·098. The observed value was 0·094 with the undiluted arachis oil solution (1 mm.) and 0·105 with a 10 per cent solution in cyclohexane (1 cm.). The effect of the solvent on the E values makes an unfortunate complication and, if no destruction of vitamin A β-naphthoate occurred, a good case could be made out for 166/0·098 = 1694 as against 1740. There is, however, not much to choose between the alternatives when the various sources of error are taken into account.

the two sides of the Atlantic. After the International Conference of 1934 it was accepted by the U.S. Pharmacopœia Commission that the U.S.P. unit should have the same value as the international unit, 3,000 of each being contained in one gram of the U.S.P. reference cod liver oil. As has been shown above, the U.S.P. reference oil does not, in fact, contain as many as 3,000 I.U. per gm. The simplest solution would, therefore, appear to be to recognize that the U.S.P. and international units have not, after all, the same magnitude, but that the former is only 2,619/3,000 or about 7/8 of the latter and that the respective conversion factors are about 2,000 and about 1,740.

This solution would leave the literature in some confusion, since the U.S.P. unit and the international unit have been regarded since the 1934 Conference as identical in value, and the terms as interchangeable, but the confusion does in any event exist and its existence is better recognized. In most of the work in which the confusion occurs, the magnitude of the discrepancy is not large enough to matter very much from the practical point of view. In connexion with commercial transactions where it is large enough to be important financially, agreement is in practice reached on the basis of concordant spectrophotometric determinations, but it is desirable that the exact nature and magnitude of this discrepancy should be recognized, and the position reviewed as evidence accumulates.

Those who took part in the work were: A. L. Bacharach, Glaxo Laboratories, Ltd., Greenford; W. A. Broom, Messrs. Boots Pure Drug Co., Ltd., Nottingham; H. M. Bruce and K. H. Coward, Pharmaceutical Society, London; A. D. Emmett and R. D. Brown, Messrs. Parke, Davis and Co., Detroit Laboratories (communicated by J. A. Freeman); E. M. Hume, Lister Institute, London; J. O. Irwin, London School of Hygiene and Tropical Medicine; T. H. Mead and S. W. F. Underhill, Messrs. The British Drug Houses, Ltd., London; T. Moore, Dunn Nutritional Laboratory, Cambridge; R. A. Morton, University, Liverpool; W. Stott, British Cod Liver Oil Producers (Hull), Ltd.: H. Wilkinson, Lever Bros. and Unilever, Ltd., Port Sunlight.

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CARNEGIE CORPORATION OF NEW YORK

THE report of the Carnegie Corporation of New York for the year ending September 30, 1942, includes the report of the president, that of the secretary, with a list of appropriations authorized during the year, and the report of the treasurer.

In his first report as president, Mr. W. A. Jessup contrasts the present programme of the Corporation with that carried on during the War of 1914–18. During that War, the Carnegie Corporation was scarcely more than an institutionalized extension of Mr. Carnegie's personal philanthropy. Its administrative machinery was new and its programme still in the making. Its direct contribution to the War took the form of generous gifts to outstanding private agencies which had undertaken to supply the amenities of life in the army camps. Appropriations to other Carnegie enterprises more actively concerned in the war effort and to the National Research Council were also voted.

Since 1918 the Corporation has granted 140,800,000 dollars to various agencies and institutions which share its concern for the advancement and diffusion of knowledge, many of which are now in a position to render direct and useful services to the Government of the United States. Secondly, the public has been educated to support the social service agencies which were the chief recipients of grants made during 1917–18, and these agencies no longer look to the Corporation for any substantial proportion of their operating income. Moreover, the present War now involves the mobilization of the whole of the nation's intelligence, and under such conditions the Corporation, owing to its peculiarly close relations with men of science and scholars, can play a useful part within the terms of established policies.

Of the grants voted during the year 1941–42 totalling 2,831,650 dollars, 536,565 dollars have been given for activities directly related to the War. Of the new grants, the largest, 100,000 dollars, has enabled the Joint Army and Navy Committee on Welfare and Recreation to conduct experimental programmes as a basis for the growing activity of the Special Service Division of the War Department. Donations amounting to 12,500 dollars were made to the American Council of Education to keep colleges and universities informed of the needs in personnel of defence agencies and conversely to inform these agencies of the man-power resources of educational institutions. The three major grants to educational institutions during the year were to the new University Centre in Atalanta, the Johns Hopkins University in Baltimore and the New York University. A grant of 10,000 dollars was voted for the formulation of special tests to be used in selecting personnel to be trained under the defence-training programme of the United States Office of Education. To prevent the curtailment of the services of the New York Academy of Medicine, an appropriation of 150,000 dollars was made to the Academy. Substantial endowment grants made to the National Academy of Sciences in earlier years have freed its operating arm, the National Research Council, from dependence on term grants, but in view of its new responsibilities the Trustees have voted a sum of 25,000 dollars to the National Academy in addition to the revolving fund of 100,000 dollars appropriated the preceding year.

Grants in support of the Social Science Research Council and the American Council of Learned Societies have also been renewed. These Councils have been the mainstay of the Government in staffing new defence bureaux and in prosecuting research to forward the war effort. The American Council of Education has served as a liaison agent between the Government and education, and the Social Science Research Council has assisted in the preliminary work on the national roster of specialized personnel and is serving as an advisor to the Government on many problems within the field of social science. On

the other hand, the activities of the Committee on Scientific Aids to Learning have had to be suspended, and its director has been loaned to the Office of Scientific Research and Development, which is assuming much of the burden carried by the National Research Council during 1917–18. In view of the uncertainty now prevailing in world conditions, total appropriations from the British Dominions and Colonies Fund were less than in any year since 1927.

The report also includes a review of the contributions of the Corporation to the development of public and academic libraries and an analysis of a summary of the total grants made by the Corporation since 1911. Of this total of 185,000,000 dollars, 70,000,000 dollars were made to agencies or enterprises established by Mr. Carnegie himself or growing immediately from them ; 48,000,000 dollars to 848 universities, colleges and schools ; 50,000,000 dollars to 777 associations, museums, libraries and agencies for research and study. More than 60 per cent of this 50 million dollars went to 22 agencies, particularly the National Academy of Sciences, including the National Research Council and the Committee on Scientific Aids to Learning (8,005,678 dollars), American Library Association (3,373,050 dollars), New York Academy of Medicine (1,625,190 dollars), American Council of Learned Societies (595,550 dollars) and Institute of International Education (1,354,979 dollars).

MEASUREMENT OF LIGHTNING

IN an article on the measurement of lightning in relation to telephone cables (*Bell Lab. Rec.*, **21**, No. 4 ; Dec. 1942), J. J. Mahoney, jun., describes some simple forms of apparatus used to ascertain the magnitude of lightning surges striking selected or other structures.

In a lightning-prone area, near Lakewood, New Jersey, a number of steel masts were connected to about four miles of cable, buried for lightning tests in 1939 and not connected in any way to the Bell System plant. A tall steel mast is attached to the top of a wooden pole to direct lightning to buried telephone cables. The lightning current is conducted over a wire to an adjacent shorter pole on which measuring equipment is installed.

The tests include measurements of the crest value of the lightning current entering the cables, steepness of the wave front, the quantity of electricity in the lightning surge and the crest voltage across the insulation of the buried cable conductors. When plant damage occurs, an attempt is made to correlate it with the characteristics of the observed stroke. The ability of bare copper wires of various sizes to carry lightning current is being studied incidentally.

Since months may pass before a stroke is observed, simple inexpensive devices must be used. Their record is in the permanent magnetism given to them by the lightning. In one form, the magnetic links are straight pieces of laminated iron, each about 1½ in. long, enclosed in a Bakelite shell, mounted so as to intercept a magnetic field of greater or less strength, depending on their distance from the conductor, and so record currents from 500 to 10,000 amp. The links are calibrated in advance by determining the intensity of magnetization given to them by known currents.

The wave front steepness of a lightning surge is ascertained by inserting a magnetic link in a coil which is coupled with the lightning conductor. The apparatus has a rectangular loop of wire, one side of which is wound as a solenoid to enclose the link. When mounted a short distance from a conductor carrying a lightning surge, the link becomes magnetized and measures the peak current in the test circuit. From this and the crest value of the current in the lightning conductor, the time when the crest value of the discharge current is reached can be calculated from the resistive and inductive constants of the test circuit. Three loops are usually used at different distances from the conductor in order to increase accuracy of measurement.

The electrical charge of a lightning stroke is found by connecting a resistance in series with the lightning conductor and shunting an inductance across the resistance. The crest value of current in the inductance is measured by a magnetic link, and the charge then calculated from the product of the current and the inductance divided by the resistance. Peak voltages produced in telephone conductors by lightning are measured by a klydonograph, which consists of a blunt electrode in contact with the emulsion of a photographic plate backed with sheet metal and protected by a light-tight housing. The approximate magnitude and the polarity of the applied voltage can be determined by the size and appearance of the figure appearing on the developed plate. To measure the ability of lightning current to fuse bare copper wires of different gauges, several short lengths are connected in series on a terminal strip and inserted in the lead from each mast. Arcs between the ends of bent wires carry the discharge past test wires which have fused.

All the instruments used are simple to install, inexpensive and require no attention except that they are checked after each lightning storm by bringing a pocket compass near the links to test them for magnetism. Those found magnetized are removed for more accurate tests, and the photographic plates of the voltage recorders in the circuits affected are developed. The cable conductors are checked at the same time to detect plant damage.

Of three lightning strokes which have hit this experimental plant, only one struck a mast and splintered it slightly. This occurred in July 1939, before the buried cable and measuring equipment were installed. The second stroke came in October of the same year, striking a tree and entering a test cable near it by arcing from the tree's roots. The nearest measuring equipment, approximately 500 ft. away, recorded a crest current of 12,000 amp. The cable was considerably damaged. A third stroke occurred in July 1941. It also hit a tree and the lightning current entered the same cable through tree roots. Peak currents from this stroke varied from about 1,600 to 11,000 amp. at different points of the installation. Voltages ranged from 2 to 10 kV. and the quantity of electricity from 1 to 4 coulombs. Surge recorders showed that the time from start to crest of the discharge was 16 μsec. Bare copper wires of 24 and 28 gauge fused on the poles nearest the tree hit. A steel culvert conducted current to the cable buried north of the road. The cable which was struck was about ½ in. in diameter, including its lead sheath, and was enclosed in a vulcanized rubber covering about 1/16 in. thick. Small puncture marks were found in the rubber where the lightning current entered the sheath. No other damage was found.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public.)*

Monday, May 10

ROYAL GEOGRAPHICAL SOCIETY (at Exhibition Road, London, S.W.7), at 8 p.m.—Sir Percy Loraine: "Perspectives of the Near East".

Tuesday, May 11

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—K. de B. Codrington: "Afghanistan Today".

ILLUMINATING ENGINEERING SOCIETY (at Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 4.30 p.m. Annual General Meeting.—Sir John Parsons: "Light and Vision".

ROYAL PHOTOGRAPHIC SOCIETY: SCIENTIFIC AND TECHNICAL GROUP, (at 16 Princes Gate, London, S.W.7), at 5.0 p.m.—Dr. G. Spiegler: "Contrast and Definition on X-Ray Pictures (in Relation to General Photography)".

Wednesday, May 12

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. Marion Delf: "The Nature and Uses of Seaweeds".

PHYSICAL SOCIETY: COLOUR GROUP (at the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Mr. G. S. Fawcett (Tintometer, Ltd.): "Sixty Years of Colorimetry".

Thursday, May 13

TOWN AND COUNTRY PLANNING ASSOCIATION (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Dr. Dudley Stamp: "Reconstruction and Country Life".

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 2.45 p.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

Friday, May 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, London, W.1), at 4.30 p.m.—Prof. H. Dingle: "Copernicus".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m. Sir George Stapledon, C.B.E., F.R.S.: "Grassland and Modern Farming".

ASSOCIATION OF SCIENTIFIC WORKERS (HARPENDEN BRANCH) (at Harpenden Congregational Church Hall), at 5 p.m.—"World Agriculture and Man's Nutritional Needs, 4." Sir John Russell, F.R.S.: "Agriculture in Relation to Nutritional Demands".*

Saturday, May 15

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Dr. O. Godart: "Belgian Scientists and the War".

APPOINTMENTS VACANT

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

MEN with a sound practical knowledge of MODERN CROP HUSBANDRY and FARM ROUTINE able to arrange and carry out demonstrations on farms, Devon County War Agricultural Executive Committee—Executive Officer, Bradninch Hall, Exeter (May 15).

An ASSISTANT SECRETARY to the Norfolk War Agricultural Executive Committee—Secretary, Sprowston, Norwich (May 22).

(1) TWO TECHNICAL OFFICERS, with technical and practical knowledge of AGRICULTURE, to work under the direction of the Technical Development Sub-Committee; (2) TWO DISTRICT OFFICERS, with a practical knowledge of AGRICULTURE, to work under the direction of the Executive Committee; (3) an ASSISTANT PESTS OFFICER, County of the Isle of Ely War Agricultural Executive Committee—Executive Officer, Marcam House, March (May 24).

(1) METALLURGICAL CHEMIST for light alloy foundry, with experience of works technical control and if possible of pyrometry; (2) WOMAN ANALYTICAL CHEMIST, if possible with experience of light alloys; (3) METALLURGIST with some experience of non-ferrous work, H.T. furnaces and producer gas plant, for an aircraft factory, South Wales—Appointments Office, 26 High Street, Cardiff.

Retired professional man or woman required as Temporary (full-time) LIBRARIAN by Royal Society of Arts for purpose of compiling a catalogue of approximately 3,000 books—Acting Secretary, 6–8 John Adam Street, London, W.C.2.

LECTURER IN CHEMISTRY (temporary) for the Military College of Science—Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2, quoting Ref. O.N.F. 1079.

BIOCHEMICAL ASSISTANT for Hospital Laboratory with University Degree with Chemistry or Biochemistry as a principal subject, at the Royal Sussex County Hospital, Brighton—Pathologist, Royal Sussex County Hospital, Brighton, 7.

A TEMPORARY FULL-TIME TEACHER (man) of PHYSICS and CHEMISTRY (graduate) for teaching duties and to take charge under the Acting Principal, of the Science and Technical division of the Norwood Technical Institute, Knights Hill, S.E.27—Education Officer, T.1, The County Hall, Westminster Bridge, S.E.1, with stamped addressed foolscap envelope.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Forest Products Research Laboratory. A Handbook of Empire Timbers. (War Emergency Supplement.) Edited by H. A. Cox. Pp. 42. (London: H.M. Stationery Office.) 9*d*. net. [54

Proceedings of the Royal Irish Academy. Vol. 49, Section B, No. 2: The Distribution and Origin of the British Lepidoptera. By Dr. Bryan P. Beirne. Pp. 27–60. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. [54

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 3, No. 22: Some Applications of Marcel Riesz's Integrals of Fractional Order. By E. T. Copson. Pp. 260–272. (Edinburgh and London: Oliver and Boyd.) 1*s*. [54

The Colonies: the Labour Party's Post-War Policy for the African and Pacific Colonies. Pp. 24. (London: The Labour Party.) 3*d*. [94

South-West Essex Technical College and School of Art. Annual Report, Session 1941–42. Pp. 32+4 plates. (London: South-West Essex Technical College and School of Art, Walthamstow.) [94

The Welding of Cast Iron: a Review. By J. G. Pearce. (T.9.) Pp. 22. (London: Institute of Welding.) 2*s*. [94

Report on a Preliminary Investigation of the Welding of Cast Iron. By W. J. Driscoll. (R.19.) Pp. 10. (London: Institute of Welding.) 2*s*. 6*d*. [94

Proceedings of the Royal Irish Academy. Vol. 48, Section B, No. 12: Salmon of the River Corrib, together with Notes on the Growth of Brown Trout in the Corrib System. By Arthur E. J. Went. Pp. 269–298+plate 2. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. [124

Other Countries

Smithsonian Institution: Bureau of American Ethnology. Bulletin 132: Source Material on the History and Ethnology of the Caddo Indians. By John R. Swanton. Pp. vii+332+19 plates. (Washington, D.C.: Government Printing Office.) 75 cents. [54

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1942. Pp. iii+118. (Washington, D.C.: Government Printing Office.) 20 cents. [54

Department of Agriculture, Fiji. Bulletin No. 22: An Introduction to the Mosquitoes of Fiji; Descriptive Notes on the Commoner Species, their Breeding Places and Occurrence, together with Simplified Keys for Distinguishing the Adults and Larvae of Fijian Mosquitoes. By R. W. Paine. Second edition. Pp. 35. (Suva: Department of Agriculture.) [54

Bernice P. Bishop Museum. Bulletin 172: Insects of Guam, I. Pp. v+218+10 plates. Bulletin 173: The Genus Nysius and its Allies in the Hawaiian Islands (Hemiptera, Lygaeidae, Oroillini). By Robert Leslie Usinger. Pp. ii+168+12 plates. Bulletin 175: Report of the Director for 1941. By Peter H. Buck (Te Rangi Hiroa). Pp. ii+20. Bulletin 176: Shallow-water Asteroidea and Ophiuroidea of Hawaii. By Charles A. Ely. Pp. ii+64+13 plates. (Honolulu: Bernice P. Bishop Museum.) [74

Occasional Papers of the Bernice P. Bishop Museum. Vol. 16, No. 14: Mosses collected by Hawaiian Bog Survey of 1938. By Edwin B. Bartram. Pp. 321–336. Vol. 16, No. 17: Hawaiian Beliefs and Customs during Birth, Infancy and Childhood. By Mary Kawena Pukui. Pp. 357–382. Vol. 17, No. 1: Polynesian Spiders. By Lucien Berland. Pp. 24. Vol. 17, No. 2: Lichens of Nihoa and Necker Islands. By A. H. Magnusson. Pp. 25–42. Vol. 17, No. 3: Pycnogonids from Hawaii. By William A. Hilton. Pp. 43–56. Vol. 17, No. 4: Shell Fishhooks of the California Coast. By Eugene Robinson. Pp. 57–66. Vol. 17, No. 5: A New Hawaiian Panicum (Gramineae). By Edward Y. Hosaka. Pp. 67–70. Vol. 17, No. 6: Psyllidae from Rapa, the Caroline, Society, and Austral Islands (Homoptera). By Leonard D. Tuthill. Pp. 71–78. Vol. 17, No. 7: New Combinations in the Gleicheniaceae and in Styphelia (Epacridaceae). By Harold St. John. (Pacific Plant Studies, 1.) Pp. 79–84. Vol. 17, No. 8: New Caledonian Microcryptorhynchus (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 85–90. Vol. 17, No. 9: Notes on Fijian Land Snails. By C. Montague Cooke, Jr. Pp. 91–96. Vol. 17, No. 10: Teredinidae of Hawaii. By Charles Howard Edmondson. Pp. 97–150. (Honolulu: Bernice P. Bishop Museum.) [74

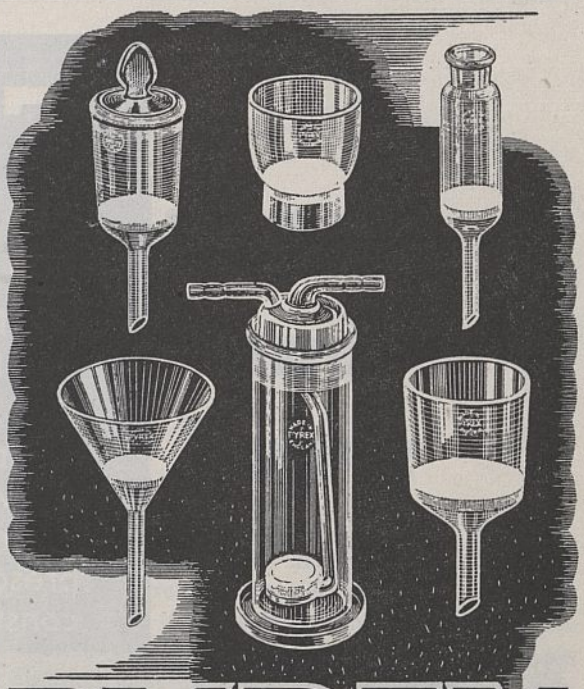
Imperial College of Tropical Agriculture: Department of Mycology and Bacteriology. Memoir No. 7: Studies in the Witches' Broom Disease of Cacao caused by *Marasmius perniciosus* Stahel. Part 1: Introduction, Symptoms and Etiology. By R. E. D. Baker and S. H. Crowdy. Pp. 28+18 plates. (Trinidad: Imperial College of Tropical Agriculture.) [84

Department of Science and Agriculture, Jamaica. Bulletin No. 31 (New Series): A Survey of the Yields of Sugar Cane in Jamaica, 1940-1941. By R. F. Innes. Pp. 31. (Kingston: Government Printing Office.) 6*d*. [124

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st March 1942. Pp. 18. (Kingston: Government Printing Office.) [124

U.S. Department of Agriculture. Technical Bulletin No. 809: Biology of the Narcissus Bulb Fly in the Pacific Northwest. By Charles F. Doucette, Randall Latta, Charles H. Martin and Ralph Schopp and Paul M. Eide. Pp. 67. Technical Bulletin No. 816: Life History, Habits and Control of the Beanstalk Weevil (*Sternechus paludatus*) in the Estancia Valley, New Mexico. By J. G. Shaw and J. R. Douglass. Pp. 36. (Washington, D.C.: Government Printing Office.) [124

Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the Year ending 30th June, 1941. Pp. ii+73. (Delhi: Manager of Publications.) 1·8 rupees; 2*s*. 3*d*. [124



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