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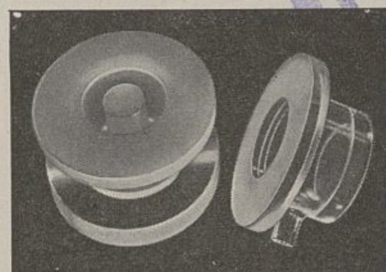

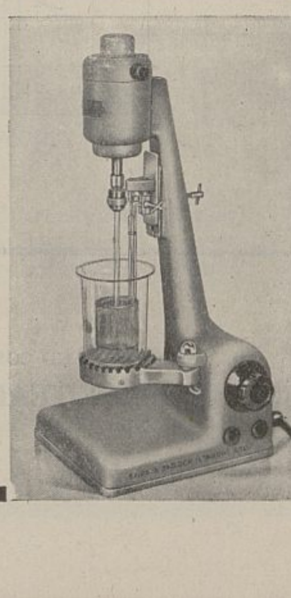

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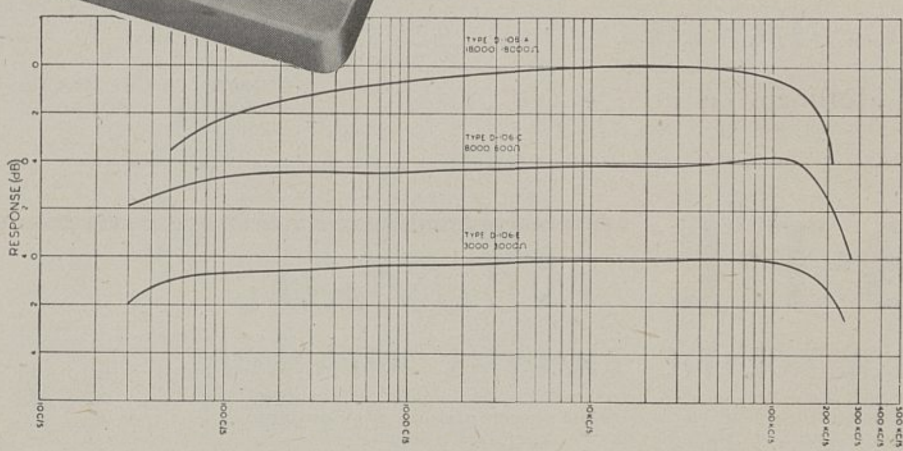

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UNIVERSITIES AND RECONSTRUCTION

THE address which Mr. Archibald MacLeish, director of the Office of Facts and Figures, delivered before the American Library Association on June 26, 1942, and which has been included in an admirable "America faces the War" pamphlet (No. 16. Total War and the People's Peace. Oxford University Press. 6*d*. net), directs attention to some very important issues. That the whole Nazi regime is an attack on the scholar's world with its freedom of thought, of investigation and of utterance, was realized by many in Great Britain long before the outbreak of armed conflict. Intellectuals generally have now learnt that their world is in real and present danger, but it is not yet appreciated everywhere that it can be saved only by courageous and unrelenting attack.

In the world of science, growing co-operation between British and American workers is encouraging a sense of realism and an understanding of the ultimate issues in the world of the mind, and here we find little hesitation in accepting the necessity of offensive war. Over a wide range of intellectual life, in both Great Britain and the United States, there is still failure, however, to perceive that the defence of the country of the mind involves, as Mr. MacLeish points out, an affirmation, an assertion of a fighting and positive belief in intellectual things, a willingness not only to resist attacks upon their world and on themselves but also to conceive offensives of their own and fight them through and win them. The city of the mind cannot be defended save from its own ramparts, and this conflict cannot be won by arms alone, for it is a conflict fought for men's convictions and ultimate ideals.

Failure to grasp that essential truth is responsible for much of the weakness and ineffectiveness of our political warfare—for the lack of imagination, to take a recent example, which has failed to grasp the opportunity presented by the Beveridge Report. The War might still be lost, Mr. MacLeish reminds us, whatever the victories of arms, if the battles of belief are lost, above all if the battle to maintain the power and authority of truth and free intelligence were lost, the confidence of men in learning and in reason and in truth broken and replaced by trust in force and ignorance and superstition—if the central battle for the preservation of the ultimate authority of mind in human life ended in defeat.

It is idle to deny that that battle can be lost. Harsh necessity has taught the peoples of occupied Europe, no less than those of the United Nations, that the fantastic plans of the Nazis for the conquest of the mind have to be taken seriously. The havoc they have already wrought in Germany is plainly displayed. One by one the lights of learning and freedom of investigation and utterance have been extinguished in the great centres of Western Europe in spite of centuries of proud leadership and tradition. We know now that the task which confronts the United Nations is not alone that of overthrowing the physical power of Nazi Germany, but also of opening again the frontiers of the mind and destroying the dominion which the prostitution of education by this twentieth century barbarism has imposed first on Germany herself and then on the whole of occupied Europe.

That task of liberation might well cause us to pause in spite of the encouragement which we can draw from the Fighting French and the other free peoples who have escaped to continue the struggle while their country and homes lie still under the conqueror's yoke. It is all the greater task on account of the extent to which the confidence of men in learning and in intellectual things has been undermined even among the free peoples. There was never a time, either in Britain or in the United States, when learning was held cheaper than it is to-day, or when men of learning and of letters had less honour.

Mr. MacLeish has well earned the gratitude of scientific workers, along with that of others who are concerned with the preservation of man's real intellectual and cultural heritage, for his courageous summons to the offensive, and his address has been issued at an opportune moment, when the importance of education in post-war plans not only in Great Britain but also in European reconstruction has received renewed attention. The report, "Axis Oppression of Education", issued by the Inter-Allied Information Committee, gives a picture of the German efforts to suppress every kind of knowledge which is likely to conflict with totalitarian theory, and the brutality as well as systematic thoroughness with which they have set about the standardization of thought; it provides ample evidence of the timeliness of Mr. MacLeish's appeal. In the face of the destruction, perversion or appropriation of educational resources thus portrayed, none can doubt the folly of that purely defensive and detached attitude which too many scientific men and other scholars once adopted of watching the steady deterioration of German science and scholarship under the Nazi system, with not only its contempt for learning but also its restrictions on the wellsprings of the creative thought from which all real progress comes.

This record of the closing of universities, the deliberate destruction of all higher intellectual life, the turning of the universities of Czechoslovakia and Poland, of Athens and Salonika, of Brussels and of Leyden into Nazi institutions for the use of the Germans, the destruction elsewhere of all buildings and the plundering of libraries and scientific laboratories, the persecution, torture and murder of professors and students alike, the determined attempt to deprive the occupied peoples of Europe of intellectual leadership, leaves no room for doubt as to the immense problem which will confront the United Nations in this field of education after the War. Even if we leave on one side the question of education in post-war Germany and the measures to be adopted to revive learning and scholarship in ways that will assist the emergence of a new Germany, the building up of education in the ravaged countries is a task that will demand generous help.

That problem was indeed one of those considered by the British Association Committee on Post-war University Education in its interim report (see NATURE, **150**, 716; 1942). Under the third of its terms of reference, the Committee is charged with surveying the position regarding teaching material, apparatus, books and staff in universities which have been damaged, destroyed, disorganized or closed as a result of war, and to make recommendations for their rehabilitation. The report suggests several ways in which such help could be given, including assistance in the provision of equipment and books, the supply of periodicals issued during the War by scientific and other learned societies in Great Britain, apart from the full restoration by the enemy Powers of stolen or destroyed university property.

Possibly even more important than the material restitution or assistance is that of assisting in the provision of teachers and research workers in the universities of the occupied countries after the War. It may be necessary for British and American universities to train teachers and research workers for some of those universities where staff has been killed or dispersed by the Nazis, and to give foreign students special facilities in the Allied universities. The full benefit of research work in progress in Great Britain, in the U.S.S.R. and in the United States during the War must be made freely available in this task of rehabilitation, and those barriers to the frontiers of knowledge which had been steadily growing in the last thirty years must be finally laid low.

To carry out this task, however, makes large intellectual and moral demands on Allied universities and leadership, quite apart from the call to share physical and material resources. The universities have an important, even a decisive, part to play in reconstruction, and they cannot play their part effectively unless we have clear ideas as to exactly what are their functions in time of war and in the society we wish to build after the War. Without clear ideas as to their place and functions in the educational system, we cannot expect to find them endowed with the personnel or the resources which will enable them worthily to play their part in either national or international reconstruction. That conception lies behind both the first and the second terms of reference of the British Association's Committee. The valuable suggestions made in the Committee's interim report with regard to the modification of the policy and methods of university education so as to promote international collaboration and the free interchange of ideas, and to relate university education to the needs and service of the community, have already been discussed in these columns.

The place of the universities in world education is discussed by Miss H. Wodehouse in *Agenda* of October, 1942. In this thoughtful article, in which the dual aspect of the life of the universities, teaching and research, is carefully considered, Miss Wodehouse suggests that the contribution of the university worker to the conduct of affairs will probably be made primarily on the side of the organization of thought. This influence will be exerted through his lucid and impartial sifting out of the fundamental issues, the clarification of problems as well as the unprejudiced investigation of the facts, through sound judgment and resourcefulness rather than through driving power. This involves, however, that no narrow view must be taken of the functions of the university in the dissemination of knowledge. Such functions cannot be discharged solely through teaching ; they must embrace the whole field of adult education and whatever new instruments may be placed in the hand of the skilful expositor by scientific advance.

One acute problem must be frankly faced, because it impinges also on the question of the size and organization of universities, as well as their distribution. Miss Wodehouse, it may be noted, would see possibly some limitation on the numbers of universities themselves, if not of the students attending them, but urges a determined effort to improve the standards and conditions of the university colleges. This effort must of course involve the safeguarding of the independence and freedom of utterance and investigation of their teaching as well as of their research staff. This is fundamental, for the universities cannot make their full contribution to the national life unless they are free to handle controversial subjects according to their best judgment without pressure from sectional or prejudiced interests.

That fundamental liberty must include not merely the right of investigation—which in Great Britain has scarcely been denied—but also the equally important right to teach controversial subjects. Unless that right is acknowledged and is used with wisdom and with force, the universities cannot maintain the vital touch with the whole life of the community essential for them to exercise their full power. No task may make more searching demands on the wisdom and judgment of the members of a university, but it cannot be evaded if we are to have an educated people and an electorate competent to meet the demands of democracy. Nor indeed, as Miss Wodehouse shows, is such teaching of controversial subjects either rare or impossible.

In his survey of reconstruction problems in the House of Commons on December 1, Sir William Jowitt devoted his closing remarks to the question of education. There is, as he said, a wide measure of agreement as to the main lines educational advance should follow : the placing of the full-time schooling of the child on a sound basis ; the efficient organization of part-time education and of adult education ; the establishment of a finer and more intimate relation between industry and education ; and the determination of the appropriate units of education administration.

Some of these problems have been reviewed in a pamphlet, "Education : A Plan for the Future", published on behalf of the Association of Directors and Secretaries for Education by the Oxford University Press, and the administrative problems were reviewed in Mr. H. O. Lester Smith's recent book, "To Whom do the Schools Belong ?". The pamphlet just mentioned enumerates for immediate and detailed investigation, first, the recruitment, training and remuneration of teachers ; secondly, the re-definition of the areas and functions of local education authorities ; and thirdly, the establishment of the Board of Education as the Government Department responsible for the supervision of all educational work. Taken by itself, the third proposition, with its implications in the field of health, might prove incompatible with that overdue overhaul of the machinery and functions of government on the lines of the Haldane Report, while the suggestion that the local education authority is the proper authority to look after both the health and education of children is, to say the least, open to challenge; but there can be no question as to the importance of the administrative problems involved and of bringing to them a new spirit and an open mind in determining the functions of ministries and the relation of research and professional interests to the administrative machine. Clearly it is desirable that each type of authority should be examined to decide on the fact rs which make for strength and efficiency and those leading to weakness or apathy. Such an examination is an essential preliminary to a constructive re-definition of administrative areas which draws on the accumulated experience of the past to provide for the efficient administration of the educational system of the future.

The importance of such questions may none the less be over-emphasized, and in the chapter on university and adult education the Association of Directors and Secretaries of Education does something less than justice to the place and contribution of the universities, both in reconstruction and in the educational system of to-morrow. True, as is pointed out, there should be closer co-operation between the universities and local education authorities in the discharge of their responsibility to the adult population, and the universities may well come to assume much larger responsibilities in adult education by exploring new ways of furthering that object. If education for citizenship and the ideal of public service is, however, to gain its full place in university life, if the emphasis is to be placed on the responsibilities rather than the opportunities of a university career, it will not be sufficient merely to consider questions of access to the universities rather than those of organization and curricula within the university. The British Association Committee and Miss Wodehouse are here on much firmer ground than the Association of Directors and Secretaries of Education.

We shall not secure the most effective contribution of the universities to the reconstruction of Great Britain or of Europe merely by ensuring that all young men and women who have shown their ability to profit by a university education should have the opportunity of proceeding to the university. With that we must at least ensure that there is some acknowledgment of civic responsibility by those admitted, some attempt to fit themselves not merely for a career but also for service to the community. To defer entry to universities until after a year of approved national or international service, whether civil or military, is a wise if not indispensable corollary to the rendering of access to the universities wider and easier for those possessing the ability to profit by such training.

Even if with this goes the institution of entrance tests of the type suggested by the British Association's Committee in its report, the universities may still fail of their full purpose unless they can solve for themselves the ultimate problem of democracy—the reconciliation of freedom and discipline. Their freedom of investigation and inquiry, both in the field of physical science and in the controversial problems on which the social sciences inevitably impinge, must be guarded as jealously as their freedom of utterance, and their right to guide opinion within or without their walls by unbiased and searching inquiry and fearless and frank statement of fact and inference. That freedom and those rights can only be exercised when they are linked to the self-discipline essential in scientific investigation and in the teaching of difficult controversial and living problems. The success or failure of reconstruction may depend on the extent to which the universities succeed in solving this central problem and most searching test of democracy, and in sending out into the world men and women who have not only learned to reconcile for themselves freedom and discipline, but in doing so have also acquired a spirit of service and a zest for life.

The field of reconstruction in Great Britain and in Europe, and supremely the rehabilitation of academic and professional life in the devastated lands of Europe, provide the universities with an unrivalled opportunity to guide and sustain the generous spirit of youth in paths of service to humanity, and will in time repair the havoc which ten years of barbarism have wrought in European culture and learning. The Government's recent decision regarding the calling-up of university entrants taking arts courses should not be considered apart from these wider claims on the universities for the man-power and woman-power to build the peace when the War is won. It would be a disastrous economy to pursue any policy, even in this crisis of man-power, which disturbed unduly the balance of education and deprived us in the post-war years of exactly that type of ardent, trained and intelligent youthful leadership for which Sir Stafford Cripps has so eloquently appealed.

"VIS ET PRAETEREA NIHIL"—THE PSYCHOLOGY OF A DYNAMIST

My Self, My Thinking, My Thoughts

By K. W. Monsarrat. Pp. ix + 140. (Liverpool: University Press of Liverpool, Ltd.; Bickley: Hodder and Stoughton, Ltd., 1942.) 7*s*. 6*d*. net.

THIS book should be read in conjunction with the author's larger work, "Human Understanding and its World", published in 1937. In the present book, Dr. Monsarrat contends that the methods which have been successfully used in elaborating a consistent picture of the physical universe may be equally successful if applied to an evaluation of thought processes and the individuals engaged on such processes.

Dr. Monsarrat points out that when we apply our minds to the study of what used to be called matter, all inquiries as to what it *is* lead to a dead-end because they are unanswerable—the only answerable inquiries are those which ask what it *does*, how it acts. This leads him to deny the existence of any inert or static reality, and to affirm that all items of reality are "power-items". Since the observed properties of an electron are wholly accounted for by its electrical charge, Dr. Monsarrat, as a positivist, feels entitled to regard the electron as an item of energy and nothing more. Inquiries as to the nature and provenance of this energy are improper and unanswerable; they are unanswerable because the first egress of this energy into the realm of the observable is effected through a quantum emission, and the sequence of states and events leading up to a quantum emission is entirely hidden from us. Even apart from this, it is improper to ask what the electron *is in itself*, since our observation only shows what the electron does in a transaction with some other power-item—a power-item 'transacting' in isolation is unthinkable, and the observation of a power-item in action involves a transaction with the observer.

Consequently, since all knowledge is of items in relation to other items, Dr. Monsarrat abandons the search for absolute truth as chimærical and adopts the relative truth of consistency as his critical canon. For him, true and untrue are "synonymous with congruous and incongruous, accordant and discordant". In other words, "truth" is a property of thought transactions enabling them to be carried forward, and without which thought must either cease entirely or blur out into incoherence. The atom, then, is a dynamic assembly of power-items in action, the molecule is a larger assembly of such atomic assemblies, molecules themselves form higher-order "congregates" which by interaction with other congregates acquire stable structure and pattern, giving individuality, form and properties. All individuals are compounded of power-in-action—this view satisfies the consistency canon, and is the only view which satisfies it.

Turning now to a study of thoughts and the thinker, the author at once encounters a difficulty connected with the possibility of observation. He points out that while we most certainly know, since this is an immediate given, yet because psychic processes go inexorably forward in the time-continuum we can never know our own knowing. Introspection is therefore impossible. Dr. Monsarrat obtains access to the character of his own thinking by making the assumption that his own speech-behaviour gives a reliable account of the thoughts which produced it. This assumption is, of course, a very considerable one, and the author appears to furnish no other warrant for it than to point out that it involves no inconsistency—it enables him to prosecute his inquiry in a coherent manner. Analysis of his own speech-forms convinces Dr. Monsarrat that he too is compounded of power-in-action and nothing more, and that so-called material determinations are merely the relationships limiting this power. Matter is thus dispensed with, the body-mind problem ceases to vex, living and lifeless become names connoting no real differences, the metaphysician is finally deflated, and the man of science is left alone in a monistic universe of which he is the sole interpreter. "Influence is fundamentally of one kind—its effects vary only because it is variously organized."

In his earlier book, Dr. Monsarrat had referred to "the essential δύναμις which is, for us, Nature itself".

How do assemblies and organization come about ? The author says, "I envisage the atoms as constructed of complementary power-units bound by their need for each other". This archetypal union gives us the clue to the simple formula at the end of the book by which the world may find issue from the ills which beset it. Dr. Monsarrat sees three ways lying open to the world : the predatory way, which is the way of competition, power-politics and grab ; the way of fear, which is the way of religion ; and the way of grace, which is the way of science and intelligence. His formula for the way of grace lays down that individuals should "seek their own pleasure by discovering what will please their associates, and by giving them these pleasures".

It scarcely needed the writing of a new book to prove that if everyone *were* unselfish the world would be a happier place. What is really needed is a formula for the steady advance of mankind towards the actual practice of such unselfishness, and such a formula science has not yet produced, and indeed shows little prospect of producing. Surely it is foolish to expect such a formula from those who hold that man is merely a complicated molecular aggregate, and that an adequate account of his nature and dealings may be given by reference to the physical observables which he embodies. Man *is* different, and many of his specific differences are touched upon by Dr. Monsarrat in a way which brings home to the reader the fact that the author has not met with a full measure of success in complying with his own self-imposed critical canon of consistency. He admits that certain individuals (metaphysicians, one gathers) indulge in processes of abstraction the product of which is "fantastic" ; he maintains that common-sense opinions issue from a haphazard survey guided only by desire ; he points out that the predatory way and the way of fear have been the ways of choice for the greater part of the individuals in human history so far. There are then, and history shows that there always have been, trends of the whole individual which run counter to other trends of the same whole individual, and a monistic science cannot integrate these two sets of tendencies into a unitary framework, still less can it heal the conflict between them.

It is not clear what exactly the author conceives power-in-action to be, nor whether he understands power-not-in-action to be a possibility. In his earlier work he stated that the properties of an electron are wholly accounted for by its electrical charge, "electrical charge being a term we use to describe a particular sort of behaviour". There are still minds which reel at the thought of behaviour with nothing behaving, of action without an agent, or of patterning without something patterned, and it may be doubted whether this book will dispel their last doubts. The author makes great use of the idea that the concept of power is derived from the fact that the individual's first, primitive and irreducible affirmation is an affirmation of himself as *able and acting*, but he neglects the fact that this is an affirmation, not of unsubjectivated acting, but of the *self's* own action—*I* am acting ; *I* am knowing.

With the best will in the world, I was unable to find that the numerous diagrams threw any light on the matter under discussion in the book.

J. LEYCESTER KING.

First Steps in Astronomy without a Telescope

By P. F. Burns. Pp. x+214. (London : Ginn and Co., Ltd., n.d.) 5s.

THE late Sir Frank Dyson, when speaking on an educational platform, used to express his disapproval of the omission of so fascinating a subject as astronomy from schemes of science instruction in schools. Nor was he satisfied with the reply that the skies are most attractive when children ought to be in their beds asleep, and that anyhow telescopes are not so easily come by as test-tubes. So much is experimental work preferred to observation and calculation that, as the author of this book says, very few children leave our schools with even a fragmentary knowledge of the starry heavens and of the place of the earth in the universe. To those teachers who would like to remedy this defect Mr. Burns's book will at once appeal. In writing it he has had also in mind young people who are members of the A.T.C. or J.T.C., or who as guides and scouts study for the astronomer's or star-man's badge. The needs of adults also, who wish for guidance in the study of the heavens, have definitely determined both the approach to, and much of the subject-matter of, this introduction to outdoor astronomy. The book is clearly written, carefully graduated, abundantly illustrated, and beautifully produced. It should take its place not only as a text-book, but also as a gift-book.

Control of the Common Fevers

By Twenty-one Contributors, arranged with the help of Dr. Robert Cruickshank by the Editor of *The Lancet*. Pp. vi+361. (London : *The Lancet*, Ltd., 1942.) 12*s*. 6*d*. net.

THIS is a book which will appeal to a large circle of readers, especially health officers and laboratory workers. The subjects discussed are diphtheria, streptococcal infections, scarlet fever, erysipelas, puerperal sepsis, rheumatic fever, pertussis, measles, the common cold, epidemic influenza, the pneumonias, enteric fevers, bacterial food poisoning, bacillary dysentery, gastro-enteritis, undulant fever, cerebrospinal fever, poliomyelitis, catarrhal jaundice, Weil's disease, small-pox and the Rickettsiases. The text is liberally interspersed with charts and diagrams, and a short bibliography of mainly British and American works is appended to all but one (puerperal sepsis) of the chapters, while suggestions for further reading are made at the end of the book.

A Handlist of the Birds of the Sevenoaks or Western District of Kent

By James M. Harrison. Pp. xviii+165+68 plates. (London : H. F. and G. Witherby, Ltd., 1942.) 30*s*. net.

MR. HARRISON'S book is a large and detailed work. The forty-one coloured plates are from good original water-colours by the author, and there are several half-tone and line illustrations.

The observations recorded are those of the author gleaned over a period of twenty years, correlated with those of as many other ornithologists as the author himself could discover. A bibliography, glossary of scientific terms and an index are appended. The work is necessarily specialized and will appeal mainly to those living in the west of Kent and to other British ornithologists.

GOVERNMENT AND SCIENCE IN GREAT BRITAIN*

By The Right Hon. SIR STAFFORD CRIPPS, P.C.

THE problem of the utilization of the scientist in the war effort is one that has been much discussed, though there is in reality no difference in the principles that should be applied in time of war and in time of peace. Whether it is for the purpose of winning victory in war, or of winning decent standards of living in peace, we should equally desire to utilize the highest degree of scientific knowledge in our industries.

There are two main factors in this problem: the provision of an adequate supply of skilled scientific staff, and the proper utilization of the scientific staff available. The neglect of scientific organization, and the failure to appreciate to the full the great part that science was bound to play in a modern war, led us, in the pre-war years, to neglect the organization of the scientific side of war. This we have attempted to remedy in the typical British way by improvising an *ad hoc* organization to deal with the various problems as they arose. We have not created a tidy, blue-print plan of scientific organization of the war effort, but have rather attempted to make the best use of our resources at those points where the resources seemed likely to produce the most valuable results in the quickest time. Hence our structure is one which it is easy to criticize as lacking method and orderliness, but, on the whole, it has, I believe, done as much for us as would any more tidy plan have accomplished, unless such a plan had been laid down and worked out well in advance. In sketching that organization it is perhaps easiest to start at the top.

There are five members of the War Cabinet who are, more or less, directly concerned with scientific matters and who thus represent in the War Cabinet some portion of our scientific effort. In addition to them, the Paymaster-General is a pure scientist and, in a very direct way, is able to assist and advise the Prime Minister who is, of course, Minister of Defence also, upon scientific matters.

In the War Cabinet, the Lord President of the Council is responsible for the Scientific Advisory Committee, which has wide terms of reference upon all scientific matters; and through that Committee the Cabinet is in touch with the Royal Society and with all the principal learned societies of Great Britain. The pooling of scientific knowledge throughout the Commonwealth is assisted by the Committee's association with the scientific liaison offices of the Dominions, and valuable contacts for the exchange of information have also been established with the appropriate bodies in the United States. The Lord President is also responsible for the Engineering Advisory Committee, which carries out similar functions in the field of engineering.

The Council referred to in the Lord President's title is, of course, the Privy Council, and this has long been associated with scientific research. It is the parent body to the Agricultural Research Council and the Medical Research Council, and to the Department of Scientific and Industrial Research, which originated in the War of 1914–18. This latter body is, in its turn, responsible for the National Physical Laboratory and many other research bodies and organizations; and is in intimate association with other research associations both Governmental and industrial. All these are, as it were, centralized research and advisory bodies serving equally any Department.

Next we come to the Minister of Production. Last September three distinguished scientists were attached to the Minister of Production in an advisory capacity as full-time employees of the Government. These advisers are available to assist in all the Departments and can recommend measures for more effective co-ordination. They also act as a link with the British Central Scientific Office in Washington, which co-operates with the members of the supply missions in their joint working with American science. In addition, the Minister of Production is responsible for the Radio Board, which was set up recently to co-ordinate the whole of the work on radio in all the Services, including the Post Office. I preside, in my personal capacity, over this Radio Board on behalf of the Minister of Production.

The Minister of Labour and National Service is responsible for the Central Scientific Register and, in collaboration with the universities, the professional institutions, and the other Government departments concerned, as well as with organizations in Canada and the United States, he has seen to the training and mobilization of our scientific man-power. This has been a most difficult task, especially having in view the enormous growth of scientific personnel required in the Services for operating some of the newest devices.

The Minister of Home Security deals with the specialized scientific needs arising out of the problems of security against air attack, and is responsible for a research and experimental department concerned primarily with protection against the effects of bombing.

The fifth member of the War Cabinet is, of course, the Minister of Defence, and he is connected with the scientific side of the defence services for which the two Secretaries of State and the First Lord of the Admiralty are responsible. He also acts as chairman of the Anti-U-Boat Committee, which deals, among other things, with the scientific side of the anti-U-boat warfare.

So much for the highest level. Next we come to the various supply ministries and the fighting Services. There is a host of liaison committees at different levels between these different Ministries for the exchange of scientific information and experience, but each has its own scientific organization under a director of scientific research. The Ministry of Aircraft Production also has an important organization devoted to radio development, under the controller of communications equipment; though there are, in addition, many scientists operating outside the research sphere, both in development and production, and on operational planning.

One of the most marked developments during the War has been the growth of the application of purely scientific methods to operations, and there are now large scientific staffs in all three Services devoting their skill and energy to operational research.

Co-ordination of Planning and Development

The need for close linkage between the experience in the field and the planning and development of new weapons has been fully realized and methods for obtaining this have been gradually improved as the War has proceeded. Recently a new deputy chief of the Imperial General Staff has been appointed

* Address before a conference of the Association of Scientific Workers on "Planning of Science: in War and in Peace", held during January 30–31.

with the responsibility for ensuring that the Army requirements—and the means of fulfilling them—are projected against the background of modern science and research. In addition to being a member of the Army Council, he is a member of the Ministry of Supply Council and of a number of technical committees of that Ministry. He has under him a scientific adviser to the Army Council, who is also a member of the Scientific Advisory Council of the Ministry of Supply.

In the same way the chairman of the Aeronautical Research Committee is also a member of the Air Council and of the Ministry of Aircraft Production Supply Council, thereby giving a scientific link between the Air Ministry and the Ministry of Aircraft Production.

On the whole range of specialist committees, dealing with every aspect of the air programme, the Air Ministry, the Admiralty, and the Ministry of Aircraft Production are represented.

In the main testing establishments there is complete co-ordination between Service and civilian staff, who together carry the responsibility for testing. In a similar way the controller of communications in the Air Ministry is also controller of communications equipment in the Ministry of Aircraft Production and sits as a member of the Radio Board ; as also does his vice-controller in my Ministry, who is also scientific adviser on telecommunications to the Secretary of State for Air. In this way we have been able to co-ordinate closely the work between the scientist and the Service user.

I have given these indications of the method of organizing scientific work and co-ordination in order to show that at many levels there is a close integration of the work.

This is not to say that, with ample staff and plenty of time, some better organization might not have been elaborated ; but it is sufficient, perhaps, to indicate that the Government attaches the very highest importance to the proper utilization of our scientific effort and has gradually built up during the course of the War a machinery which, from the practical utility point of view, has enabled us in many branches of science to keep well ahead of our enemies.

Government and Industry

A great deal of our scientific strength in Great Britain is of course not in the employment of the Government at all but in the employ of private companies. Many of the great pre-War industrial organizations already had highly skilled research laboratories, which they have extended and which are now working whole-time on Government work.

It is not an easy matter to co-ordinate these organizations, as there has been, in some cases, a not unnatural reluctance for industrial research departments to pool the results of their research, though in other cases this pooling has been done most willingly and to the fullest extent. All these research organizations are, in one way or another, linked up with the various Supply Ministries, though we have not yet reached a perfect method of co-ordination and there is still, I believe, room for a better integration of this section of research and development.

There is one additional feature which I should mention, and perhaps I may do this especially in association with my own Ministry. We have an Aeronautical Research Committee with a number of sub-committees, the members of which are drawn from technical Government staffs and independent scientists with the necessary qualifications. From time to time the membership of these bodies is changed with the view of giving a freshness of outlook ; but the difficulty is, of course, now being felt that so many scientists are either in Government or industrial employment that it is not easy to find independent scientists to serve.

In addition to this, there are advisory committees from the industries themselves consisting of engineers or scientists to whom specific problems may be referred or from whom advice may be sought upon the way to tackle definite questions.

I think that our main difficulty with regard to the proper utilization of the scientists in this war has been our failure to realize, at a sufficiently early stage, that this was going to be a truly scientific war, and that the battle would not be won merely by the physical ascendancy of our race but rather by the ingenuity of those who have been trained in our secondary schools, technical colleges, and universities. This realization has gradually grown upon the country and we are now fully alive to the fact that our survival and our victory depend to a great extent upon the output of our scientists and our research institutions, and that everything must be done to utilize to the full that very high degree of scientific intelligence which Great Britain undoubtedly possesses.

We need not be too critical of the exact manner in which that scientific knowledge is made available, provided only that it is made available and that there are no difficulties from those who still, perhaps, fail to realize fully how great a part science must play.

The scientists of Great Britain have undoubtedly achieved the most remarkable progress during the years of the War, but we must do everything in our power to maintain the lead that we have gained ; I know that, as in the past our scientists have without stint given their services and their devotion to the country so, too, in the future we can look to them for new implements and new devices which will make our salvation certain and will hasten our victory.

THE PLANNING OF SCIENCE

AN open conference on the "Planning of Science" was held in the Caxton Hall, London, on January 30 and 31, under the auspices of the Association of Scientific Workers. Perhaps the most significant comment on the subject was unspoken. For the first time those wishing to confer on the planning of science presented a substantial problem in London traffic control ; 30 per cent of those wishing to attend the first session were—despite resort to a remarkably uncomfortable scale of overcrowding—unable to hear the discussion even from the lobbies ; overflow accommodation, regrettably unavailable for the first session, had to be made available for the third ; the least well-attended session was still a large gathering. No better index of the radical change in public interest need be sought.

Sir Robert Watson Watt, president of the Association of Scientific Workers, at the conclusion of his opening remarks, read a message of greeting dated from Moscow, January 29, 1943, from Vladimir Komarov, president of the Academy of Sciences of the U.S.S.R., and Nikolai Derzhavin, chairman of the Soviet Scientists' Anti-Fascist Committee and member of the Academy of Sciences of the U.S.S.R., in the following terms :

"The role of science is a particularly big one in this War. It was with great satisfaction that we learned that British scientists are devoting their Conference to questions leading to the solution of problems connected with the rapid rout of Hitlerism.

"Since the War broke out Soviet scientists have devoted all their energy to the war effort. Under war conditions, all Soviet scientists have turned their efforts in one direction—to help the Red Army and the industry of the U.S.S.R. This has meant the complete reorganization of all scientific research work. It was necessary to select a few of the many problems on which the Academy of Sciences of the U.S.S.R. was working, those few which gave an answer to war-time problems.

"The Institutes of the Academy of Sciences selected, from among the subjects being worked on, those which are of importance to the War. The programme which was drawn up in this way was communicated to military organizations, who confirmed the importance of the subjects mentioned, and added new problems interesting the Army and Navy. After this, we held a number of conferences with leading commanders of the various arms of the Fighting Services and with leaders of the defence industries. The result was that we were able to concentrate the efforts of our scientists on the most important tasks and also to make full use of our numerous institutes and laboratories.

"The results of 1942 show that we have given great help to the Red Army and have been able to provide the front with many new weapons.

"The reorganization of the work of the Academy of Sciences of the U.S.S.R. in order to satisfy the needs of the Army, made a number of organizational measures necessary. In the early days of the War, the Academy of Sciences organized a Commission for the Mobilization of the Resources of the Urals, Western Siberia and Kazakhstan for Defence Needs. This Commission is working under the guidance of the president of the Academy of Sciences of the U.S.S.R., Vladimir Komarov. The significance of the work done by the Commission may be judged by the fact that the workers of the Commission received Stalin Prizes in 1942.

"Three other Commissions are working for the purpose of mobilizing scientists for defence : first, the Naval Technical Commission, consisting of representatives of the Academy of Sciences, naval establishments and scientific research institutes outside the system of the Academy ; second, a War Medicine Commission ; third, the Commission for the Mobilization of the Resources of the Volga and Kama Districts for Defence Needs. In addition to the work of strengthening the might of the Red Army, scientists of the Soviet Union are continuing their theoretical investigations.

"Without analysing the measures proposed by you for organization of the work of scientists in your country, measures which are dictated by the specific features of the country concerned, we express our confidence that our colleagues in science will take all necessary measures to hasten the rout of the Hitlerite gangs and bring nearer the complete victory of the United Nations."

The Conference then listened (by the courtesy of the B.B.C.) to a recorded exchange of greetings by trans-Atlantic telephone, between Dr. Harry Grundfest, of the Rockefeller Institute for Medical Research and national secretary of the American Association of Scientific Workers, and Sir Robert Watson Watt.

The Central Direction

Sir Stafford Cripps (whose address on "Government and Science" is reproduced in full on p. 152 of this issue) outlined the somewhat complex structure of ministerial, departmental and extra-departmental groups concerned with governmental control of science in application to the war effort in Britain. A schematic diagram was included in the exhibition of photographs, diagrams and printed matter which formed part of the Conference. While the diagram is known to contain errors of balance and detail, it is a useful preliminary attempt to bring the present British arrangements into a single picture.

Sir Alfred Egerton presented a corresponding outline of the arrangements in the United States of America.

Dr. David Shoenberg, who has worked under Kapitza in the Institute for Physical Problems of the Academy of Sciences of the U.S.S.R., Moscow, spoke on "Wartime Science in the U.S.S.R.". He supplemented his account of the structure for central direction of the scientific effort in U.S.S.R. by reading the organizational portions of the greetings from Moscow reproduced above. The general organization outlined by Dr. Shoenberg was also represented diagrammatically.

Existing Systems

It was not unnatural that the detail of the pictures seen across an ocean or half a continent should appear simpler than that of the close-up. But oversimplification in presentation of the less familiar systems of the United States and the U.S.S.R. could not wholly account for the criticisms of that of Great Britain. The Conference may not have judged the organizations catalogued by Sir Stafford Cripps as harshly as did the speaker who quoted Lord Chesterfield's opinion, according to the Duke of Wellington, of the generals of his day: "I only hope that when the enemy reads the list of their names he trembles as I do". There was, however, found no one to go beyond Sir Stafford's qualified enthusiasm : "on the whole . . . done as much for us as would any more tidy plan . . . unless . . . worked out well in advance".

Speakers who had first-hand knowledge of conditions in the United States and the U.S.S.R. emphasized the large scale of provision for research, for scientific and technical education, and for the application of science by both these allied nations. The general lavishness of their support for science, the magnificent facilities, the numerical adequacy of the research teams and the scale of technical help and workshop services were all contrasted with the limited provision at home. "Boston Tech." and "Cal. Tech." are the giants of their class, but the somewhat smaller institutes in the U.S.S.R. are no less generously appointed.

Dr. Shoenberg gave an impressive account of the way in which scientific work was from the beginning linked to purpose, and of the "conscious planning" which distributed inter-related problems over a number of institutes, with consequent avoidance of overlapping, and facilitation of collaboration. He emphasized the scale on which long-term biological research is being maintained in the U.S.S.R. and contrasted this policy with the British policy of diverting biologists towards filling gaps left by our inadequate supply of physicists.

The speed with which the gap between research and production could be bridged in the United States was illustrated by the case of a pilot plant for a new explosive-manufacturing process. This plant was in production within thirty days of the conference between the university chemist and the chemical engineers. Sir Alfred Egerton, who gave this example, selected "the high scientific importance of the Industrial Research laboratories" as the greatest difference between the United States and Great Britain.

The Ages of Wisdom

The most insistent criticism of the existing arrangements in Great Britain was directed against the general failure to bring the young scientific and technical workers in the laboratory or the plant into the formation of policy, the implicit assumption that the most distinguished men are the oldest men, the septuagenarian, octogenarian and (in one case) nonagenarian chairmen, the obstacles preventing the minor member of the scientific democracy bringing his views to the governing body.

It was recognized that the young worker should not be snatched from his productive work to full-time service in governing or co-ordinating bodies, but it was regarded as impossible for the most modern scientific technique to be represented by the once brilliant laboratory or plant worker who has been so long in 'management' that he is no longer in touch with the thoughts and ways of his immediate successors.

The Conference was reminded of C. K. Mees's dictum that "the man on the job knows most, the Director of Research very little, the committee of Vice-Presidents nothing at all".

There was constant emphasis on the need for planning and co-ordination from below, to complement and consolidate with planning and co-ordination from above.

Closely related to this group of comments was that which called for direct contacts between the relatively junior executive officers in the Fighting Services and the junior scientific workers who could solve the problems posed by their serving contemporaries.

A Central Scientific and Technical Board

Mr. E. D. Swann, speaking for the executive of the Association of Scientific Workers, reviewed the deficiency in the applications of science to the war effort which the Association discussed in its earlier Conference, and the partial rectification which has been achieved in the intervening year. These deficiencies include failure to pool information and facilities, to concentrate effort on vital war needs only, to ensure full co-ordination between Government departments and between these departments and industry, to utilize fully the initiative of the individual worker.

Towards the fuller rectification of these defects the Association proposes the setting up of a Central Scientific and Technical Board, composed of scientifically and technically qualified persons. This Board would be in direct contact with the War Cabinet and able to raise items on its agenda. In this important respect the proposed Board would differ from the existing advisory bodies. Its functions would be to advise the War Cabinet on scientific matters and to relate the country's scientific effort to the strategy determined by the War Cabinet. In relation to science the Board would possess executive powers enabling it to survey scientific problems, to allocate priorities to the various problems and the necessary resources to deal with them. It would establish the date by which scientific projects should reach completion and review their progress and the resources allocated to them from time to time. The Board would need the authority to initiate or stop programmes of work and to transfer personnel where necessary. It would also need powers to demand any scientific or technical data from any firm or industrial department.

It was clearly recognized that over-planning of science may produce a greater measure of frustration than does our present scale of under-planning. What is sought is a system which will make it easy for the individual scientific and technical worker to give his full effort, with adequate facilities, in that grouping which is best adjusted to the need of the moment, and with an understanding of the broad reasons for its programme in relation to that need.

"We do not want the individual worker to spend a large part of his time explaining to central planning boards what he would have been doing if he had not been explaining to them. We do want the central boards to help the workers to do their work better, by explaining to them why they are asked to do certain things in a certain grouping at a certain time. But mainly we want to ensure that the things and the grouping and the timing are part of one integrated plan of utilization."

Science and the Soldier

Air Chief Marshal Sir Philip Joubert said "the association of science and the fighting man is no new thing. But perhaps it has reached its highest development during the adolescence of the Royal Air Force". He described the "harmonious co-operation of science and the military art which achieved outstanding success in the Battle of Britain".

Sir Philip's main theme was the growth, the essential nature, and the necessary limits of operational research.

"The desirable situation is when the Service side realizes a series of needs and passes straightforward questions to the scientist. Such questions must, of course, be capable of consideration by scientific methods. By this I mean they must be questions of fact, not of theory. The facts of the war in the air can be clearly stated. For example, it may be necessary to decide how many flying hours with so many aircraft are required to achieve a certain result. Given past experience, scientific analysis will quickly provide the answer to this question. Naturally, all the questions are not so simple in form.

"The position becomes more complicated when the military staff are not quite certain what they want and are unable to state their case clearly. The scientist then must grope for his solution and it is here that a very serious difficulty may arise.

"The prosecution of war is, in principle, an art. The methods to be employed are based on past experience and study, but their application to a particular problem must be a matter of judgment. The military man, by education and experience, if he is to succeed, must have this judgment. The scientist is not fitted, either by his training or his experience, to exercise that judgment. But if he is insufficiently guided by the military staff, in the course of his researches he is almost certain to trespass into the realm of military art. It is therefore of the utmost importance that the military staff should give the scientist the clearest guidance on his duties.

"If, however, the scientist never initiates any action and always waits to be asked a question by the military staff, he will lose half his value. It is a truism to say that the solution to a problem which puzzles those who are constantly working on it is often grasped very quickly by a new-comer, and it is certain that the advent of the Operational Research Sections has resulted in many difficulties being cleared away by the sound advice they have given. I must, however, insist upon the point that this advice should be confined to the purely factual aspect of any problem. To my mind it is not the business of Operational Research Sections to advise on future operations. They can examine past operations and draw conclusions from them, but it is for the military staffs to apply these conclusions as modified by their military judgment."

The natural extension of the methods of operational research into post-war life generally was treated by a member of an operational research staff in a thoughtful and stimulating contribution, one of several from which the importance of operational research methods emerged very clearly.

Science and the Educational System

It was noteworthy that the first and the last addresses to the Conference, as well as many between, ascribed the major obstacles to full utilization of science in the service of humanity to the unbalance in education between science and the 'humanities'. This diminishing but persisting unbalance, it was stated, accounts for the famine of scientific and technical workers which now faces us. It accounts, too, for the disproportionate effort required to convey to the administrators, the politicians and the industrialists the true nature of science in the service of civilization, its method and its possibilities.

It is, however, impossible to await the radical cure, which requires first the re-education of our educators. The process must be undertaken, but we must simultaneously take measures which will have earlier effect.

Science and Parliament

The Parliamentary and Scientific Committee owes to the Association of Scientific Workers alike its foundation and its resuscitation from the remarkable suspension of its activities which was decided on at the beginning of the War. The Committee goes far towards solution of the problem of acquainting Parliament with scientific opinion on all matters of current importance. It aids the presentation of questions and resolutions in Parliament, and approach to Ministers by deputation and interview.

Lord Hinchingbrooke offered advice to the Conference on the technique of bringing scientific ideas into the forum of Parliament. He said that politicians are people who know a little about a very great deal, and urged the need for showing clearly the application of any idea presented, and for avoiding dilution of important information by its inclusion in bulky and frequent collections of miscellaneous matter.

Prof. S. Chapman, while refusing to accept politics as anything higher than a regrettable necessity in the relations of science and the community, is convinced that scientific workers should be of and among the legislators, should be in the Mother of Parliaments as of right and of duty. Science should be recognized as one of the Estates of the Realm, and should have its life representatives in the Upper House. These "bishops of science", men and women, should be chosen by the scientific workers themselves, and should come from the age groups of the thirties and forties as well as from the fifties and sixties. They should number twenty rather than two, they would not necessarily be the very best scientists, but should have knowledge of politics and affairs in addition to their scientific knowledge.

Science and Industrial Managements

Colonel W. C. Devereux, managing director of High Duty Alloys, Ltd., spoke as a "professional manager", from that inarticulate class called "management".

"I hope I am right in believing that the day is past for ever when the scientific worker in industry—the works chemist or metallurgist—was regarded by the management as a necessary evil; as someone who should be put away quietly in a dirty little shack miscalled a laboratory, and brought out only to put on the carpet and abused for anything that had gone wrong, or to produce an immediate solution to any troubles which would not yield to more direct methods of attack. To-day, the value of scientific research and control is appreciated by progressive management as an essential part of a manufacturing organization. I do not believe that good management, and by this I mean competent men who understand the technical processes they control, finds any great difficulty in interpreting and applying the recommendations of the scientific workers. The greater difficulty is to convey to the scientist the problems requiring solution and to direct him along the right lines of investigation."

Kettering, of General Motors, sums up the position very wisely when he says: "It may not always be the best policy to adopt a course that is best technically, but those responsible for policy can never form a right judgment without knowledge of what is right technically".

After outlining the organization of the scientific and technical staff in his own companies—on a scale exceptional in industry—Col. Devereux quoted the results of two investigations initiated by his economy committee, one for fuel economy in which the £35,000 capital expenditure incurred in providing re-designed combustion chambers and the like was saved within the first year of use, and one for modifications in a bought-out material, the cost of the investigation being repaid by the savings on a single day's purchases.

Col. Devereux was critical alike of the research associations and of the existing national laboratories. The former "have not so far been a really important factor in industrial development. This is readily understandable when one considers the . . . lack of backing which these organizations receive from industry and the Government." "Our existing national laboratories . . . sometimes become a sort of blissful oasis where certain scientific gentlemen can browse in quiet seclusion to their hearts' content." His constructive prescriptions for a better state of things deserves more space than can be given in this summary of nine hours of wide-ranging discussion; he proved himself a powerful and stimulating friend of the scientific worker.

Joint Production Committees

A substantial proportion of the detailed discussion on the immediate fuller application of scientific and technical knowledge to war production was devoted to the problem of Joint Production and Advisory Committees in industry. The Association noted with special satisfaction the acceptance by the Minister of

Aircraft Production of its contention that scientific and technical staffs should have their own representation alongside 'management' and 'labour' in these committees. The strength of the resentment felt by the Conference in relation to "the deliberate policy of the Employers' National Federation to exclude from the Joint Production and Advisory Committees any representatives of the staff" was unmistakable.

A representative from Hayes made a valuable contribution describing the success of local co-operation between scientific and technical staff and other organized groups of the labour force towards mitigating the evils resulting from this exclusion from Joint Production Committees. Only one speaker was able to present himself as an actual member of such a Committee, although another was able to underline the absurdity of a situation in which one technical worker, excluded from membership of a Joint Production Committee, has already been co-opted to the Committee on four separate occasions to help in the consideration of special problems.

International Co-operation

Throughout the discussion there was constant reference to the need for closer inter-Allied co-operation, and in particular to the need for wide extension of the existing arrangements by which young workers from the war laboratories visit their colleagues in other countries, not merely for discussion but also for work side by side in Allied teams. It was emphasized by Sir Robert Watson Watt that only the indispensables should be spared from this vital work.

The inadequacy of the initial response by the United States and Great Britain alike to the U.S.S.R. offer of help on the synthetic rubber problem was cited as an example of grievous failure in inter-Allied co-operation, not yet incapable of rectification. Immediate action, again by way of a personal mission of young and active workers, was called for.

Determining the Future

The contributions by Sir Lawrence Bragg, "The Position of Scientists after the War", by Prof. P. M. S. Blackett on "The Rehabilitation of Fundamental Research", and by Prof. H. Levy on "The Basis of Scientific Planning", introduced the discussion, in the third and final session of the Conference, on "Determining the Future". The proceedings at this long and crowded session were of such importance that they merit separate treatment. No attempt is, therefore, made to summarize them in the present review.

Summary

The points on which the most vigorous criticism, and pressure for reform, were expressed in the Conference were:

(1) The need for a stronger, simpler and more closely knit fabric of central direction of scientific effort in the War, controlled by active scientific workers with full knowledge of War Cabinet policy and current strategy.

(2) The need for constant participation by the young scientific worker in the shaping and direction of policy and in its execution.

(3) The need for direct interchange of view between the junior user and the junior scientific worker. (This was admirably summed up by Mr. Hilton Brown in a broadcast to schools on February 2, in which he showed the junior military officer and the junior scientific officer at the foot of the two legs of the letter A, without adequate provision of bridges below the apex.)

PLACE OF RESEARCH IN THE CONTROL OF INJURIOUS INSECTS*

By Prof. J. W. MUNRO

Imperial College of Science and Technology

It is well to remember that it is not necessary nor is it even practicable wholly to exterminate populations of injurious insects. For example, the Ministry of Agriculture has found that the growing of wheat on land carrying a population of wireworms of 600,000 per acre is economic, but on land carrying a higher population it is risky. It follows that if on heavily infested land the wireworm population could be reduced below 600,000 per acre the growing of wheat would be economical and for practical purposes control would be achieved.

As an example of the different kinds of work or investigation which the control of injurious insects entails I propose to take the control of insects affecting food-stuffs and other produce during transit and storage. These insects are, especially in war-time, a potential danger to the national economy, and methods of controlling them are only now being developed in Great Britain.

In 1929 I was asked by the Australian Dried Fruits Board to advise and assist them in dealing with infestation of sultanas and raisins by the phycitid moth *Plodia interpunctella*. The infestation occurred in these dried fruits on their arrival in London, and persisted and increased during storage in the warehouses prior to marketing.

The facts concerning this infestation and the measures which had then been taken to combat it were these. Infestation undoubtedly occurred in the drying and packing sheds of the fruit growers in Australia. It occurred in the packages of the fruit on shipment, and on the voyage from Australia to England became aggravated during the passage through the tropics. Measures were being taken in Australia to reduce infestation and, in Great Britain, a system of fumigation of all incoming fruit had been introduced. Cases of fruit arriving on shipboard in the Thames were transferred to barges for delivery to various warehouses up river, and all these cases were fumigated. A further step towards control was taken at that time by centralizing storage in a single group of warehouses instead of spreading it over many warehouses, and it seemed as if the prospect of control was promising. In 1929, however, it became evident that these measures were unavailing and it was then that I accepted responsibility for a review of the whole question of control to be practised in Great Britain and for the conduct of such investigations as might be necessary to ensure it.

A rapid survey of the conditions then prevailing showed that failure to achieve control was caused by the inefficiency of the fumigation of the fruit in barges and chambers, and it became necessary to investigate this. It soon became evident that fumigation practice was wholly empirical and that that could only be remedied by investigation of a number of problems. The more important of these concerned methods of determining the concentration of the gas obtained during the fumigation both in the air space of the barge or chamber and on and within the sultanas and raisins. Then came the need to

* Substance of a discourse before the Royal Institution on December 18.

study how a gas behaved during fumigation, to study the factors that affected its distribution and determined how much of the gas was adsorbed on the walls of the barge or chamber, on the fruit boxes and on the fruit itself, and how much was available after adsorption had taken place to perform the primary function of killing the insects. Then came other problems. It became necessary to ascertain for a number of fumigants what concentrations were required to kill the insects—caterpillars, chrysalides and moths in various stages of development and in different physiological states. For this experimental work it was necessary to rear large numbers of insects, and before much progress had been made with that, quite a number of problems of entomological interest arose, such as why some insects became sterile when reared at temperatures above 27° C. and why on some foods some species flourished better than others.

Already a wide field of investigation had become necessary involving work in physical chemistry and insect biology. Almost at the beginning of the physical chemical work on the behaviour of gases during fumigation, it became clear that mixtures of gases used as fumigants had obvious disadvantages. Such mixtures are used when the more toxic or active gas is inflammable or explosive and the purpose of the mixture is to reduce the risk of fire and explosion by using a non-inflammable gas as a blanketing agent. It soon became apparent that the failure of the fumigation system used by the Australian Dried Fruits Board lay in the use of a mixed fumigant. This fumigant was a mixture of carbon disulphide and carbon tetrachloride. Carbon disulphide is reasonably toxic, but inflammable and explosive. Carbon tetrachloride is poorly toxic to insects and non-inflammable.

The operator in charge of fumigation was, in fact, in a dilemma. If he made for safety against fire risk he was almost certain to fail to get a high percentage 'kill' of the insects. If he made for a high 'kill' he ran serious risk of fire and explosion. The practical result was that he had to risk survival of some insects because after one or two accidents he dared not risk more explosions. In doing this he allowed a population of insects to build itself up in the warehouses in which the fruit was stored after fumigation. We were not aware of that at the time. Meanwhile, we decided as a result of preliminary chemical work to recommend the abandonment of a mixed fumigant and the adoption of the simple fumigant ethylene oxide. After some experimental work in barges we secured a complete destruction of insects by using ethylene oxide, and the prospect of controlling Plodia in dried fruits looked good.

It was not until ethylene oxide had been in use for some time that we found that, even when we were certain all insects in the fruit had been destroyed, complaints were still made by merchants that the fruit they purchased was infested. Then we had to try to find out the defect in our new methods. There was no defect in our system of fumigation of fruit on arrival. The cause of continued complaints was that fruit was becoming re-infested during storage in the warehouse and this was a direct result of the failure of the mixed fumigant previously used. Here we were faced with a new practical problem. We had controlled insects in fruit during the transfer from shipboard to the wharf by fumigation in barges. We now had to control them in the warehouses. A series of rather costly experiments carried out showed that fumigation of large warehouses of 150,000 cubic feet capacity was at that time impracticable. Leakage was considerable and cost almost prohibitive. I then decided to try the use of a spray to kill caterpillars crawling on the fruit boxes and around walls and dunnage. That was not very promising. Then with some hesitation I decided on a rather bold experiment. A research student in my department was studying the rhythm of emergence of moths from their chrysalides. These moths showed a marked rhythm of emergence, leaving their chrysalides when the temperature of the day fell about dusk. It seemed possible that if the moths in the warehouse also showed such regularity we might be able to destroy them by spraying. The spraying of caterpillars on wares and walls failed because only those caterpillars which were exposed could be killed by the spray then in use, while large numbers hidden in cracks and crevices could not be reached. On the other hand, if by a systematic attack on the moths as they emerged from these cracks and crevices we could in time reduce their numbers below an economic level, control would be achieved. By sending up into the warehouse at dusk a fine spray of pyrethrum in oil we found we could kill large numbers of moths, and then the boldness of our strategy was rewarded by a wholly unexpected result. The mist sent up settled everywhere, forming a fine film of pyrethrum in oil, and this film proved fatal to caterpillars crawling over it. It was in fact so effective that in the following season we abandoned spraying at dusk and instituted a regular system of spraying in the daytime.

During three seasons in London and two seasons of this work in Bristol, Liverpool, Manchester and Glasgow we continued this combination of fumigation in barges and spraying in warehouses, and found then that we had successfully controlled infestation by Plodia.

Over the period 1930–35 the cost of laboratory research, experimental work at the docks, and actual control work at the docks was in round figures £30,000. In 1939 the saving effected as a result of the control measures devised had reached a value of £150,000. One further feature of this work deserves mention. Throughout the whole period of the work, both in the early stages when the work was experimental and in the later stages when it became routine practice, there was the fullest confidence and co-operation between the research workers and the officers of the Australian Dried Fruits Board.

In the course of our laboratory investigations we were acquiring knowledge of the behaviour of fumigants and of the principles underlying fumigation; we were also acquiring much knowledge of the habits and biology of insects. The work done on fumigants may readily be divided into large-scale experimental work at the London docks and laboratory experimental work. The first concerned the application of fumigants to ships and warehouses and dealt with such problems as the measurement of gas concentrations during fumigation; the distribution of the gases ethylene oxide and hydrogen cyanide in empty warehouses, the effects of different methods of stacking or piling goods on the distribution of these gases in barges and warehouses, and the various means by which distribution could be improved by using vaporizers and fans.

The laboratory work dealt with the determination of fumigants. First, methods of determination were devised, and then the amounts of gas remaining in various food products were determined. This work was of high importance because it afforded the means for ascertaining how far various fumigants could be used with safety on various foods under varying conditions, what residues were left in the foods and what measures were required to reduce these residues to the lowest level. The results of all this work have recently been summarized and published by the Department of Scientific and Industrial Research as a pamphlet, under the title "The Principles and Practice of Fumigation".

The biological work done may also be divided into field work carried out at the London docks and laboratory work. The field work comprised studies of the life-histories and habits of various insects living in warehouses, and studies of the effect of sprays and fumigants on the populations of these insects. Laboratory work dealt with the factors affecting insect fertility both during development and in the adult stages. Systematic revision of groups or genera of the most important insects infesting foodstuffs was undertaken, notably a revision of the moths of the genera Ephestia and Plodia. Other subjects studied were the resistance of insects to high temperature, the experimental analysis of the factors governing the hours of emergence of insects from their pupæ, the nutritional requirements of important species, and certain aspects of respiration. Then came various studies of the toxicity of fumigants, ethylene oxide, hydrogen cyanide and sulphur dioxide, and of various contact insecticides such as pyrethrum and the thiocyanates.

In 1937 a small beetle belonging to the family Ptinidæ, or spider beetles, appeared in the fruit warehouses and caused considerable concern. The chief cause of this was that, unlike *Plodia interpunctella*, this beetle was not very susceptible to our Pyrethrum insecticide. This new problem, together with others which had arisen both in our chemical and in our biological work, clearly showed the need to extend our scientific work to include insect physiology, and the most cogent argument for that lay in the part knowledge of physiology could play in giving us a better understanding of our insecticide problems. So, with the assistance of the Agricultural Research Council, we embarked on physiological work, and because the insecticides (fumigants and sprays) with which we were concerned had to act through the skin or cuticle of the insect, it seemed reasonable to begin with a study of the insect cuticle and its bearing on the mode of action of insecticides. The work undertaken was broadly considered under three main heads: a study of the changes occurring in the cuticle during growth of the insect, a study of the biochemistry of the cuticle, and a study of the lesions produced in various organs or tissues when the insecticide had penetrated the cuticle.

Meanwhile our practical work on the control of insects infesting dried fruits had ceased and I was concerned with another practical problem, the control of the bed-bug. That work was being undertaken on behalf of the Medical Research Council, and in the course of it a fraction of heavy naphtha as produced in gas works was examined as a potential insecticide. This heavy naphtha comprised a number of constituents: indene, pseudocumene, coumarone and paraffins. Of these it was thought pseudocumene would be the most insecticidal, and in particular it was taken for granted that the paraffins were inactive and were in fact unwanted diluents. On this assumption it was decided to eliminate the paraffins, but when this was done the toxicity or insecticidal value of the heavy naphtha fell markedly and some of the paraffins had to be restored. After some further work the practical use of heavy naphtha against the bed-bug was made possible and the work on it ceased. Meanwhile, the interesting scientific problem of the part played by the apparently inert and relatively non-toxic paraffins remained, and by means of a grant from the Department of Scientific and Industrial Research the problem was studied further by investigating the permeability of the insect cuticle, again as an aid to the understanding of the mode of action of insecticides. This investigation had not gone far when it became evident that the really fundamental questions to be answered lay in the realm of surface physics and colloid chemistry, and again the scope of our scientific work was extended.

With that broad but unavoidably confused sketch of the relationship between the practical problem of controlling injurious insects and the laboratory investigations which are essential to its solution, I think we can now consider the place of research in entomological practice. The following items of experience gained in this work deserve notice because they illustrate three fundamental principles in applied entomology. First, that the way to tackle a practical problem is to get right down to it. When that is done the scientific problem becomes clearer. Second, that the research necessary for the solution of practical problems can only be defined when both research and practice keep in the closest touch with one another. In so young a science as biology applied in fields other than medicine it is idle to suppose that research basic to agriculture or to industry or to public health can be planned within the four walls of a laboratory. Third, that the scientific work required for the solution of practical problems cannot be confined by any doctrinaire or academic definition of the branch or branches of science in which it lies. The fact that a practitioner is a zoologist or an entomologist by training is no excuse for his failing to follow his work into chemistry or physics if that is necessary.

I should like to stress these points because recent experience in dealing with war-time problems has itself stressed them. The practical work on fumigation and on the use of pyrethrum-in-oil films carried out in controlling insects infesting dried fruits forms the basis of the extensive control of insects affecting foodstuffs now practised by the Infestation Control Branch of the Ministry of Food. All the fields of research opened up in attaining the control of the moth *Plodia interpunctella* are now being worked in and extended by the recently established Pest Infestation Laboratory of the Department of Scientific and Industrial Research, and it is, I think, significant that the most recent development of all, the investigation of the factors affecting the passage of insecticides through the insect cuticle, offers reasonable promise that it may before very long provide a means of greatly saving insecticide materials. These are now, as a result of the war, 'in short supply' and urgently needed not only for the protection of growing crops and of food in store but even more for the control of flies, mosquitoes and other insect vectors of disease which are so important a factor on all the fronts on which we are now fighting.

Experience in the last three years has stressed another important feature of insect control work. In spite of the great extension of practice and of the greatly increased tempo of research and particularly of what is called short-term or *ad hoc* research, it is the long-term or basic research which is paying the highest dividends in practical results. This may seem paradoxical. The objectives of short-term or *ad hoc* research are those thought to be within reasonably easy reach, and the research itself usually covers a severely restricted field. The objectives of basic or long-term research are usually distant and the research itself is nearly always planned on a broad basis. It is precisely this planning on a broad basis that makes it valuable not only in science but also in practice, and in the light of the experience of the last three years I am almost tempted to believe that if provision is made for long-range research on a broad basis in which the closest contact is maintained with practice, much of the *ad hoc* work carried out in relation to the control of injurious insects might be dispensed with. That may, however, be to simplify matters too much, because there is often a gap between basic research and practice which can only be filled by *ad hoc* work. On the other hand, my own experience strongly suggests that it might be better if this necessary *ad hoc* work were carried out jointly by the practitioners and the research workers.

In recent years in applied entomology there has grown up a kind of investigation commonly called *ad hoc* research which has in my opinion little value. It is the kind of work which assumes that any kind of investigation, because it relates to an injurious insect or to the use of insecticides, is *ipso facto* of economic or applied scientific value. The literature of economic entomology is overburdened with accounts of work of that kind almost to the despair of the serious research worker and of the practitioner alike, because the work described is too often neither good science nor good practice. The possibility that in economic as in scientific work the discovery of new laws and principles may solve a problem cannot be overlooked, and in seeking to discover new laws and principles relating to insect behaviour or to the mode of action of insecticides it may be the simpler, if not the only, approach to study quite other insects than the injurious ones and then, having gained an understanding of principles, apply these principles to the solution of the practical problem.

I refer to this misunderstanding of research in applied entomology because recent experience has thrown it into high relief, and because the same experience has emphasized the value of a background of research as free and untrammelled by immediately practical considerations as is possible in a workaday world.

I favour, then, the freest basic research in the closest contact with practice, but I often meet with the view that free research aimed at the discovery of new laws and principles is incompatible with practice ; that it is impracticable in war-time ; that research and practice cannot run in double harness, and that their aims are totally different. That their aims may be different I do not for a moment deny, but that they are incompatible is demonstrably untrue.

So it comes about that in this field of work in the control of injurious insects there is and must be a continuous going to and fro between practice and research and between research and practice. They are not incompatible ; they are complementary, and it may be some compensation for the sorrow and tragedy of war if in this and in other fields fundamental research and practice can continue to work together.

MUSEUMS AND EDUCATION

By G. F. WESTCOTT

Science Museum, South Kensington, London

THE present world upheaval is partly due to the fact that man's control over his physical environment has advanced rapidly, while the ideas and methods which he uses for controlling his relations with his fellows have developed much more slowly.

One of the most important psychological features of man is his emotional and habit-forming nature. This nature has been essential to the development of civilization, by enabling the individuals of a nation to act together as a community with a common purpose. It is particularly valuable when reasoning cannot be used, whether for lack of intelligence or time or when the amount of evidence available to all is insufficient to produce logically a reasonable uniformity of opinion. No human being can be logical all the time : we all use many ideas, obtained by habit or suggestion or by previous reasoning, which are frequently emotionally reinforced and have become practically impervious to reason or suggestion in normal conditions. These ideas are often the guiding principles of our lives, which enable us to act quickly and help to give us our characters. They simplify our lives and save us from becoming choked by logical entanglements. It is an example of the small part reason plays in human life that these most fundamental ideas, particularly liable to emotional reinforcement, have received the least amount of study by scientific methods.

In the past, poor communications and the strong influence of tradition have been safeguards against the sudden rise over a large area of a new system of ideas. But to-day there is a loss of faith in tradition and, as we have seen only too clearly, the tremendous developments in our methods of communication and propaganda, especially when combined with repression and the destruction of all opposition (which can also now be organized and applied rapidly over a wide area), can change the purpose of a nation in a very short time, with disastrous results to the whole world. Emotions are so strong that they can be acted upon to reinforce almost any idea, whether right or wrong, and even against the balance of direct evidence. Repeated propaganda, especially if contradictions are suppressed, can also be used to form mental habits and so strengthen particular ideas.

In the past there has been a number of ideologies, sometimes on a national basis, and competition between them may have tended to ensure the survival of the fittest, even though this may often have meant mainly the ability to destroy its rivals by force or subterfuge ; but the world seems to be approaching a time when, at least in certain directions, there may be only a few generally accepted views. It is essential, if development is not to be retarded, to provide for constant criticism and research, so that the best ideas may have a chance of coming into use. Perhaps a practical objective science of ideas and thought will be developed as a safeguard—indeed, work has already been done on these lines. This would result in further mental instruments being devised to enable man to transcend his natural abilities.

A practical ideology must satisfy at least two conditions : it must be expressed in such a way that it will communicate at least some acceptable meaning to many of the individuals concerned, and it must be

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(Incorporated by Royal Charter, 1885)

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

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Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1. The last day for the receipt of applications is Monday, March 1, 1943.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS.
Principal of the College.

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The Chair of Chemistry in the University College of North Wales, Bangor, having become vacant, the College Council will proceed to appoint a Professor. Salary £850 per annum.

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F. P. G. HUNTER,
Bursar and Acting Registrar.

February 1, 1943.

Laboratory assistant wanted for school laboratory. All particulars may be obtained from, and applications sent to: The Senior Science Master, The Science Schools, Harrow School, Harrow, Middlesex.

Library assistant (temporary) required. Experience in special library essential. Salary £250 per annum. Applications to The Acting Librarian, The Chemical Society, Burlington House, Piccadilly, W.1.

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The Governing Body invites applications for a post as LECTURER IN CHEMISTRY. Duties to commence on May 1, 1943. Candidates should have a good honours degree in Chemistry. Experience in industry, teaching, and/or research is desirable. Preference will be given to candidates with special qualifications in Physical Chemistry. Salary in accordance with the Burnham Technical Scale. A special allowance might be paid to an exceptionally well-qualified candidate.

Further particulars and application form will be sent by the undersigned on receipt of a stamped addressed foolscap envelope. Last date for the receipt of applications February 13, 1943.

J. F. S. ROSS,
Principal and Clerk to the Governing Body.

January 25, 1943.

LONDON COUNTY COUNCIL

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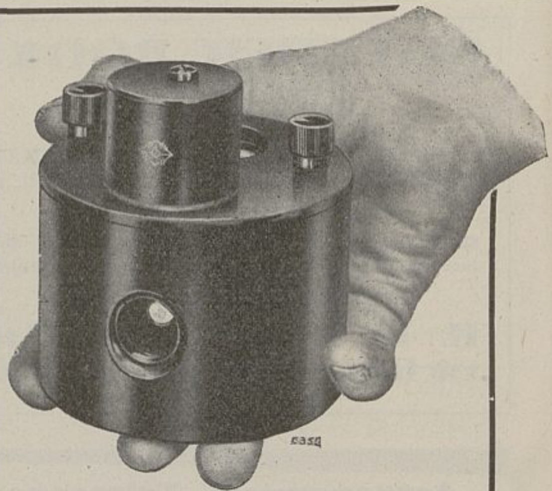

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sufficiently in touch with reality on essential points to be workable. Many of the most important ideas on which our present civilization has been built, especially in the moral and political spheres, are upheld by the authority of tradition. This, owing to its strong power of resisting change, has probably provided the stability needed for the development of civilization in other directions. Tradition, however, in these spheres seems to be losing its power and also appears to be too resistant to change to keep pace with modern events, leading to the danger and actual occurrence of revolutions based on the authority of dominating individuals using all the modern methods of mass influence. It would be disastrous if civilization were to be left to the control of such ephemeral and fortuitous authorities, and it seems clear that there is an urgent need for some new kind of authority, more universal and stable and capable of rapid adaptation to new factors in the situation as they occur. The position is perhaps similar to that of several centuries ago, when the authority of tradition began to give way to the authority of knowledge based on experiment in the domain of the physical sciences. The rapid advances which have been made in science are mainly due to the use of methods which largely eliminate the effects of emotion, habit and prejudice; if we are to advance quickly and safely in the moral sphere, I believe we must use similar methods.

At the present time it may still be expedient that our conduct and ethical ideas should be guided largely by tradition, to prevent confusion and rash experiments, but I think that with an adequate historical background there would be little danger of trouble occurring even if people should be encouraged to think logically for themselves on such subjects. In the absence of emotional reinforcement the position would be similar to that in science, where a new idea, even if truer than previous ideas, meets with great opposition until it has been thoroughly tried out and assimilated into the main body of accepted theory.

The evidence on moral and political subjects obtained and presented by scientific methods is steadily increasing and may soon be sufficient to ensure a reasonable uniformity of educated opinion, if made readily available to all adults. Particularly since the beginning of the present century, new ideas and methods have been introduced into psychology and, though as yet psychology is apt to be regarded more as an art than a science and there is much conflict of ideas still to be resolved, our knowledge of human conduct has been considerably increased. The time is not far distant when our knowledge of how men do act will greatly influence our views as to how they should act. Such an ethic would increase our understanding and sympathy for others, whether nations, races or individuals.

It seems essential, especially if democracy is to survive and produce the best results, that as many people as possible should be taught how to think for themselves, and how to protect themselves from emotional exploitation for false or evil purposes. The individual must become more critical; though fortunately he cannot escape his emotional nature, and thus deprive life of much of its interest and drive, he can do his best to ensure that his feelings shall only be used to reinforce ideas, and particularly innovations, which conform with the best evidence available.

I would suggest that, among the objects of education in a democracy, the following are important:

(1) To provide the individual with a reasonably stable and dependable background for his mental development.

(2) To teach him how to think for himself and how to obtain reliable data, and to encourage him to use reasonable criticism and constant research.

(3) To help him to learn how to use his emotions and how to guard himself against their misuse by others.

(4) To discover and develop his abilities, so that he may become a useful member of the community.

Museums as an Educational Medium

In this particular connexion let us consider our national museums. The four selected objects are of the kind for which museums could be of the greatest assistance, and the following indicate some of the ways in which museums could help to attain these objects.

(1) For the later mental development of the individual a historical background is the most universal and stable. A knowledge of the past is a great help in understanding and dealing with the present and preparing for the future. Museums, by preserving the physical evidences of the past and by orderly arrangement, can do much to provide a common historical background.

(2) By examining examples of the work of men of the past, of the triumphs of critical thinkers and of scientific research, the visitor to a museum is bound to be impressed by the value of these methods and may be encouraged to try to use them himself. Museums and their associated public libraries would themselves be one of the sources of reliable data.

(3) Museums at the present time only help towards obtaining emotional control indirectly; for example, by inference from the insight they give into historical processes. To be more effective (*a*) there should be a museum (or part of a museum) devoted to psychology, and (*b*) an attempt should be made in museums generally to illustrate the influence of widespread (and consequently often emotionally reinforced) ideas on the development of civilization, so as to show which have produced permanent and which relatively fleeting effects. The evidential material thus made available in an interesting way would provide a stable background for judging the value of ideas.

The opportunity afforded by museums for studying the actual evidence on which authorities have based their theories, and the illustrations of the methods used to develop our understanding of the universe should help to produce a more rational attitude towards authority in general. Though we cannot be expert on all subjects, we can carefully examine the evidence in some small selected part of the field of knowledge and so obtain a better understanding of the foundations on which authority rests, particularly in the domains of science and history.

(4) By covering the whole field of man's thought, knowledge and activities, museums could help to discover to the individual (and his teacher) any particular interests or abilities which he may possess, and so enable him to decide in what way he could best serve the community and himself—that is to say, stimulate education rather than inject instruction.

Advantages of National Museums

Museums, especially the national museums, have advantages from an educational point of view over local teaching establishments in some respects. For example, they contain unique examples of historical and evidential value; their material can be made to appeal to nearly all the human senses, and thus be made more interesting; expenses can be incurred for special exhibits which would be beyond the means of every local school or college; they can cover nearly the whole field of human knowledge and endeavour. As the educational possibilities of museums become more generally recognized, the time may come when visits to them will be included in the experience of all individuals (perhaps specially arranged tours to cover several weeks). The organization and display of museums would be adapted to increase their educational value.

One can visualize the time when the national museums will be organized to cover all the branches of knowledge systematically. For example, there would be a museum or museums illustrating what may roughly be defined as "Man's methods of dealing with himself and with his fellow men": this might include such subjects as government, laws, customs, warfare, religions, philosophies, education, psychology, physiology, anatomy and medicine.

These museums would deal with their particular subjects fairly fully and contain as much as possible of the important actual evidence available, such as historical relics. Descriptive labels would be attached to each exhibit: these should include sources of evidence and appropriate cross-references, and thus encourage the visitor to further research and self-education. Exhibits representing recent advances in our knowledge in the present or of the past would be brought particularly to the visitor's notice; in fact, it would be to museums that the public would naturally go for the latest information on such subjects.

Special Museums

In addition to these national museums dealing with limited and specialized subjects, I think there is another type of museum which would be of great educational value. This would deal with the development of civilization in general and as a whole, and form an introduction to, and a link between, the national museums. It would be integrative, and in it an attempt would be made to make the past live again. The ideas, politics, social organization, arts, crafts, and sciences, etc., of the past would be combined. It would be impossible to show the complete story of the development of civilization in the world as a continuous process, and so only certain important phases would be selected for treatment. For example, for a museum in Great Britain, a selection of periods such as the following might be made: early Egyptian; early Greek; Roman; Europe in Dark Ages; Italian Renaissance; and then, say, three periods of English history. The final period would be outside the museum—the actual present world. Of course, the periods, if thought desirable, could be extended backward in time to prehistoric eras.

In this museum actual relics of the periods would not normally be shown (unless large numbers in good condition happened to be available), but the reconstructions would be made as accurately as possible on the available evidence. Great care would be taken to provide suitable explanatory labels. Such a museum would not claim to represent final truth, but merely to be a careful attempt to reconstruct the past. It would invite criticism and would, of course, be modified as new evidence came to light. Possibly, in suitable cases, the staff might be dressed in the costumes of the periods illustrated, and other means of adding realism adopted.

Mental instruments and methods have developed as well as material instruments, and it is most important to bring this out. Lecture theatres, cinemas and stages, where plays illustrating the life and ideas and demonstrations of the arts and crafts and instruments of the past could be given, might form an important part of the museum. There might also be rooms devoted to the great philosophers, and their philosophies, which influenced the periods concerned.

OBITUARIES

Dr. Cyril Crossland

BY the death of Dr. Cyril Crossland on January 7 at Copenhagen at the age of sixty-four, zoology has lost one of its last explorer-naturalists of the Darwin type. He was educated in the Lake District, where his father was a well-known lake painter. During his whole life he suffered from deafness, but this did not prevent him from becoming a personality in Clare College, Cambridge, where he compelled its steward to provide vegetarian meals for him and his numerous disciples.

Wanting an assistant for his researches on the naked Mollusca, Sir Charles Eliot, Consul General and Commissioner, took Crossland to East Africa, where he developed a taste for small boat sailing, which enabled him to explore the coasts of Zanzibar, Pemba and the adjacent mainland. He compared the barrier reefs off the latter with those described by Darwin off Brazil, both series being formed by erosion. Zanzibar proved to be an enlarged portion of the continental barrier, whereas Pemba was an independent elevation; the coastal flats of the whole area were due to a recent lowering of sea-level. No reefs were found that could be considered as due to growth *in situ*. For comparison, he next visited the Azores, having been appointed fellow of the University of St. Andrews, discovering well-consolidated Dendrophyllia, Vermetus and Lithothamnion coastal formations.

In 1904, Crossland proceeded to the Red Sea on a year's biological exploration, in which he covered about five hundred miles of its western coast, collecting all the time. "Its shores are all composed of elevated coral and are fringed with its luxuriant growth, while Barrier and other reefs and patches fill the sea for miles from either shore." The Sudan was being opened up by the development of Port Sudan, and Crossland was given a commission for the economic culture of shell oysters, being allowed a free hand. He ran a farm for the next fifteen years at Donganab, about sixty miles north of Port Sudan, off which there was a maze of surface reefs and submerged banks with clear water between. Here he built a patriarchal settlement for his fishermen and he became a source of supply for Red Sea animals to nearly every school of zoology and museum in Europe. In 1913 he published his "Desert and Water Gardens of the Red Sea", descriptive of the lives of his people and reefs and of the sides of his fault line, more than 1,500 miles linearly of coral reef. In the War of 1914–18 his settlement was useful in policing the Red Sea, and his oyster farm was producing a crop of millions, for he had succeeded, where all his predecessors had failed, in breeding his oysters, laying their spat and protecting their shells. Meantime, the market for pearl shell had gone, Vienna, its chief user, being almost a city of the dead, and he himself driven to hawking his shells where he could. Donganab was abandoned and Crossland came back to England.

During the next twenty years, Crossland used Cambridge as his home base, writing many papers on his collections, those on the chætopods in a class by themselves. There came next that curious expedition on the sailing yacht *St. George*, which anyone could join, each "going as he pleased". He wrote admirable accounts of the calm and muddy seas off Panama and of the fresh volcanic slopes of the Galapagos. In the older bays of the Marquesas corals tried to build in a singularly barren region. He left the ship at Tahiti, where he settled on its coasts for a year, to study its highly developed reefs and a luxuriant fauna, the most easterly outlier of Malaya. The surrounds of Tahiti, Mocrea and later Rarotonga were compared to those of other regions, with striking results. Basaltic stones were found lying in the reef surfaces or bedded in the rock below. The reefs are going back rather than extending seawards, and in extreme cases appear as submerged banks. The lagoons were formed by the hollowing out of an originally continuous reef. These important conclusions were followed by a close study of the corals, on which he was still engaged up to the time of his death.

Crossland, however, was called from retirement once again to go to the Red Sea, being commissioned by the Egyptian Government to found a biological station at Ghardaqa off the mouth of the Gulf of Suez. Like everything else, he did this well, the facilities for keeping living organisms being excellent. He explored the deep waters of the Gulf of Akaba and of the Red Sea off the same. To-day his station is a flourishing institution and Dr. Gohar, its director, generously extends its hospitality to Western workers.

In many respects Crossland was a most attractive person. He enthused everyone with whom he came into contact, this extending to his native labour wherever he was. His published researches number about forty and are characterized by their original, often unorthodox, outlook. They demand the study of all who are concerned with biological and faunistic research in the tropics. His deafness was a tragedy, for it prevented that personal contact with his fellows so valuable to research workers. J. S. GARDINER.

Dr. Alexander Russell, F.R.S.

DR. ALEXANDER RUSSELL, advisory principal and governor of Faraday House College, died at his home at Mill Hill on January 14.

Dr. Russell was born at Ayr in 1861 and graduated at the University of Glasgow with first-class honours in mathematics and natural science. In 1882 he went to Caius College, Cambridge, and became a wrangler in 1886. He was for a time mathematical lecturer at Caius, and afterwards mathematical master at Cheltenham College and then at the Oxford Military College.

In 1890 Dr. Russell joined the staff of Faraday House, so that he was associated with it practically from the beginning. He became principal in 1909 and remained in this position until 1939, when he became advisory principal, leaving the more active work to a younger man. It was during these thirty years that he built up the college and its reputation, so that the name of Faraday House is always linked with his and can never be dissociated as long as it exists. No successor can take his place.

Many honours came to Dr. Russell during that time. He was awarded the D.Sc. by his old University of Glasgow in 1908 and in 1924 the LL.D. He was elected president of the Institution of Electrical Engineers in 1925 and had been president of the Physical Society and vice-president of the Institute of Physics, and nominated an electrical inspector by the Electricity Commissioners. He was elected to the Royal Society in 1924 and finally in 1940 he was awarded the Faraday Medal of the Institution of Electrical Engineers. There have been only eighteen recipients of this medal since its foundation, and among them are such famous names as Sir Oliver Lodge, Lord Rutherford, and Sir William Bragg.

Dr. Russell had been a pupil of Lord Kelvin, who had been a friend of Faraday, so that an authentic link was preserved, through him, with the pioneer of practical electricity.

Dr. Russell was fortunate in being known in the electrical world in the early days of the practical application of alternating currents and was able to apply his mathematical knowledge to the problems that they raised. His two books, "Alternating Currents" and "Theory of Cables", became standards, and the method he invented for computing the mean horizontal candle-power of a lamp is still called the "Russell angles". He was a most industrious writer and produced a life of Lord Kelvin as well as many papers communicated to the Royal Society, the Physical Society and the Institution of Electrical Engineers. For many years he was a frequent contributor to NATURE.

One of Dr. Russell's great interests was lightning and atmospheric electricity, but during his latter years he became absorbed in the theory of numbers.

In the early days of television, Dr. Russell took a party of engineers to Baird's early studio in St. Martin's Lane. It was suggested that an attempt should be made to transmit a human face, and Dr. Russell was selected for the experiment. It has, therefore, been claimed that he was the first man to be televized, but complete confirmation of this fact is lacking.

Many hundreds of old students of Faraday House College, now scattered all over the world and in the Services, will remember Dr. Russell by his kindness and helpfulness to all who came to him. This is the truest and most lasting memorial to the memory of a great man. W. R. C. COODE-ADAMS.

Prof. R. G. Collingwood, F.B.A.

PROF. ROBIN GEORGE COLLINGWOOD, archæologist, historian, and philosopher, originally acquired his artistic and scholarly tastes from his father, W. G. Collingwood, the friend and biographer of Ruskin, and his Jewish mother. He early became an omnivorous reader and an adept linguist, and thus laid the foundations of the almost universal learning which was the surprise and delight of his friends in conversation. In boyhood, too, he learnt how to use his hands in playing the piano and violin, in draughtsmanship, and in sailing a boat (always a favourite recreation), and he thus acquired the manual dexterity which was later a prominent characteristic, evidenced, for example, in toys he made for his children and in his beautiful handwriting.

At Oxford he came under the influence of Haverfield, who deepened the interest in Roman Britain which he had already caught from his father. But philosophy claimed him, and it was a philosophical fellowship to which he was elected at Pembroke College in 1912. Always too absorbed in his studies to have much time for social distractions, he had comparatively few close friends, although his attachment to those he had, like theirs to him, was deep and lasting. No less enduring was the regard of his pupils, for on them he lavished the resources of his vigorous and original mind, placing philosophical problems in their historical context and illuminating them with his extraordinary power of graphic exposition.

During his years at Pembroke he was working equally strenuously at excavating Roman sites, collecting inscriptions, and re-interpreting the history of Roman Britain. His work in these fields was recorded in a long series of publications, culminating in "The Archæology of Roman Britain" and finally in the first volume of the "Oxford History of England", on which his fame as an historian securely rests. It was as much for his historical as for his philosophical work that he was elected a fellow of the British Academy and given the honorary degree of LL.D. at St. Andrews.

In philosophy his aim was to persuade philosophers that history was as important for their investigations as physical science. In this aim his work is meeting with some success, although his own philosophy has not yet been so widely accepted as his history. His standing as a philosopher will probably rest ultimately on his "Essay on Philosophical Method"; his later books, "The Principles of Art", "An Essay on Metaphysics", and "The New Leviathan", all contain original thinking of the highest order, and they are written with a lucidity and verve uncommon in philosophical works, but they lack the finish of the earlier book, and over parts of them there hangs the shadow of his increasing ill-health.

Insomnia and overwork had begun to undermine his strength even before he became Waynflete professor of metaphysical philosophy at Oxford in 1935; and the hope that his new office, by easing his teaching burden, might enable him to recuperate and to expound his own philosophy *in extenso* was only partially fulfilled. After a serious breakdown in 1938 he fought a steadily losing battle; in 1941, when he could no longer both lecture and write, he chose to resign his chair. But there was no recovery, and he died on January 9 at the comparatively early age of fifty-three, mourned by his friends as a lovable personality, by scholars in general as one whose contributions to learning have substance and permanent worth.

T. M. KNOX.

WE regret to announce the following deaths:

Sir Robert Armstrong-Jones, C.B.E., consulting physician in psychological medicine at St. Bartholomew's Hospital, formerly general secretary and later president of the Medico-Psychological Association, on January 30, aged eighty-five.

Prof. C. C. Farr, F.R.S., emeritus professor of physics in Canterbury College, Christchurch, New Zealand, aged seventy-six.

Dr. F. S. Sinnatt, C.B., M.B.E., F.R.S., director of fuel research, Department of Scientific and Industrial Research, on January 27, aged sixty-two.

NEWS and VIEWS

Geological Society Awards

THE Council of the Geological Society has made the following awards: Wollaston Medal to Prof. A. E. Fersman in recognition of his fundamental contributions in the field of geochemistry and his researches on the economic mineralogy of Russia; Murchison Medal to Prof. A. Brammall for his notable contributions to geochemistry and petrogenesis, especially of the rocks of Dartmoor and Malvern; Lyell Medal to Mr. D. N. Wadia, lately of the Geological Survey of India, for his work on the syntaxis of the Himalaya and his contributions to the geology of India, especially Kashmir; Bigsby Medal to Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, for his geological studies on Persia, Oman and his important share in the discovery of oil in England; Wollaston Fund to Miss Ethel D. Currie in recognition of her valuable researches in palæontology; Murchison Fund to Mr. A. G. Davis for his work on the Cretaceous and Tertiary fossils of south-eastern England; one moiety of the Lyell Fund to Mr. F. A. Bannister and another moiety to Dr. M. H. Hey, for their joint X-ray and chemical investigation of minerals.

Highway Engineering at the University of the Witwatersrand

DR. BERNARD H. KNIGHT, research officer in highway engineering in the University of the Witwatersrand, Johannesburg, has been appointed to the newly created chair of highway engineering in that University, with effect from April 1 next. It is believed that this chair of highway engineering, which is tenable in the Department of Civil Engineering, is the first of its kind to be founded in the British Empire outside Great Britain. Its establishment has been made possible by the joint support of the South African Iron and Steel Corporation and the National Road Board. Dr. Knight, who was formerly lecturer in road engineering at the College of Estate Management, London, was appointed senior research assistant in highway engineering at the University of the Witwatersrand early in 1939. Since then, three post-graduate scholarships in highway engineering have been established in its Department of Civil Engineering. The marked development in highway engineering research which has taken place at this University has been made possible by the provision of the new Civil Engineering Laboratories situated in the Hillman Building, which was officially opened by the Prime Minister of the Union of South Africa, General Smuts, in June, 1941.

Science Students and Industrial Experience

THE War is undoubtedly speeding up many changes in our educational habits. Until quite recently, it was the custom for students of engineering only, either during vacation or otherwise, to spend some part of their time in the practice of engineering on the industrial side. The needs of total war have brought out something that has always been latent in every branch of science, namely, its close linkage at some point with industrial practice, either on the side of production or of technological research. It is not surprising, therefore, that students in pure and in applied science, in addition to those in engineering proper, should seek the opportunity of adding to their experience by taking part in industrial life when the opportunity presents itself. This is underlined in the recent report, for the year ending October, 1942, on the vacation apprenticeship scheme in operation at the Imperial College of Science and Technology. The scheme is sponsored by the Imperial College Union, and is under the chairmanship of Prof. H. Levy, representing the governing body.

During the past year, 340 students have spent on the average nearly six weeks in research departments and in works, assisting with special investigations, studying the productive processes and the schemes of organization. Some 170 of the foremost firms of Great Britain and many Government departments have willingly co-operated with the Committee in this venture, and have been sufficiently interested to write reports on progress. The scheme has been extended to cover intending students in the summer vacation prior to entry, provided they have reached the Intermediate B.Sc. standard. Last year 32 students entered the scheme at this stage. Apart from the financial return to the students themselves, it is clear that this will give them experience that must react very favourably on their capacity to assimilate the more theoretical studies with which they are necessarily concerned at college; and the fact that the proportion of students of chemistry, physics and mathematics availing themselves of the opportunity presented is steadily increasing is an indication that the scheme meets a real need. Its educational consequences will be well worth watching.

Government Grant to Universities

SIR KINGSLEY WOOD, Chancellor of the Exchequer, has announced, in the form of a written reply to a question by Sir E. Graham-Little, the Government's policy with regard to financial support of the universities of Great Britain. He said that, although the impact of the War on university finance has so far been less severe than was expected, the Government has maintained unchanged the annual provision for university grants at £2,149,000. This policy was adopted in view of the vital part played by the universities in the life of the country, their essential contributions towards the national effort in war-time, and the prospect that immediately after the War they will be faced with very large demands on their funds in order to resume normal activities. These considerations have lost none of their force, and the Government, after considering a report from the University Grants Committee, has again decided to maintain the provision at its existing level.

Swedish Forest Products

ACCORDING to the Swedish International Press Bureau, a survey of Sweden's production of forest products of a chemical nature was recently given by Mr. Otto Cyren, director of the Swedish Chemical Office. Speaking of chemical pulp, one of Sweden's most outstanding export products in normal times, he said that Sweden is in a very good position in respect of quality, as the slowly growing timber in northerly regions gives very long fibres, and consequently the strongest pulp and paper are obtained from it. The most important by-product of the sulphite pulp production is sulphite spirit, which up to most recent years was the only product recovered. Mixed with petrol, it was of importance as a motor fuel. The purity of the rectified spirit now surpasses that obtained from grain and potatoes, and it is therefore used also for human consumption. Researches on the possibility of using sulphite spirit as the basis of more highly developed products were not initiated until the present crisis made the matter urgent. As an instance he described the work carried on by the Mo and Domsjo Company. In 1941 this company completed a factory for the production of sulphite spirit with a capacity for 10 million litres of 95 per cent spirit a year. At this factory intensive research work is going on, with the view of producing various synthetic products from the spirit. From the black lye obtained in the sulphite pulp process there are produced *inter alia* certain crude acids, the first factory for using this raw product having been built at the Bergvik och Ala pulp mill. The sebacic acid produced here, called 'pine fatty acid', is used to replace fat in washing mediums, as a substitute for linseed oil in paints, etc.

The output of charcoal in Sweden has trebled in the last couple of years, mainly due to the extensive producer-gas traction of motor-cars, and the by-products from the carbonization are now being recovered more carefully than before. The charring of old tree stumps, with their high content of rosin, alone gives about 20,000 tons of tar a year. Wood tar is now used as motor fuel for fishing boats in place of crude oil, and has probably saved the Swedish high-sea fisheries from total stoppage. It is also used for the production of lubricants. In summing up the situation for the Swedish forest products industry, Mr. Cyren stated that in 1941 the Swedish exports of woodstuffs had declined by about one third, and the pulp and paper by two thirds, compared with the pre-war level. But in compensation the forests, by supplying cattle feed, wood fuel, motor fuel, lubricants, textile material, fatty oils, and a good many other useful products, have saved the country from catastrophe.

Variation in δ Ursæ Majoris

MR. F. M. HOLBORN suspected at the end of August that this star was fainter than usual, and this suspicion has since been confirmed by Mr. N. F. Knight, who observed it in North Africa. His latest estimate of its magnitude on December 10 was 3·8–3·9, and on January 14 and 15 Mr. Holborn found that its magnitude was 3·7 (normal mag. 3·4).

Announcements

THE following appointments in the Colonial Service have recently been made: H. B. N. Hynes, entomologist, Kenya; G. R. Groves (horticulturist, Bermuda), curator of the Botanical Gardens, British Guiana.

DR. G. M. B. DOBSON'S discourse at the Royal Institution on February 12 on "The Air we breathe in Town and Country" will deal with the results of the survey by the Department of Scientific and Industrial Research of the air pollution of Leicester. This was the first detailed survey of the kind ever undertaken in Great Britain. The scientific officer in charge at Leicester was Dr. A. R. Meetham, who was responsible for carrying out the work there.

LETTERS TO THE EDITORS

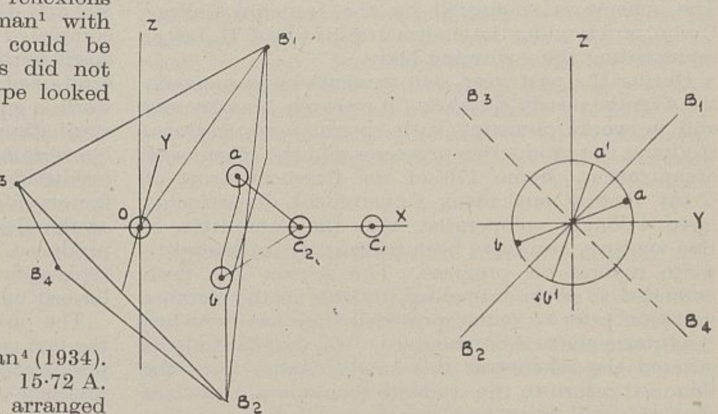
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Change of Symmetry with Temperature

DURING the course of an investigation into the effect of temperature on X-ray reflexion in crystals, some photographs were taken of basic beryllium acetate to see whether any of the diffuse reflexions observed by Charlesby, Finch and Wilman[1] with electron diffraction in organic crystals could be detected with X-rays. The photographs did not show with certainty any effect of the type looked for, but another effect was observed. At the time (1939), we did not think the matter of very great importance, but recently the results were shown here to Prof. W. T. Astbury, who suggested that they were of sufficient interest to deserve recording.

The structure of basic beryllium acetate has been described by Bragg and Morgan[2] (1923), by Morgan and Astbury[3] (1926) and by Pauling and Sherman[4] (1934). The crystal is cubic and the unit, of 15·72 A. edge, contains eight molecules $OBe_4(Ac)_6$ arranged in a 'diamond' structure. Morgan and Astbury state : "The unique oxygen atom lies at the centre of a regular tehrahedron of beryllium atoms, while the six equivalent acetate groups are associated with the edges of the tetrahedron. Each acetate group is symmetrical about a dyad axis, that is, its two oxygen atoms are equivalent and the three-fold symmetry of the (CH_3) group is for some reason non-effective. The plane of each acetate group, since full tetrahedral symmetry does not extend beyond the tetrahedron of beryllium atoms, must lie oblique to the tetrahedron edge with which it is associated." The positions of the oxygen atoms have been determined by Pauling and Sherman.

The obliquity of the plane of the acetate atoms to the edge of the tetrahedron of beryllium atoms is inferred from a lack of symmetry in Laue photographs taken with the X-ray beam parallel to a [111] direction. As may be seen in Fig. 1 (left) the pattern is not symmetrical about the lines *AA′*, *BB′*, *CC′*, having only simple threefold symmetry when examined at room temperature. However, if the temperature is raised to 100° C. the picture, Fig. 1 (right) becomes symmetrical about the lines *AA′*, *BB′*, *CC′*, and resembles the Laue photograph to be expected from a crystal with holohedral symmetry. The change to this holohedral type of pattern takes place between 30° and 50° C.



(*a*) (*b*)

Fig. 2.

Fig. 1 (right). A few of the weaker Laue spots disappear as the temperature rises, but apart from this (and the intensity changes which produce symmetry) the pattern does not alter in any radical way, so that the change is not to be ascribed to a change of phase. It is reversible, and a single crystal suffers no damage by being repeatedly heated to 100° C. and cooled to room temperature, a fact which also indicates that no recrystallization has occurred. Fig. 1 (left) is not identical with the Laue photograph reproduced in Morgan and Astbury's paper, presumably on account of different conditions of excitation of the X-ray tube. Our photographs were obtained with radiation from a silver target operated at 60 kV. Fluorazure intensifying screens were used ; exposure 10 min. at 18 ma. ; 5 cm. film to specimen. It will be noted that in Fig. 1 the intense reflections 612, 210, 520 are not accompanied by their counterparts 621, 201 and 502 on the opposite side of *AA′* : in general, the intensity of (*hkl*) is not equal to that of (*hlk*) below 30° C.

The cause of the change in symmetry of the Laue photographs is probably most easily seen by the aid of the diagram (Fig. 2*a*), which is a sketch (not to scale) of part of the molecule near the corner of the unit cube. The unique oxygen atom at *O* falls in

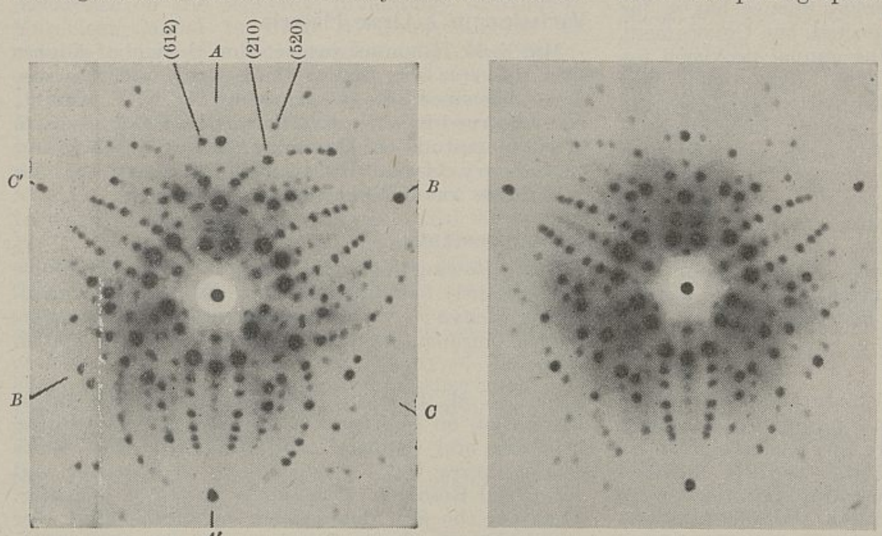


Fig. 1. LAUE PHOTOGRAPHS OF BASIC BERYLLIUM ACETATE. X-RAYS PARALLEL TO [111], [211] VERTICAL. SILVER TARGET ; FLUORAZURE INTENSIFYING ; 5 CM. FILM TO SPECIMEN. REDUCED IN THE RATIO 3 : 2. LEFT : AT ROOM TEMPERATURE. RIGHT : AT 100° C.

the centre of the regular tetrahedron B_1, B_2, B_3, B_4 of beryllium atoms. The acetate group $CH_3—C\begin{smallmatrix}\nearrow O \\ \searrow O—\end{smallmatrix}$ is a plane Y-shaped structure, a methyl group at its foot, a carbon atom at its middle and two structurally equivalent oxygen atoms at the extremities of the arms. These are shown in the sketch at C_1, C_2, a and b. In the 'end on' view of Fig. 2b, B_1B_2, B_3B_4 are the traces of the edges of the tetrahedron of beryllium atoms viewed along XO. These edges are parallel to 110 axes of the unit cube and lie in planes of symmetry for the holohedral crystal. The line ab joining the two oxygen atoms is, at room temperatures, inclined to the line B_1B_2 (and B_3B_4); as the temperature rises, its mean position must be such as to produce a symmetrical distribution about this line. This can occur in several ways; for example: (1) if the atomic vibrations carry ab to $a'b'$ (symmetry about B_3B_4 is secured automatically if it is present about B_1B_2), (2) if the acetate Y rotates about its stem so that ab in Fig. 2b describe a circle. The mean position of these two atoms must have a symmetrical aspect to produce the photograph of Fig. 1, and must therefore be in, or at right angles to, B_1B_2.

Further investigation might throw light on the amplitude of the thermal movements to which the observed change of symmetry is due: the onset of vibration across the symmetry plane should be accompanied by an abnormal rise of specific heat. Molecular rotation in nitrate crystals has been reported by Hendricks, Posnjak and Kracek[5] and is accompanied by a change of symmetry such as that here recorded. It seems that if Laue photographs are used to determine symmetry, they should be taken at as low a temperature as possible.

We are indebted to Dr. D. V. N. Hardy, Chemical Research Laboratory, for the preparation of the single crystals of basic beryllium acetate used in this investigation.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

G. D. PRESTON.
J. TROTTER.

Metallurgy Department,
National Physical Laboratory,
Teddington.
Jan. 11.

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Magnetization of Matter by Ultra-Violet Radiation

Ehrenhaft and Banet have reported[1] finding that magnetic poles are produced in various pieces of "non-magnetic" and annealed pieces of iron by exposure to ultra-violet radiation. The detecting instrument used was a simple compass needle. Focken[2], on the other hand, repeated these experiments with more sensitive apparatus, but found no evidence of any such induced magnetization. We have recently attempted similar experiments.

The deflexion magnetometer used was of the reflecting type and its sensitivity was 9,800 mm. at one metre per oersted, as compared with 9,000 mm. at one metre for the instrument used by Focken. We consider that for specimens distant 10 cm. from the needle, a change in the magnetic moment of 0·25 C.G.S. unit could be detected with certainty. The ultraviolet source was a D.C. mercury arc enclosed in a quartz envelope. The specimen under test was placed with its centre 10 cm. from the needle and in the end-on position with respect to it. In this position, one surface of the specimen was fully exposed to radiation propagated at right angles to its length. Each specimen was also exposed to radiation propagated approximately parallel to its length, and to do this conveniently, each was moved to the broadside position. In these positions, the material was always placed at right angles to the magnetic meridian. With the arc running, and the specimen in place, but shielded from the radiation by a shutter, the magnetometer reading was noted. The shutter was then opened, the light spot from the magnetometer being kept under observation. This procedure ensures that the only change in conditions is exposure to radiation, other magnetizing influences such as the fields of the arc and the earth remaining substantially constant throughout any given test.

The experiments were also repeated for end-on and broadside positions when the radiation was concentrated on the specimen by means of a quartz lens.

Three types of materials in the form of rods, approximately 8 cm. long, were tried, namely, transformer iron, mild steel and a hard steel.

In no case could any change be detected in the magnetic condition of the rods, either at the instant of exposure or after exposures ranging from $\frac{1}{2}$ hour to 3 hours. By placing the rods in a vertical position and illuminating as before, we tested for possible magnetization at right angles to the length. Here, also, the results were negative.

S. L. MARTIN.
A. K. CONNOR.

Physics Laboratories,
Melbourne Technical College,
Australia.
Nov. 17.

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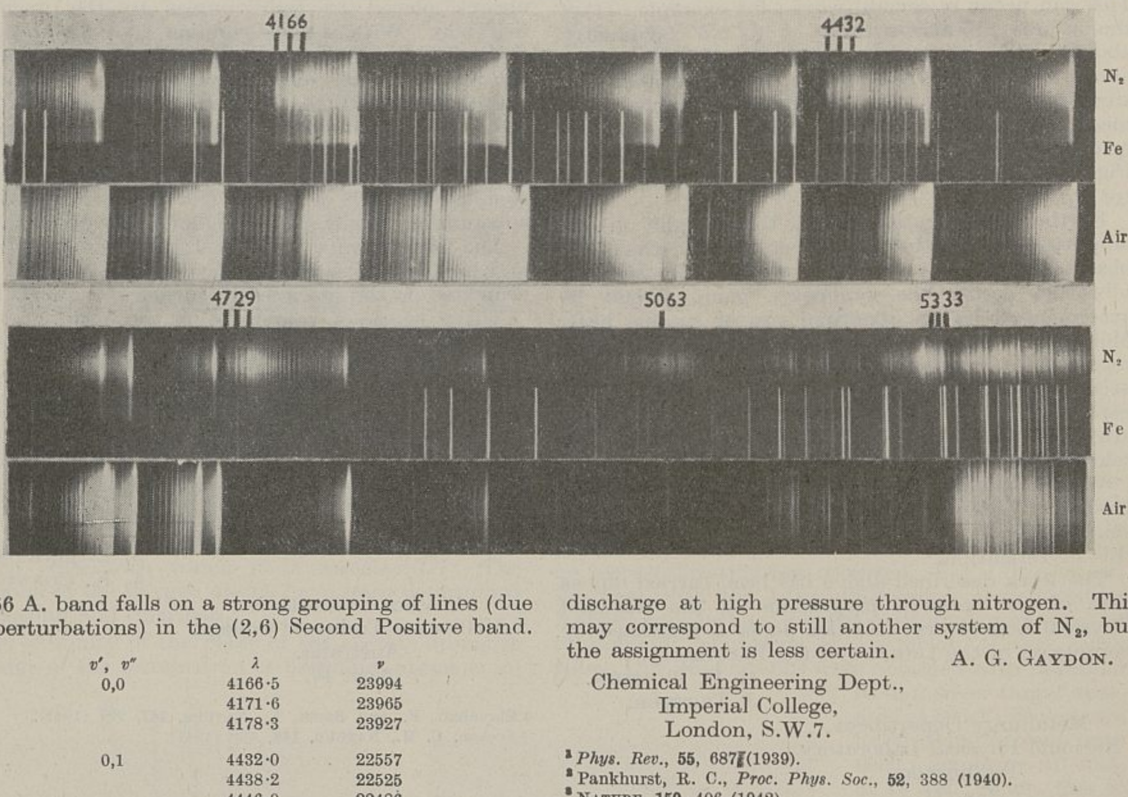
A New Band Spectrum Associated with Nitrogen

DURING an attempt to improve measurements on the Vegard-Kaplan bands of N_2 using a silent (ozonizer type) discharge through nitrogen as source, as recommended by Wulf and Melvin[1], three new bands in the blue region of the spectrum were observed. These bands were afterwards obtained quite readily in an ordinary induction-coil discharge through nitrogen at relatively very high pressure (around 10 cm. mercury). The bands were obtained with commercial nitrogen, with special oxygen-free nitrogen, and with atmospheric nitrogen made by bubbling air through alkaline pyrogallol. The bands do not appear at lower pressure or in discharges through air. The bands disappear if a little oxygen is mixed with the nitrogen, and hydrogen and water vapour also have an inhibiting action. In all the spectra taken, the NO γ and OH bands were weakly present, but all the experimental evidence seems to favour the assignment of the bands to N_2.

The accompanying illustration shows the bands as photographed on a glass prism spectrograph with a dispersion of around 10 A./mm. A spectrum of a discharge through air showing only the First and Second Positive bands of N_2, with a little N_2^+, is given for comparison. The new bands are degraded to the red and show several heads, having a complex rotational structure rather similar in general appearance to that of the Third Positive bands of carbon monoxide ($^3\Sigma \rightarrow {}^3\Pi$). Three of the heads of the three strong bands have been carefully measured and are given in the table, with *provisional* assignment of vibrational quantum numbers. The head of the 4,166 A. band falls on a strong grouping of lines (due to perturbations) in the (2,6) Second Positive band.



v', v''	λ	ν
0,0	4166·5	23994
	4171·6	23965
	4178·3	23927
0,1	4432·0	22557
	4438·2	22525
	4446·0	22486
0,2	4729·2	21139
	4736·0	21109
	4744·2	21072

Weaker bands at about 5,063 and 5,440 A. may be the (0,3) and (0,4) bands respectively, but overlapping by weak First and Second Positive bands of N_2 renders accurate location of heads difficult. There is also weak band structure around 5,575 A., which *might* be the (1,5) band.

The separation between the (0,0) and (0,1) and between the (0,1) and (0,2) bands is 1,440 and 1,416 cm.$^{-1}$ respectively. The corresponding differences for the $A^3\Sigma$ state of N_2 are 1,432·5 and 1,404·7. The present measurements should be accurate to 1 or 2 cm.$^{-1}$, and, unless there is a big difference between the positions of the origins and heads of the bands, it can be assumed that $A^3\Sigma$ is not involved.

It seems surprising, at first sight, that a readily observable system of N_2 in the blue should have been overlooked for so long, but it may be pointed out that the bands are overlaid by the much stronger Second Positive system, which were not themselves accurately measured before 1940[2]. The discovery of a new system of N_2 involving two new molecular states, probably of fairly low energy, gives some support for the view recently expressed by Gaydon and Penney[3] that the non-crossing rule, that potential curves of molecular states of the same species cannot cross, may hold for nitrogen, and thus that the dissociation energy is higher than the value of 7·38 electron volts in common use.

In addition to the new band system, a single band, degraded to the violet with heads at 5,333·5, 5,327·3 and 5,320·0 A., also appears in spectra of the ozonizer discharge and in a low current-density induction-coil discharge at high pressure through nitrogen. This may correspond to still another system of N_2, but the assignment is less certain.

A. G. GAYDON.

Chemical Engineering Dept.,
Imperial College,
London, S.W.7.

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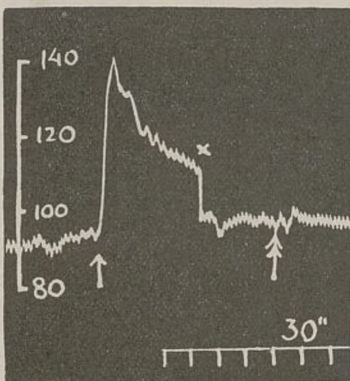
Pressor Substances in Urine and Plasma from Normal and Hypertensive Subjects

NORMAL urine contains a pressor principle[1] which has been identified as *iso*-amylamine[2] and found to account for most of the urine pressor action.

If normal urine is concentrated *in vacuo* at neutral or slightly acid reaction and quantitatively extracted with ether at *p*H 9–10, the ethereal extract consistently contains a pressor substance which conforms in its properties with *iso*-amylamine. A strong pressor action was generally obtained with an amount of extract corresponding to 100 ml. normal urine. Similarly prepared extracts from the urine of ten hypertensive patients (essential hypertension and chronic nephritis) contained much less of this substance when tested on the cat's blood pressure. Thus the extract of 100 ml. urine in some cases was completely inactive (see accompanying figure). It has been reported that the urine pressor activity does not differ significantly in extracts from normal and hypertensive subjects[3], but also that urine from arteriosclerotic and hypertensive patients contains less of the pressor substance, though no quantitative data have been given[1,2].

No evidence has been obtained in our experiments for the presence of significant amounts of other ether-soluble pressor agents, such as tyramine. This is in accord with other observations[4]. Ether extracts of acidified urine may contain small amounts of a pressor substance, differing from *iso*-amylamine.



CAT'S BLOOD PRESSURE. ↑ ETHER EXTRACT OF 100 ML. NORMAL URINE. ⇑ ETHER EXTRACT OF 100 ML. URINE FROM PATIENT WITH ESSENTIAL HYPERTENSION.

Extracts of heparine venous plasma from normals and hypertensives were prepared by precipitation with alcohol and concentrated *in vacuo*, the residue being extracted with ten volumes of methyl alcohol, which was distilled off. When tested on the cat's blood pressure, normal plasma extracts regularly produced a moderate rise in pressure in amounts corresponding to 25 ml. plasma, whereas plasma extracts from hypertensive patients usually produced a much smaller action, in both cases preceded by a short lowering of the blood pressure. The test animals were atropinized and had received 0·15 mgm. ergotamine tartrate per kgm. in order to exclude the action of the buffer nerves.

The results suggest important changes in the production or excretion of biologically active metabolites in essential hypertension.

U. S. v. EULER.
T. SJÖSTRAND.

Physiology Department,
Karolinska Institutet,
Stockholm. Jan. 10.

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[4] Enger, R., and Arnold, H.. *Z. klin. Med.*, **132**, 271 (1937).

Determination of the Osmotic Pressure of Biological Fluids

IN 1938 Blegen and Rehberg[1] described a method for determining the osmotic pressure of biological fluids based on the measurement of the initial rate of outflow of water from one solution through a semipermeable membrane into another solution of somewhat higher osmotic concentration. As semipermeable membranes they used small collodion bags impregnated with copper-ferrocyanide[2]. The collodion bag is alternately filled with the unknown fluid and with a solution of sodium chloride of known strength, and is connected to a piece of capillary tubing (0·2–0·5 mm. internal bore) which is bent at right angles so as to form a longer, horizontal arm of about 15 cm. length carrying a millimetre scale. When the bag containing the unknown fluid or the sodium chloride solution is immersed in a sodium chloride solution of higher concentration, the meniscus begins to move, and the rate of movement, which is taken to be proportional to the concentration difference, is determined at intervals.

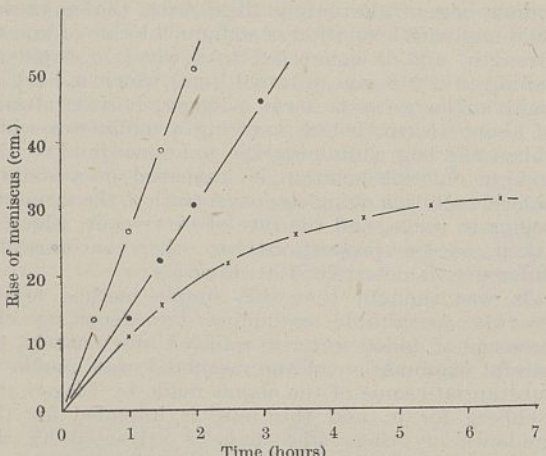
It was thought that this simple method might provide a suitable technique for detecting the presence of added water in milk. Unfortunately, on careful examination of the method I was unable to substantiate some of the claims made by Blegen and Rehberg for it, and this note is intended for the guidance of others who may be attracted by the apparent simplicity and ease of the procedure described by the Norwegian authors.

Batches of membranes were prepared by the method described by Blegen, and standardized by determining the rate of movement of the meniscus for 0·80 against 1·00 per cent sodium chloride solution. Only membranes which gave a constant rate of movement for at least 40 minutes were used in further work. A series of membranes was selected varying in the rate of movement from 1 mm. to 20 mm. per minute, using capillaries of 0·25 mm. internal bore. With all these membranes it was possible to determine the concentration of sodium chloride solutions with great accuracy, thus far confirming Blegen and Rehberg's findings. Difficulties arose, however, as soon as milk was chosen as the 'unknown' fluid. A rapid movement of the meniscus was observed, even when a bag filled with milk was immersed in salt solution isosmotic with the milk.

Blegen and Rehberg state that with serum the results of their method were "of the same order of magnitude as with Hill's (thermo-electric) method", but only one example in which actual comparison was made between the two methods is cited. The results were in good agreement, but the value of 0·179 n = 1·05 per cent NaCl is outside the usual range of values for human serum of 0·90–0·97 per cent NaCl[3]. In tests with sera prepared from cow's blood, I found that the results obtained by the Blegen and Rehberg method were always appreciably higher than those of the freezing point test which was used as method of comparison. Thus, a serum with a freezing point corresponding to 0·94 per cent sodium chloride gave a value of 1·02 per cent sodium chloride when tested by the water permeability method.

The difficulties encountered with milk and serum led to a study of simpler systems, using a modified experimental arrangement in which collodion bags were connected to vertical capillary tubes of about 60 cm. length and of approximately 1 mm. internal bore. Isosmotic solutions of sodium chloride, urea, and sucrose were tested against each other, and the accompanying graph shows results typical of these experiments.

An apparent 'osmotic pressure' between solutions which were, in fact, isosmotic was observed with all membranes, even with those which showed little movement of the meniscus in the standard test with sodium chloride solutions mentioned above. The anomalous behaviour finds its explanation in the fact that the membranes are not truly semipermeable,



All solutions isosmotic to 0·88 per cent sodium chloride.

	Inside membrane	Outside membrane
×	NaCl	Urea
●	Sucrose	NaCl
○	Sucrose	Urea

but allow the slow diffusion of small molecules and ions. The more diffusible substance will then increase the osmotic concentration on the opposite side of the membrane, thus causing a flow of water in that direction, with the result illustrated in the graph. As the osmotic forces in milk, serum and other biological fluids are due to a variety of substances in addition to sodium chloride, anomalies of the kind observed are only to be expected with these fluids. Unless a method can be designed by which truly semipermeable membranes can be prepared with ease —and in this I did not succeed—the technique of Blegen and Rehberg appears scarcely commendable for biological work.

In conclusion, brief mention should be made of the interesting possibility of the occurrence of membranes of the 'slowly-permeable' type in living organisms. The graph illustrates clearly the considerable forces at play between isosmotic systems separated by this type of membrane.

R. ASCHAFFENBURG.

National Institute for Research in Dairying,
University of Reading.
Jan. 15.

[1] Blegen, E., and Rehberg, P. B., *Scand. Arch. f. Physiol.*, **80**, 40 (1938)
[2] Blegen, E., *Scand. Arch. f. Physiol.*, **81**, 8 (1939).
[3] Margaria, R., *J. Physiol.*, **70**, 417 (1930).

Nucleoli in *Agropyron repens*, Beauv.

DURING an investigation of the shoot apex of *Agropyron repens*, Beauv., longitudinal sections were obtained in which the nucleoli stood out in strong contrast to the rest of the nucleus. When this was noticed, counts were made and the maximum number per nucleus was found to be six. Photograph *A* shows the six nucleoli in the nucleus of a developing sclerenchyma cell, while *B* shows the six in the nucleus of a procambium initial. Sometimes there was a suggestion that the nucleoli were of three sizes, a large pair, a slightly smaller pair and a small pair, though this was not at all definite, and the appearance shown in *A* and *B* seemed more common (? some nucleoli only partly represented in the sections).

Observations were easiest on the cells of the developing strands and the associated sclerenchyma because the nuclei here are considerably elongated and there is consequently less tendency for the nucleoli to fuse together. Since these nuclei are about five to eight times as long as they are wide, it is often possible to have all six nucleoli well separated from each other and all in focus at the same time, making it fairly easy to observe and photograph them.

A *B*

NUCLEOLI IN *Agropyron repens*, BEAUV. (× *c*. 1000).

The possession of six nucleoli by *Agropyron repens* is interesting, first, because it accords with the hexaploid somatic chromosome number of 42 (Avdulov[1], Peto[2], although they also record plants with 28, 34 and 35 chromosomes), and secondly, because it is paralleled in the hexaploid wheats *Triticum vulgare* and *T. Spelta*[3], which have a somatic number of 42 and also possess six nucleoli.

Botany Department,
The University,
Leeds 2. Jan. 9.

B. C. SHARMAN.

[1] Avdulov, N. P., *Bull. Appl. Bot. Suppl.*, **44**, 1 (1931).
[2] Peto, F. H., *Can. J. Res.*, **3**, 428 (1930).
[3] Pathak, G. N., *J. Genetics*, **39**, 437 (1940).

Synthetic Rubber

CLEARLY Dr. Naunton is acutely sensitive, justifiably, about synthetic rubber. His review of my book in NATURE of December 26, p. 751, is unfair in several respects. Undoubtedly, there are errors in the book. I am grateful to have them pointed out. But why add to them ?

Dr. Naunton says : "The author apparently is under the impression that isobutylene and butadiene will co-polymerize in almost any proportions in which the experimenter mixes them, but this is, of course, not the case". On several pages I state that butyl rubber is a co-polymer of olefine with a small amount of diolefine.

He scorns my account of handling butyl rubber. Yet the latest official directive for handling butyl rubber states : "The following precautions will greatly enhance the ease of handling butyl rubber on the mill : (*a*) mill roll temperatures at the outset should be warm, 105 deg. F. to 115 deg. F. When the band has been formed, and during mixing, roll temperature should be kept as low as possible". Am I so far wrong ?

Dr. Naunton dismisses too lightly the part chemical concerns are playing in the United States productions. He is evidently a scientific 'Bourbon' in his underestimation of the intelligence of the 'general reader'

Three out of thirteen references on "Copolymerization" are to U.S.S.R. work; two to British work. As the subject is considered in relationship to synthetic rubbers, is this so unbalanced as to justify Dr. Naunton's querulousness ?

An official directive on Hycar OR, with Dr. Naunton's name attached, does not differ substantially from my own comments. I am somewhat mystified by the criticism.

I reiterate my belief that the industrial welfare of Great Britain can only be guaranteed by achievement based on hard work, and not merely by discussion and buying licences.

HARRY BARRON.

"Spinney Corner",
Bassett Avenue,
Southampton.

I CANNOT agree that the review of Dr. Barron's book was unfair. It was critical but definitely not unfair.

It is true that Dr. Barron states in the book that the commercial product known as butyl rubber contains only a small amount of diolefine, but the criticism was levelled at the general case of interpolymerizing of isobutylene and diolefines, where important generalizations have been missed and misleading facts and figures have been quoted. Dr. Barron would be well advised to put more trust in experimental work and less in published information. The *fact* remains that butyl rubber runs smoothly on a cold mill but breaks up on a hot one.

I think Dr. Barron is confusing intelligence with knowledge. The 'general reader' is often far more intelligent than the chemist, but no amount of intelligence without chemical knowledge will enable him to appreciate structural formulæ.

I would remind Dr. Barron that I was not "querulous" about the emphasis which had been given to U.S.S.R. work on co-polymerization but on the narrower field of the constitution of co-polymers. The work of Hill, Lewis and Simonsen published in 1939 should surely have been mentioned.

In Dr. Barron's comment about Hycar OR, we see at last our different points of view. Dr. Barron wishes to paint a picture in which effect is obtained at the cost of only substantial accuracy, but a textbook as distinct from journalism is not a picture but a sharp photographic reproduction of facts.

W. J. S. NAUNTON.

Manchester.

Future of University Education

THE British Association report on Post-War University Education (see NATURE, December 19, 1942) contains some excellent suggestions. The plea for the further extension of residential facilities at the modern universities, for example, is fully justified by experience in the University of Reading, which was a pioneer in this field. Nor will anyone dissent from the Committee's premise that a scientific career should be broadly based upon the "humanities". One must, however, disagree with the conclusion which is drawn that a study of the "humanities" should be included as an essential part of the university 'honours courses' for science students. All freshmen will, before entering their honours course, have enjoyed some six or seven years of secondary education, and it is in the secondary school that the essential foundations of a general education should have been laid. The period available is ample, if wisely used, to stimulate any intellectual interests of which the student is capable, and of laying a foundation upon which he should be able to develop those interests by leisure reading.

If, in point of fact, the schools have been betrayed (whether by the pressure of the university scholarship system, or other cause) into too great specialization, so that the present undergraduate is less widely read than his predecessors, the remedy is to be found by an overhaul of the school curriculum rather than by inserting irrelevant subjects into university courses. Omniscience is no longer a possible educational objective, and there must be some stage at which a science student begins to concentrate upon those special subjects, the mastery of which will enable him to make his specific contribution to the welfare of society. I suggest that this point comes naturally at the beginning of his university career. A wise tutor will, no doubt, encourage his students to a wide course of reading in their leisure time, and to a reasonable participation in undergraduate societies; but the student should not be distracted from his main objective by having to face an examination in any non-related subject.

There is one point, however, on which I believe the Committee has moved on to very dangerous ground. It is, perhaps naturally, expressed more clearly in the article in NATURE on the report than in the more cautious words of the Committee itself. I quote the relevant paragraph.

"It is therefore with a feeling of deep satisfaction that we note the Committee's insistence on training for world citizenship in all faculties, pass and honours, of our universities. . . . Social studies and the humanities must play a certain part in the training of all students. This applies especially to science students, for it is almost axiomatic that, in present circumstances, a man might gain a first-class degree in science and be no more appreciative of the essentials of world citizenship than any less fortunate individual who has not gone so far as through a secondary school."

To suggest that a graduate is, or ought to be, a higher type of *citizen* than the man whose gifts do not lead to a university education is to misunderstand the nature of citizenship in a democratic community. It has a totalitarian ring about it, and is calculated to arouse indignation in many manual workers who feel, and rightly so, that their conviction of what constitutes the basis of a sound social order is entitled to as much respect as that of the intellectual. I hear from colleagues who have recently been holding discussion groups with the Forces that similar pronouncements by our 'intelligentsia'—who are apt to take it for granted that high intellectual training is a pre-requisite for leadership in the new age—is already causing serious resentment.

Society will choose its own leaders; wisely, we may hope, but certainly for qualities in no way connected with academic distinction, even in sociological subjects. But society will also need, for its great task of restoration, men and women of high ability and intensive training in each of the sciences—and the humanities, too—and will welcome them, not as superior world citizens, but for the special contributions which their scientific education enables them to make. The education and training of these experts is the special function of the university, from which it should not be deflected. For the undergraduate who has the ability which justifies an honours course in science, the eager pursuit of the training which is to fit him for this task is his best form of social service.

J. A. CROWTHER.

University of Reading.

SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

THE annual conference of the Society of Agricultural Bacteriologists, held at the University of Leeds during August 27–29, 1942, reflected the influence of war-time conditions. Several members of the Society were unable to leave their duties in order to attend the conference, and the papers, particularly those concerned with dairying, showed that problems of immediate practical importance are being investigated. The field covered by the discussions was nevertheless wide and afforded an index of the activities of a society which exists with the object of advancing the study of general, agricultural and related branches of bacteriology.

A contribution to the bacteriology of sewage disposal dealt with the nitrifying activity of biological film from percolating filters. The activity was measured by inoculating an ammonium sulphate-calcium carbonate solution with a dilute suspension of film, aerating the cultures in inverted conical flasks, and determining the rate of production of nitrite and nitrate. Nitrifying activity was found to be influenced by season, depth below the surface of the filter and the rate of treatment of sewage. Film produced in ordinary single filtration acted differently from film obtained in the process of alternating double filtration, in which two filters are operated in series with a periodic change in the order of flow.

In the disposal of certain industrial wastes the activity of the sulphate-reducing organism *Vibrio desulphuricans* may require control. It has been shown that this microbe may be easily suppressed by the relatively simple and inexpensive method of adjusting the hydrogen ion concentration to less than *p*H5 or more than *p*H10. An illustration of the practical application of this principle was cited. A pond used for the reception of a waste containing 20–30 per cent of fatty matter and 3–4 per cent of sulphate (as calcium sulphate), at the rate of about forty tons a week, created a nuisance in the locality owing to the evolution of hydrogen sulphide. The *p*H value of the water was brought to 3 by adding sulphuric acid and the trouble was eliminated.

Shellfish which have been subjected to the process of self-purification in tanks of clean sea water have recently provided a problem. On arrival at inland markets they sporadically harbour large numbers of coliform organisms, and the suspicion that purification has been inadequate naturally arises. Investigation showed, however, that this occurrence is due to multiplication during transport of coliform bacilli which have no sanitary significance. With the object of finding a rapid method which would differentiate typical *Bacterium coli* from other members of the group the modification of the Eijkman test using MacConkey's broth was re-investigated. Taking the production of acid and gas as the differential criterion, an incubation temperature of exactly 44° C. afforded the best separation of the types. In an examination of 1881 cultures derived from a variety of sources, 97·5 per cent of the typical *B. coli* produced acid and gas at 44° and only 5·2 per cent of the other coliform strains did so.

The coliform group in its relation to dairy products was also discussed. It has been found that the presumptive test for the presence of these organisms when applied to milk gives a lower estimate of the coliform population than when applied to water. Abnormal gas formation in factory-made Cheddar cheese was attributed to coliform bacilli introduced into pasteurized cheese milk from such sources as coolers and pipe lines. While various types of this group were isolated, typical *B. coli* predominated at all stages in the making and ripening of the cheese examined and appeared to be responsible for the majority of cases of gas production.

Bacteriophage active against streptococci, which may be responsible for difficulties in the making of Cheddar cheese, has now been successfully demonstrated in high dilutions prepared from cheese up to 3½ months old.

The resazurin reduction test is receiving much attention as a means of grading milk. One paper described the chemistry of resazurin and gave practical hints on the test. Other two papers dealt with the 10-minute resazurin test which is now used for the rapid recognition of unsatisfactory milk, a product which has become an important problem under war-time conditions. According to the colour of the milk-dye mixture after 10 minutes at 37° C. milk may be classified in three categories : (1) suitable for the liquid milk market, (2) suitable for manufacture only, and (3) unacceptable for any purpose. The results usually agree with those of methylene blue reduction and are obtained in a shorter time. Other rapid tests, such as those utilizing titratable acidity, *p*H, clot formation on boiling, alcohol precipitation, smell and taste, have been found to be less suitable for use on the receiving platform of creameries. A fourth paper presented evidence that the resazurin test, when performed at 18° C., gives within two hours a reliable indication of the keeping quality of milk. Samples of really poor keeping quality can be detected within 30 minutes by the 18° test.

Mastitis of the dairy cow was discussed in three contributions. A comparison of diagnostic methods applied to a large number of samples led to the conclusion that for the detection of sub-clinical mastitis a combination of two indirect tests, the determination of the leucocyte content and of the electrical conductivity of milk, is superior to the isolation and identification of the infecting organism in reliability, speed and cost of materials. Milk from an infected quarter has an abnormally high cell count and, largely owing to an excess of chlorides, a high conductivity. The standards adopted to differentiate between normal and infected milk were 500,000 cells per ml. and a conductivity of $49 \cdot 0 \times 10^{-4}$ mhos.

In the second paper on mastitis, which described field observations on the control of the disease, methods of cultivating *Streptococcus agalactiæ* were compared, and evidence was presented to show that factors such as unsuitable milking machines have an important influence in raising the infection rate. The third paper dealing with mastitis described a broth containing peptone, yeastrel, mannitol, æsculin and hippurate which permits *S. agalactiæ* to display the majority of its differential characters. It is thus possible to identify the organism by preparing a single culture in the composite medium.

Other contributions to the proceedings dealt with methods of increasing the heat resistance of the spores of a putrefactive anærobe and with the control of moulds (Penicillium and Mucor) in meat pies by changing the methods of manufacture.

In spite of difficulties due to the War, this conference was most successful and did not depart from the trend towards greater variety of interests which has characterized annual meetings of the Society.

BIRDS AND BUTTERFLIES

By DR. C. B. WILLIAMS
Rothamsted Experimental Station

THE extraordinary mimetic resemblances which exist between certain apparently edible species of insects and other distasteful species, which are found in the same neighbourhood, reach their highest development in the Rhopalocera or butterflies. The resemblances are purely external and frequently confined to the upper surfaces of the wings only. They are obviously meant to deceive an eye.

If this mimicry has been brought about by natural selection of smaller or larger variations because they are of survival value to the mimics, there must be some enemy whose eye is deceived, and further, in view of the perfection of many of the resemblances, it must be sometimes not deceived by the less perfect resemblances.

Undoubtedly the chief death-rate of butterflies is in the egg, caterpillar and chrysalis stage, but these resemblances which we are now considering are in the adults, so that we have to search for an enemy which can exert a considerable selection pressure in the short period between the emergence of the butterfly from the chrysalis and the time that most of its eggs are laid ; for after this latter no selection is of survival value to the race.

We need, therefore, a sharp-eyed predator which is active by day and which sees the butterflies when their upper surfaces are exposed, that is, probably when in flight. Birds are the obvious choice, but when the suggestion was first critically examined it was found that the evidence of bird attack on butterflies was very small. Quite experienced field naturalists commented on its rarity.

In the subsequent search for evidence two promising lines of work have been in progress. At an early stage field experiments were made by offering to tame or wild birds butterflies that were believed to be palatable or distasteful, together with mimics of the latter.

More recently, progress has been made by the discovery that the butterfly wings often show definite marks where they have been nipped by the beak of a bird. In these cases, of course, the butterflies have been fortunate enough to escape. The marks may be so definite that the size and angle of the beak may be measured and a close guess made at the group or even species of bird that caused the injury.

Prof. G. D. H. Carpenter has been associated with these lines of study for many years and in two recent papers*, one prepared from notes left by the late C. F. M. Swynnerton, he brings forward much new evidence on both counts.

On the problem of the relative frequency of beak marks he shows that in more than ten thousand museum specimens of the distasteful genus Euploea, 123 (1·15 per cent) showed beak marks on the wings ; in more than six thousand African Danain butterflies, also distasteful, 117 (1·05 per cent) had marks ; but in more than seven thousand African Colotes spp., a quite edible genus, only 11 (0·15 per cent) were marked.

* (1) Observations and experiments in Africa by the late C. F. M. Swynnerton on wild birds eating butterflies and the preferences shown. *Proc. Linn. Soc. Lon.*, Session 154, 10–46 (1942).

(2) The relative frequency of beak marks on butterflies of different edibility to birds. *Proc. Zool. Soc. Lon.* (A), **111**, 223–230 (1941).

The inference is, as Prof. Carpenter points out, not that the distasteful species are more frequently bitten by birds, but that, being bitten, they more frequently escape or are allowed to escape.

A comparison was also made between 550 distasteful Danaine models which showed 17 individuals with beak marks, and 340 Nymphaline mimics, of which there was only a single one with a beak mark.

In an appendix to this paper, it is also shown that of 613 distasteful butterflies from all parts of the world which had beak marks, 133 or 21 per cent had evidence of more than one attack, while of 179 edible butterflies with beak marks only 21, or 11·7 per cent, had evidence of more than one attack. The difference is statistically significant.

Prof. Carpenter's conclusion, which seems to be justified, is that distasteful (aposematic) species are more frequently found with beak marks because they "live to fight another day", owing to not having been eaten by their bird enemies even when they have been seized.

The summary of Swynnerton's field experiments is a mine of interesting information. The main portion deals with the behaviour of birds towards butterflies of different species which were 'planted' in positions visible to the birds but prevented by various means from flying away. Twenty-two such experiments are described and the results are very striking. Time and time again the more distasteful species are either completely neglected, or, even more convincingly, carefully examined at first and then neglected. The more palatable species, on the contrary, were eaten in very high proportions. The distinction between palatable and distasteful is not absolute but comparative, and very hungry birds will eat relatively distasteful species, while replete birds will require to be tempted by a particularly choice morsel. Other things being equal, a hungry bird will eat a large butterfly in preference to a smaller one.

In one example given (Section C, Experiment 1), 84 butterflies were exposed, and after five hours 45 had been eaten. Among the butterflies were 7 Danains (aposematic), none of which had been touched, and 24 *Vanessa cardui*, of which 22 had been eaten.

In other experiments the birds were shown to be definitely deceived by mimics of aposematic species.

There is no doubt that a considerable body of evidence has been brought forward to show that birds are important and critical enemies of butterflies, that they have to learn by experience the appearance of distasteful species, and that once having learnt this they are frequently deceived by mimetic resemblance.

UTILIZATION OF GLASS

PROF. W. E. S. TURNER read a paper on "New Uses for Glass" before the Royal Society of Arts on January 20. He briefly traced through history the development of the use of glass from its main original use for decorative purposes to its ever-widening use as an essential material for utilitarian purposes. No period has seen more fruitful advances than the past fifteen years.

Systematic scientific investigation has resulted in providing us with glasses having a density from 2 up to 8 : a coefficient of thermal expansion varying at least thirty-fold ; a range of thermal endurance such that objects made from some glasses can be heated to glowing and quenched in water without fracture; a range of load-bearing capacity up to six and even ten-fold; electrical resistance varying up to at least ten thousand-fold; while the non-corrodible character of modern types of glasses is such that it can and has replaced stainless steel, offers resistance to steam at high temperatures and pressure, to strong acids and many liquids which are chemically corrosive of other known materials and is without any action on the most sensitive of physiological, biological and chemical preparations.

Sheet glass is now drawn continuously in the flat state more than one hundred inches wide; plate glass is, by the latest British process, not only rolled continuously some 12 ft. wide, but is simultaneously ground and polished on both sides. Thousands of different articles such as bottles, jars, tumblers and drinking vessels of all kinds, even complicated articles like jugs with handles and wine glasses with feet, are now produced entirely by automatic machinery; half a million electric light bulbs per day are turned out by automatic machines and miles of glass tubing of various kinds and diameters. Glass can be converted into flakes and drawn into threads as fine as silk at the speed of some six thousand feet per minute, with numerous uses in the production of yarn and woven textiles, as filtering mediums and for insulating purposes.

The modern processes of tempering glass have tremendously increased its safety factor against breakage and made its use possible against extremes of heat and cold, for transparent pressure chambers, for high-power electric insulators, a base on which to spray a metal for grids to form electric radiators, for the tops of hot stoves, and for general constructional purposes, including doors provided with metal fittings. The combination of layers of glass with very thin layers of transparent plastic materials has given laminated glass for transport vehicles and, when used in multi-layers, bullet-resisting glass, as used in tanks and aeroplanes.

The advances in sealing glass to metals have made possible the construction of metal filament electric lamps, cathode ray tubes and radio valves; mercury arc rectifiers, in glass envelopes and operating with electrodes at high temperatures, are now in operation in many transformer stations.

Glass can also be coloured for the transmission of light and radiation; colourless glasses will transmit X-rays with high efficiency, whereas lead- and barium-containing glass provides screens for protection against X-rays. Glasses are made with a high transmission for ultra-violet light; and deeply coloured glasses can be made which transmit nothing but ultra-violet light on one hand or infra-red on the other.

FORTHCOMING EVENTS

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

Saturday, February 6

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Nutrition in Pregnancy".

British Rheologists' Club (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.15 p.m.—Dr. R. N. Haward: "The Extension and Impact Resistance of some Plastic Materials".

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. F. A. Bannister: "The Determination of Minerals by X-Ray Methods".

Monday, February 8

Institution of Chemical Engineers (joint meeting with the Chemical Engineering Group, the Yorkshire Section of the Society of Chemical Industry, and the Leeds Area Section of the Institute of Chemistry) (in the Chemistry Lecture Theatre, The University, Woodhouse Lane, Leeds), at 6 p.m.—Dr. A. H. Jay: "The Application of Crystal Analysis to some Chemical Engineering Materials".

Tuesday, February 9

Royal College of Physicians (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Prof. M. Greenwood, F.R.S.: "Medical Statisticians from Petty to Farr" (Fitzpatrick Lectures, 1).

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir Lawrence Bragg, F.R.S.: "The Solid State", (iii) "Minus-minus Compounds".*

Illuminating Engineering Society (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 5 p.m.—Contributions on "The Effectiveness of Lighting, its Numerical Assessment", to be followed by a Discussion.

Wednesday, February 10

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. G. Glenday: "Location of Industry".

Royal College of Physicians (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Prof. M. Greenwood, F.R.S.: "Medical Statisticians from Petty to Farr" (Fitzpatrick Lectures, 2).

Institution of Electrical Engineers (Installations Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Use of Electricity in relation to Fuel Economy" (to be opened by Mr. R. H. Rawll).

Friday, February 12

Royal Institution (at 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. G. M. B. Dobson, F.R.S., and Dr. A. R. Meetham: "The Air we breathe in Town and Country".

Saturday, February 13

Iron and Steel Institute (joint meeting with the Sheffield Metallurgical Association, the Sheffield Society of Engineers and Metallurgists, and the South Yorkshire Section of the Institute of Chemistry) (at the Royal Victoria Station Hotel, Sheffield), at 2.30 p.m.—Mr. H. T. Shirley and Mr. E. Elliott: "A Critical Consideration of some Applications of the Spectrograph to Steelworks Analysis".

APPOINTMENTS VACANT

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

Lecturer in Mining—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (February 13).

Lecturer in Chemistry—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (February 13).

Graduate Master or Mistress to teach Mathematics and Geography in the Harrogate Technical Institute—Mr. W. E. C. Jalland, The Secretary to the Managers, Municipal Offices, Harrogate (February 15).

Chair of Mining—The Secretary, The University, Edmund Street, Birmingham 3 (March 1).

Instructor in Beekeeping—The Education Officer, County Hall, Wakefield (March 1).

Sir Dorab Tata Reader in Pharmaceutical Chemistry in the Department of Chemical Technology—The Registrar, University of Bombay, Bombay, India (April 15).

Head of the Mining Department—The Principal, County Technical College, Mansfield, Notts.

Lecturer in Electrical Engineering—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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Other Countries

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