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INTERNATIONAL COLLABORATION

A SIGNIFICANT feature of the discussions of post-war international reconstruction during the past year has been the renewed attention given to the League of Nations. Federal Union and other proposals for regional or world federation no longer hold the stage to the exclusion or disparagement of the League. The tendency is rather to re-examine the causes of the League's failure, to appraise more critically its achievements, and, indeed, to regard it as the starting-point of political thought and action in the field of international reconstruction.

Powerful support to that tendency has been given by Viscount Cecil's autobiography, "A Great Experiment"*. Growing recognition of the importance of economic factors in international reconstruction has directed fresh attention to fields in which the League and the International Labour Organisation have been responsible for solid achievements. Even among those who are protagonists of power politics and most sceptical of the acceptance by States of limitations on their power or sovereignty this is appreciated. Prof. E. H. Carr, in "The Twenty Years' Crisis", considers that the best hope of progress towards international reconciliation lies along the path of economic reconstruction, while in his valedictory report to the International Labour Office, Mr. J. G. Winant points the same way with great force.

"The cornerstone of the future", Mr. Winant writes, "is already apparent from the mistakes of the past. Political democracy must be broadened to include economic stability and social security. The waste of resources which has been effectively eliminated in time of war must not be allowed to return once peace has come. An unemployed or poorly employed citizenry is no basis for winning the peace. Even though, at a moment when the survival of democracy is in the balance, priority of production, energy and will must be granted to the waging of the war itself, we must not lose sight of this conclusion from the past. No opportunity to enlarge the social content of democracy must be lost. No opportunity to strengthen the fundamental social and civil rights of the great majority of citizens must be neglected. No opportunity to wipe out the want and the hopelessness of the pre-war period must be ignored. This is not only prudent national defence, it is the tradition of democratic freedom."

Mr. Winant's conclusions from experience of recent years are important. First, he says, it is clear that the democracies cannot survive unless

* A Great Experiment. By Viscount Cecil. Pp. 384. (London: Jonathan Cape, Ltd., 1941.) 16s. net.

they can achieve effective co-operation between Governments and organizations of employers and workers. In this matter of evolving new democratic machinery and institutions, he sees, in the co-operation already developed to further our war effort, the hope of extending the force of democracy everywhere. Secondly, divisions within the ranks of the workers greatly aided the spread of Fascism in Europe, and thirdly, he urges caution in making sweeping generalizations on the causes of events. Those who blame social policy for the disasters that overtook France, for example, he considers, are mixing cause and effect, and he sees danger in the tendency to blame workers' organizations for inefficiencies of national economic organization and for military failures.

Mr. Winant's report is both outspoken and optimistic, and both Great Britain and the United States have reason to be thankful that a man of the vision and wisdom revealed in this report plays so large a part in their common counsels. Mr. Winant points to the way in which the War itself, having become the dominant factor in social change, is in some countries tending to promote health measures, social security legislation, and safety precautions as an integral part of national defence programmes. That is true, however, only for the Allied countries, where the democratic ideals are valid, human personality is respected, and freedom of speech, of thought, and freedom to worship as conscience dictates, are possible.

Convinced that the International Labour Organisation has an essential part to play in building the foundations for a peace based on social and economic freedom, Mr. Winant is confident that the Organisation can strengthen the fabric of democracy and make an outstanding contribution to the mobilization of the full strength of democracy. Useful as its machinery may be in helping to adapt existing social standards to war needs and to appraise hastily improvised methods of meeting war strains on the economic and social structure, its value in the preparation for the peace is far greater.

When that time comes, we must be far more ready than we were at the end of the War of 1914–18. Social and economic problems will necessarily be in the foreground, and their solution demands careful technical preparation as well as co-operation between economic and social groups and the Government, in which the experience of the International Labour Organisation and its triparitet machinery will be of great value. It can help to plan for an orderly demobilization of war and defence industry and of military forces, and in the elaboration of the basic principles which must be included in a revised labour code.

In Mr. Winant's mind the International Labour Organisation is not merely a successful experiment. It is an effective instrument for orderly social change, the capacity of which has been proved. That, indeed, is essentially Lord Cecil's verdict on the League's work in economic and social affairs. He pays emphatic tribute to the value of its technical organizations, as well as to the work of the International Labour Organisation, and he points out that the machinery of the League has been of the first importance because it has worked far more rapidly than the old diplomatic methods and because by the pressure of publicity it has thrust aside the obstruction of interested powers.

Shortly before the outbreak of war, the Bruce Committee on the Development of International Co-operation in Economic and Social Affairs proposed the consolidation of these activities under a new general committee of the League designed to be apart from political passions and preoccupations. Lord Cecil, however, insists on the necessity of direct action to preserve peace, to supplement these activities if the fabric of civilization is to be maintained. "The marked success of the League's non-contentious work followed by the recrudescence of European war, is glaring evidence of the mistake made by those who urged that the League could be made to work as a peace-keeping machine without its coercive powers."

Lord Cecil believes that the constitutional union of independent States inside the general framework of the League might help to make men realize that it is only by international co-operation that peace can be preserved. He insists, however, on the fundamental point that no machinery can do more than facilitate the action of the peoples, and unless they and their Governments really put the enforcement of the law and the maintenance of peace as the greatest of national interests, no confederation can compel them to do so. The League experiment failed because the Governments did not do this. Lord Cecil's indictment of the absence of far-sighted and courageous leadership is severe though restrained.

Lord Cecil's volume leaves the reader in no doubt as to the greatness of this experiment in conception and scope, if not in achievement. Whether it can be considered a scientific experiment is another question. None the less, this book, with its calm appraisal and poise, as characteristic of the scientific spirit as of the judicial mind, which is Lord Cecil's by training, gives us at least a pointer to a scientific approach to the problem, the basis for further experiments on scientific lines in the future. No serious attempt at world co-operation and reorganization can afford to neglect the wisdom and experience gathered in the great experiment Lord Cecil so luminously describes.

Lord Cecil has placed us further in his debt by a pamphlet, "A Real Peace"*, addressed to a wider public, in which he attempts to apply this experience and these conclusions to the problems which will confront us in building a real peace in Europe when hostilities cease, and particularly to the central problem presented by Germany. The pamphlet is more than a reiteration of the conclusions elaborated in the final chapter of "A Great Experiment". He points once again, it is true, to deficiencies of leadership, to the ignorance and short-sightedness which brought the League to failure, and he emphasizes the central lesson that a breach of the peace anywhere is a danger to peace everywhere.

This pamphlet should assist in bringing this lesson home to all, but it is also far more specific. It indicates the importance of the German problem —the necessity of assuming that the peace-loving powers may have to deal with the menace of another German attempt to establish world tyranny by force, and that they must find some way to build up the forces of peace sufficiently to make aggression by Germany or any other power a hopeless proposition. He utters words of caution about the form of international authority which may be required, but considers that any organization for the preservation of peace in Europe should ultimately be open to any country the good faith of which can be trusted and which is prepared to enter into a definite undertaking to collaborate in that purpose with its whole strength.

The advocates of federation commonly place the responsibility for the failure of the League on national sovereignty. Robert Dell, for example, in "The Geneva Racket"†, urges that there is no chance of a permanent peace unless Europe is federated, and asserts his conviction that the abolition of absolute national sovereignty is the essential condition of any solution of the problem of peace. Such critics may well hold that Lord Cecil passes too lightly over the problem of sovereignty, but they must recognize the vital effect of a change in the spirit of the Governments, especially of the Great Powers, for which Lord Cecil contends. Without such a change and the sincere determination to use the League machinery for the purposes for which it was created, no League of Nations will work, however perfect its machinery.

The international authority, Lord Cecil considers, should be based on the representation of States, not of populations, though he would reinforce it by regional groupings ; federation is a matter rather for the future. He touches on the particular problems of minorities and of colonial possessions and mandates, on the necessity for further facilities for peaceful change, and on the three stages by which we must proceed from a state of war to one of established and ordered peace : first armistice, then a conference of belligerents of both sides to consider the actual issues raised by the war, and finally after a reasonable interval a full congress of all interested countries, neutral as well as belligerent, to decide all questions arising in a world settlement.

Lord Cecil does not claim, as Mr. Winant does for the International Labour Organisation, that the League is an instrument true and proved and adapted to our purpose. He does at least see in it an instrument which can be re-shaped, re-forged if need be, to give effective service, if only the spirit and will to use it for its high declared purpose are forthcoming. Progress towards an international society or true world federation may well proceed on two parallel lines : horizontally, through the gradual development of the League towards a federation by progressive limitations of the sovereignty of its members ; and vertically, by way of geographically limited groups or federations in the true sense of the word, established on the basis of affinity of culture, of language, of tradition and of political ideas. To both processes Lord Cecil makes a noble contribution. It is only by education, by creative thought and free discussion that there can come in fullness of time, the wisdom and understanding, the vision and determination which will build on that which remains to us of our heritage, a new League, preserving historic continuity, universality and the unity of the human race, fortified to overthrow all onslaughts of aggression ; and worthy of the sacrifices already incurred in the service of the principles of freedom, truth and justice which it enshrines.

* A Real Peace. By Viscount Cecil. Pp. v+34. (London : Hamish Hamilton, Ltd., 1941.) 6*d*. net.

† The Geneva Racket. By Robert Dell. Pp. 375. (London : Robert Hale, Ltd., 1941.) 18*s*. net.

PHYSICS AND THE FUTURE

FOR the majority of citizens science remains inaccessible. It has little or no place in their school life, their newspapers, their cinemas, their radio, or their literature. Although present-day civilization depends entirely on applied science, even the politicians and rulers, who guide our affairs, share this common unfamiliarity with science. Dramatic events like war, however, in which science is misapplied, forcibly direct attention to man's most powerful tool. If the War of 1914–18 was a chemists' war, the present affliction, with its extensive mechanization, radio propaganda and aeronautical developments is a physicists' war. Aerial bombardment alone might almost be called a nightmare of complex physical problems the solution of which would need the efforts of more than the whole of the country's physicists. In the circumstances, a scarcity of physicists is not surprising. The Board of Education is approaching the problem by offering a number of State bursaries chiefly in physics, engineering and chemistry (see p. 251).

But the dearth is world-wide. Of the 4,500 American physicists, about 1,400 are already engaged on war work and 600 more are needed within the next year. One hundred others are needed in essential production industries*. The present solution of letting some of the physicists desert the universities is hampering both the training of future physicists and the production of new physics.

If physicists were wanted in large numbers solely in war-time, and then only to assist in the slaughter of vast numbers of citizens of the world, there are many who would care little for the future of physics. But physics is of vital importance in war-time for the very reason that it will be of vital importance in the future peace. Until the biological sciences have developed, applied physics is man's most powerful tool in dealing with his environment. The fact that civilization is at present misapplying the tool means that, in peacetime, it must be used with redoubled energy both to make good the damage done and also to make up for the time lost during war.

What then are the difficulties in providing an adequate supply of physicists? In the first place, physics, like all the sciences, is expensive to teach. In many schools the sciences are still apt to be regarded as 'extras' just as in daily life the sciences are outside most men's experience. Of all the sciences, physics is the most expensive. Cost is therefore a highly relevant factor. Money and methods of teaching must be found so that every boy and girl without exception is consciously brought into contact with physical phenomena. Physics will then suffer no neglect, as at present, from ignorance. But not all intelligent boys and girls are potential physicists. Special abilities as well as love of physical phenomena are needed. A mathematical mind, if not technical skill in mathematics, is essential to the physicist in order that he may benefit from the results of mathematical physicists and that he may be able to present his own theoretical problems in suitable form to mathematicians. Then again physics is difficult because it covers not one, but several subjects.

When potential physicists are found they have to be trained. More attention has been given to this process in the United States and in the U.S.S.R. than in Great Britain. Here, expense is again the most significant factor although its influence is subtle. University teaching of physics must be associated with research. But research apparatus is so expensive that little money can be spared for extra non-graduate research assistants and technicians. It is an open secret that a university professor of physics can get more easily the money to pay an extra graduate than a non-graduate member of staff. As a result, junior members of staff are in practice appointed not only for their research abilities but also because their type of research apparatus is already in the department. In a school of research they must in fact play the part of research assistants and technicians, incidentally making apparatus for part of the time which otherwise might be spent in making physics. It would indeed be fortunate if when each new appointment were made research ability and technical experience in a particular branch of physics were combined with equal ability in training physicists.

That no very serious attention is given to the method of training physicists is a result of the comparatively short time of establishment of most physics laboratories. Two other factors are relevant. The reputation of a university physics department as a source of physicists depends upon those few students who, taking to physics as ducks take to water, are almost if not quite independent of the method of training. Then again, until comparatively recently, but few physicists have been used in industry. Conditions have now changed. Physicists whose main task in life is rather to apply than to make physics are, and will continue to be, wanted in increasing numbers. If

* *Rev. Sci. Inst.*, **12**, 177–78 and 247–49 (1941).

serious consideration were given to their training, no harm would be done to the few born physicists and much help might be given to the production of physicists who would go out into the world and apply physics to man's needs.

Before the War, the average cost of a university research paper in physics was not less than £300. The average cost of the equipment needed to start work in any one of the specialized branches of the subject was £1,000. An expenditure of £15,000,000 a day on equipment for warfare may make the expense of physics seem paltry. Sufficient evidence of poverty-stricken conditions of some physics research can be seen in such papers as appear from time to time in the *Journal of Scientific Instruments*, where research is described on finding an inexpensive way of carrying out some physical operation for which ready-made but more expensive equipment is already available.

If physicists' contributions to war help to remove ignorance of physics, the money needed for physics in peace-time may be forthcoming. Then will be the time to show that applied physics is as powerful a tool for construction as it is at present for destruction or protection. Even if a university graduate in physics has paid for his training from private sources he will still have cost the community large sums of money. By using his talents together with his training he can repay in service to mankind. Tremendous possibilities lie ahead. One only need be mentioned. At present biology is absent from the education of most men, including physicists. Officially, the physicist knows nothing of life. When this blind spot has been removed, some physicists will feel drawn to biological problems and the wonderful developments of biochemistry will be matched by those of biophysics.

The excellent equipment of the physicists in the United States and the U.S.S.R. should be a lesson not yet appreciated in Great Britain, that, generally speaking, the day of phys cs done with sealing wax and tobacco tins is past. Physics is an expensive subject and will become more so as each new development is made and applied to revitalize older branches of the subject. But in return for the cost, physicists can and will repay in service to mankind by making and applying physics and by helping to train the next generation. To help recovery from the tragedy of war every scrap of brain-power will be needed. Given the means, physicists can and will play a vital part in this recovery.

IS MARXISM SCIENCE?

Marxism : Is it Science?

By Max Eastman. Pp. 343. (London: George Allen and Unwin, Ltd., 1941.) 8*s*. 6*d* net.

MAX EASTMAN is a somewhat odd critic of Marxism. He appears to accept at the outset most of the aspects of Marxism that have made it anathema to orthodox opinion. Not only does he agree with the economic analysis Marx made of the capitalist system, but even with the revolutionary application of this analysis by Lenin. But this seeming agreement covers a fundamental objection to the whole method of Marxism. He is an inveterate opponent of dialectical materialism, not because of its results, but because it represents a type of thinking profoundly different from his own. Max Eastman is a perfect type of nineteenth-century intellectual radical, a believer in common sense and engineering, with a violent antipathy to all forms of philosophy and religion. The book itself represents only one stage in retrogression towards older views. Since it was written, Max Eastman, from being a critic of Marxist logic and philosophy, has moved to a rejection of Marxist economic theory and political ideas.

In this book his fundamental objection to Marxism is that it is religious. Religion he defines as the belief "that the external world, or some power in it, is interested in the interests of men. The religious believer persuades himself that the world is softer than it is, and that we know more about it than we do". And Marxists are religious because "they cherish a belief that the external universe is evolving with reliable, if not divine, necessity, in exactly the direction they want it to go". What he would like instead is a stern belief in the indifference of the world, and what he calls the "engineering approach" to social problems.

"An engineer wishing to convert a given form of society into a more satisfactory one, would begin by making a very rough outline of the kind of society he proposed to build. With that rough blueprint in mind he would examine the existing society, and he would also examine all past societies, and find out what are the forces which control them and the general laws of their change. When he had finished that investigation and acquired that knowledge, he would draw up a procedure or plan of action, a scheme for getting the thing moving (supposing that his investigations had proven it possible) in the direction of his proposal."

The chief sin of Marxism in his eyes is neither its analysis nor its plan of action, but the fact that it mixes analysis with action, instead of keeping them rigidly separate. To prove his thesis he examines the historical origins of Marxism, with particular emphasis on the part played by Hegelian philosophy. Philosophy is naturally to him as destructive as, and far more insidious than, religion. Philosophy to him is a characteristically German rather than Anglo-Saxon way of thinking and acting, and the proof that Marxism is saturated with philosophy is enough to damn it.

There is no doubt that this line of argument will prove highly popular with men of science of the old school. They may be a little shocked by Max Eastman's advocacy of revolution, but will be comforted by the reflection that anti-Marxist revolutionaries are rarely dangerous to the established order and that Max Eastman himself has for years been a most usefully ally to Red baiters.

To anyone who has taken part in the revaluations of science that have been going on during the last twenty years this book will appear simply as a belated landmark of an earlier mode of thought, for the arguments advanced in it are based on a conception of science that has already long been felt to be insufficient—"knowledge derived by the methods of observation, experiment and rational calculation and subject to the practical test of action". This definition, like Euclidian geometry, is true only if we concern ourselves with some small portion of knowledge and action. It is, and will long remain, the working scheme for detailed scientific research ; but if we are concerned with the whole of human experience, its inadequacy becomes manifest. Separate studies, however accurate, do not of themselves provide an integrated picture, and the observer can no longer be kept rigidly separate from the thing observed. This is particularly so in the field of human affairs, where the application of classical science has singularly failed to produce any useful results. Indeed, if we accepted Mr. Eastman's criticism, Marx would be an even greater figure than he was, because he was able to arrive at correct results by using entirely wrong methods.

The aspects that Max Eastman rejects are those which have attracted so many modern men of science to the study of Marxism. In the development of human societies radically new events are continually happening which are not seen, or are seen only with difficulty, in the far slower evolution of cosmic or biological systems. The most striking changes do not appear to be due to any external causes. In human affairs, the problem of the origin of novelty is a central point of interest. Men of science, however, have been content for the most part to ignore all novel features. Some qualify the rejection of their study on the grounds that they lie outside science and in the province of history, where the scientific method was not applicable. Others, without realizing it, evade the issue by appealing to some efficient cause, some life force, which, acting from the outside, brought the changes about. This is a mere deification of ignorance. If these changes are to be tackled scientifically, their origin must be looked for inside the system, in the interaction of its parts. It is this interaction which Marx, using Hegel's terminology, conceived of as a conflict of opposites leading towards a resolution into some new State. The fact that Hegel's opposites referred to a world of pure thought is no more refutation of his system than the fact that Newton's was derived from theology. Both were trying to set down in a language they found appropriate the new relations they had discovered. Marx's opposites, capital and labour, were real enough and engaged in real enough conflict. But if this kind of development by internal conflict could happen in rapidly changing civilized societies, it was very likely that it was happening less rapidly elsewhere ; and, by generalizing the theory of dialectical materialism, Marx and Engels, and particularly the latter, were able to indicate that other conflicts probably underlay earlier changes in human and animal life, and farther back at all critical points of cosmic history.

Critics have objected to dialectical materialism on the grounds that it does not prove anything. But Marx was aware of this, and indeed stated it explicitly. Dialectical materialism aims, not at proving things, but at discovering them. Whether or not it is scientific is an academic question, and depends on whether the word science is to be conceived of narrowly as physical science, or is to include an orderly treatment of the whole range from nebulæ to human society.

The contrast between the old and the new ways of looking at things is most clearly seen in relation to human psychology. One of Max Eastman's major objections to Marxism is its rejection of psychology in the individual sense and the statement that a human being is an ensemble of social relations. Now this central insistence on a human individual is itself a relic of Darwinian controversy, and carries farther back to Descartes's division of body and soul . . . indeed, by neglecting the social aspect, nineteenth-century men of science practically forced the acceptance of a duality between a merely animal body and an æsthetic and moral mind. Marx always rejected this view, and now the modern anthropologists are showing more and more clearly that the uniqueness of man lies not in any of his bodily or mental characteristics as such, but in the fact that he forms part of a self-perpetuating, self-conditioning community. The centre of interest in Marxism is this community and its development. Human environment is no longer, like animal environment, mainly physico-chemical or biological; it is social: and a social environment is not indifferent to the individuals composing it. If society changes it will always be ultimately because of the desires of the individuals composing it; but it will only be in the general direction of those desires if the individuals who are making the change understand the mechanisms by which change can be brought about. The value of Marxism is precisely the statement of this fact. Any attempt to apply engineering methods to human society, as Max Eastman would like to do, is necessarily to ignore the fact that the very desires of the engineer are conditioned. In so far as he is not aware of this, his aims will themselves be merely a reflection of the crudest aspirations of contemporary society. Indeed, this attitude actually leads straight to Hitlerism. "Mein Kampf" is the perfect illustration of an extremely astute social engineer at work, conscious of his end, conscious of his method, but unconscious of what conditioned his choice of end, or of the probable results of his action in destroying all the things he set out to reach.

The practical burden of Marxism is that effective choice of ends cannot be made without understanding the trends and conflicts of the existing situation. "Freedom is the recognition of necessity." But this does not make Marx a fatalist. When Lenin pointed out that socialism would not occur unless a party worked consciously for its realization, he was closer to Marx's intention than Plekhanov, who believed that it should be left to the automatic working of economic forces.

Marxists say that our actions and our knowledge are never separate, and that we would do well to realize the fact and consciously to combine them. If we imagine that they are separate, we will not only fail to be scientific, but will doom ourselves to a tragic futility.

J. D. BERNAL.

THE STATE OF PHYSIOLOGY

Annual Review of Physiology

James Murray Luck, Editor; Victor E. Hall, Associate Editor. Vol. 3. (Published by the American Physiological Society and Annual Reviews, Inc.) Pp. viii+784. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1941.) 5 dollars.

THE subject of physiology may be likened to a State at the frontiers of which lie several other sovereign States, with which it is in friendly relationship. It is a State consisting of several provinces, and while those inhabiting each province speak the language and appreciate the outlook of those across the frontier, they may be relatively ignorant of the language and customs of those who inhabit other provinces of their own State.

Here, surely, is ripe material for infiltration, with a view to conquest, by neighbouring States, for the liberation of oppressed minorities, and so on. There have, indeed, been Trojan horses (of the friendliest kind)—now it is organic chemistry that holds the key to the mystery of life—or now biophysics—that word to conjure with, that is to be the secret weapon against which none can prevail—or now all riddles dissolve before the heat and light of physical chemistry.

Yet the complex little State carries on, preserving its individuality and its ideals, in spite of all. It is enabled to do this because it has, in reviews of the kind now before us, a sort of parliamentary clearing-house—a talking-house if you wish—where those representing the subjects of its many branches can show what they stand for, and what they have achieved during the period under review. Thus some common understanding and cohesion is maintained and mutual regard kept alive between the different departments of a constantly growing endeavour. It is a pleasure to know that this service to science, which in the old days of international sanity was largely performed by publications in the German language, is, and for some years has to an increasing extent been carried forward in the English tongue, and very largely by American effort.

The present volume, considerably larger than its two predecessors, maintains the high standard of usefulness that was set by them. The contributors are all of high repute, and the outlook of the work is international, in so far as present circumstances allow.

An essential, and perhaps the most important part, of the work is the bibliographies appended to each of the articles. These represent a reasonably full list of the chief publications dealing with the subject of the article; sometimes the list runs into hundreds, and is rarely less than one hundred. The text of the articles is of the nature of a running commentary on the references. The indices of names and subjects, as is usual with American publications, are compiled with care and skill, As regards the articles themselves, it is obviously not possible to review these adequately. The following bare list of the contents, however, will show that there can be few who are interested in any of the branches of physiology who could fail to find an article that appealed to them :

The relation of bioelectric potentials to cell functioning (G. H. Bishop) ; the physiological effects of radiant energy (H. Laurens) ; physiological aspects of genetics (A. H. Sturtevant) ; developmental physiology (E. Witschi) ; growth (C. E. Palmer and A. Ciocco) ; temperature regulation (J. C. Scott and H. C. Bazett) ; energy metabolism (T. M. Carpenter) ; respiration (C. F. Schmidt and J. H. Comroe, jun.) ; physical properties of protoplasm (E. F. Adolph) ; muscle (W. O. Fenn) ; the digestive system (J. E. Thomas) ; liver and bile (W. B. Hawkins) ; formed elements of the blood (G. M. Higgins) ; heart (C. J. Wiggers and H. D. Green) ; peripheral circulation (V. E. Hall) ; electrical activity of the brain (H. H. Jasper) ; the autonomic nervous system (D. Sheehan) ; the special senses, (1) hearing (E. Barany), (2) visual receptors (R. Granit), (3) vibratory sensations and pain (Y. Zotterman) ; physiological psychology (H. S. Liddell) ; kidney (L. Leiter) ; metabolic functions of the endocrine glands (S. Soskin) ; endocrine aspects of the physiology of reproduction (O. Riddle) ; reproduction of mammals (M. H. Friedman) ; bacterial chemotherapy (E. K. Marshall, Jr.) ; histamine and anaphylaxis (W. Feldberg) ; exercise (A. H. Steinhaus).

The paper is matt and restful, and the type and make-up of the best.

C. LOVATT EVANS.

MOLECULAR SPECTRA

The Identification of Molecular Spectra
By Dr. R. W. B. Pearse and Dr. A. G. Gaydon. Pp. viii+221+8 plates. (London : Chapman and Hall, Ltd., 1941.) 42*s*. net.

TO identify a given system of bands in molecular spectroscopy, "it has hitherto remained necessary to search through original papers or to calculate the positions of bands from the tables of derived constants. . . . This task is usually tedious and sometimes impossible to one without considerable experience". Drs. Pearse and Gaydon have compiled tables of data which will facilitate the identification of bands occurring in the region 10000 A. to 2000 A. The data, in tabular form, include the recorded systems of diatomic molecules and a certain amount of data on polyatomic molecules ; in many instances the authors have extended recorded data by actual measurements. Data on complex organic molecules and on solutions have not been included, but that in no way detracts from the value of the book since it must be obvious that such a compilation must be limited by two main factors, (*a*) a defined wave-length region, and (*b*) an enforced limitation of the molecular types to be included.

Essentially the work contains two sections, and their contents can be conveyed most conveniently in the concise statements relating to them in the authors' introduction : "The first section consists of a list of the strongest heads of the more persistent and better known band systems of each molecule in order of wave-length, together with information as to origin, intensity in various sources, and appearance. The second section consists of individual lists of band heads for each system of each molecule, accompanied by notes about the occurrence and appearance of the system, the nature of the electronic transition involved, the vibrational assignment of the bands in the system, and references to the sources of the data. The lists are arranged in alphabetical order of the chemical symbols of the molecules."

The arrangement of the tables is exceptionally clear ; band heads are listed in groups of five with a space between each group, which makes their perusal less trying than if they had been printed close on each other line after line. In the second section the appearance and occurrence of each band are described in a crisp and complete manner. Thus the book is lifted from being a mere collection of data. The quoted references to original papers have been selected with care and discrimination. That the book has been compiled from the practical point of view is borne out by an excellent short account (10 pp.) of various points, troublesome to the inexperienced, arising in identification and "not usually dealt with in general text-books" ; these "practical hints" are an extremely useful feature, as is also the inclusion of fifty selected—and exceptionally well-reproduced—spectrograms.

The authors have accomplished the tiresome work of collection, selection, compilation and arrangement of the vast amount of data with clarity and skill, and the publishers and printers have done their jobs with equal acceptance. Such a book is needed by workers in this field, and the volume under review can be thoroughly recommended.

W. ROGIE ANGUS.

Chemical Computations and Errors

By Prof. Thomas B. Crumpler and Prof. John H. Yoe. Pp. xiv+247. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 18*s*. net.

THE authors state that their aim in writing this book has been to provide a course on chemical computations and errors for university students specializing in chemistry, and this they appear to have done extremely well. The subject-matter is clear, concise and well arranged, and the reviewer considers that several chapters of the book are admirably suited to the use of sixth-form pupils.

The first five chapters of the book give a simple account of exponential numbers, logarithms, the slide rule, algebraic equations, including the solution of simultaneous equations by determinants, graphical interpolation and extrapolation. The inclusion of historical details in these chapters, and indeed throughout the book, is a very pleasing feature. The chapters on the "Theory of Measurement" and the "Classification of Errors" should be most helpful to the student who takes a serious interest in his quantitative practical work, and he will understand, perhaps for the first time, why there is a difference between a cubic centimetre and a millelitre. A very clear distinction is made between "corrigible errors", that is, those errors for which corrections can be made, and "random errors" for which it is impossible to do anything.

The remainder of the book is mainly concerned with that branch of statistics which deals with the interpretations of discordances in numerical values. Chemistry students will be particularly interested in the statistical treatment of Lord Rayleigh's measurements of the density of nitrogen (pp. 186–188), where it is shown that the actual difference between the mean values for chemical nitrogen and atmospheric nitrogen is 34 times the probable error. This figure, the test shows, provides conclusive statistical evidence for believing that the composition of the two specimens of nitrogen is different.

Suitable problems are set at the end of each chapter and the answers, together with logarithm tables and a useful bibliography, are given at the end of the book.

Elements of Botanical Microtechnique

By Prof. John E. Sass. (McGraw-Hill Publications in the Botanical Sciences.) Pp. ix+222. (New York and London: McGraw-Hill Book Co. Inc., 1940.) 17*s*. 6*d*.

THIS book is the latest addition to the McGraw-Hill series of texts in plant science, which is being steadily built up into an encyclopædia of specialist monographs such as botanists have never before had available. As it follows rather closely on the appearance in the same series of Johannsen's treatise on the same subject, one may first ask what, in the circumstances, is the justification for its publication.

It is neither so comprehensive nor so detailed as the previous work, yet there can be no doubt that it has qualities which earn for it a just title to independence. In the first place it is more genuinely a students' book than Johannsen. It assumes very little preliminary knowledge, and it gets down to fundamentals with commendable practicality. Moreover, its outlook throughout is thoroughly modern and is indicative of that revolution which the commercial production of new organic solvents and plasticizers is rapidly bringing about in the field of microscopy. Old difficulties are vanishing as we begin to know how to build rationally on the empirical foundations laid by the pioneers. Not that we have got far, as yet, and one can foresee that future editions of this book will show many changes as new methods are developed.

One should note with satisfaction the passing away of the period of uncritical microtome worship and commend the sane advice given on when not to microtome. Smear methods, whole-mount methods, maceration (too long neglected), the critical comparison of fixatives: all these are welcome features, even if they are not exactly innovations. The emphasis and the clear illustration given to them in a book for students are certainly novel.

It is refreshing also to see not infrequent comments on expense in an American publication. Is this indicative of another break with tradition?

R. C. McL.

Dietetics Simplified: the Use of Foods in Health and Disease

By Prof. L. Jean Bogert. With Laboratory section by Mame T. Porter. Second edition. Pp. xi+742. (New York: The Macmillan Company, 1940.) 12*s*. 6*d*. net.

DIETETICS as a subject is peculiar in that its exact study requires elaborate detail and specialized knowledge whereas in practical application no such desiderata are necessary. This at once explains the difficulty of writing a book which should be of service to those who do not need over-much technical knowledge yet are at the same time expected to understand the principles and their employment in everyday life. Students of medicine and domestic science, hospital dietitians, nurses, etc., all need education and help.

Prof. Bogert has tried to plan "Dietetics Simplified" to meet this requirement. That she achieves her aim is shown by the appearance of a second edition three years after the first. She has not, however, felt called on to make extensive alterations but only to bring the data on special points, such as vitamins and food values, up to date.

The scope of the book is planned on generous lines. Elementary nutrition, diet in normal conditions, diet therapy and diet in disease states are supplemented by a series of chapters on cookery of every kind and by careful tables on nutrition figures. The sections on infant feeding and food for the elderly may be remarked on as illustrative of the standard set and attained.

The book is written in an easy attractive style, free from undue technicalities and well illustrated. It can certainly be commended.

MILK PRODUCTION IN WAR-TIME

By Prof. H. D. Kay, O.B.E.
National Institute for Research in Dairying

IF from the point of view of human nutrition in war-time the gravest problem is that of providing sufficient calories, the next in importance is undoubtedly that of maintaining at the highest possible level the daily inflow into the national larder of milk—with its unquestioned value in balancing and reinforcing, either for the young or the adult, a diet which may be short of calcium, vitamin A, riboflavin, animal protein, and fat. The adequate solution of the milk problem is dependent on many factors, agricultural, economic, administrative, etc. It is proposed to discuss a few of those in the first of these categories, mainly concerned with feeding and management of the dairy cow in war-time.

It is believed that of all farm animals, the modern dairy cow is the most efficient converter of farm feeding stuffs into human food. This, however, is true only for the animal of medium or higher yield, say, for present purposes, for the animal yielding not less than 500–600 gallons per lactation. It is again fortunate that, as a ruminant and by preference almost entirely a herbivore, the cow, unlike the pig and the hen, does not seriously compete directly with man for the kind of foodstuff he requires for his own diet. In the third place it is fortunate also that as a result of past research, a great deal is now known about the detailed nutritional needs of this highly specialized animal for efficient lactation, though this knowledge, particularly valuable in war-time, is effectively applied on far too small a proportion of our dairy farms.

Quantitatively, the dimensions of the problem of feeding the cow are greater in this than in the War of 1914–18. The dairy cow population at the outbreak of the present War was more than 20 per cent above that of 1914, and there has, if anything, been an upward trend in the last two years. In tonnage, the amount of food required for the dairy herd is not far short of that needed for the entire human population. The average dairy cow weighs about half a ton, and although she will provide each year say 500–600 gallons of milk, containing a dry weight of some 6 cwt. (that is, nearly twice her own dry weight) of first-class human food, she must have, if she is to remain a productive unit, not far short of four tons a year of foodstuff, estimated as dry matter. When this requirement is multiplied by well over three million (the exact number of 'dairy' cows depends on a rather arbitrary definition as between a 'dairy' cow and a 'beef' cow), the huge size of the problem—that of providing some twelve million tons (dry weight) of feeding stuff per annum to secure adequate milk production—is apparent.

It is not generally realized that as much as 80–85 per cent of the total food consumed by the dairy cow (estimated, of course, on a dry-matter basis) is, in peace-time, produced at home, from grazing and from other farm-produced foodstuffs such as hay, straw, roots, kale, silage, etc., these latter for the most part bulky foods with a relatively low energy and protein content and containing a large proportion of indigestible fibre.

For present purposes we may regard the essential food requirements for efficient lactation in the dairy cow as being a sufficiency of digestible nutrients in a bulk which does not exceed the assimilatory capacity of the animal. These nutrients have to provide (*a*) the animal's basal metabolic needs for energy, (*b*) her energy requirements for purposes of muscular movement, digestion and glandular activity, including the activity of the mammary gland and the relatively small amount of material necessary for the day-to-day repair of these tissues, and (*c*) the materials needed for the synthesis of the very considerable quantities of lactose, casein and lactalbumin, and fat secreted by the udder*. The war-time significance of this statement is that the food materials required for (*c*) are rather different in composition than those needed for (*a*) and (*b*). They are richer in protein, and belong mainly to the type of concentrates that was extensively imported from abroad in peace-time.

To obtain the necessary nutrients under (*a*), (*b*) and (*c*) from the ordinary, bulky farm foods is only possible if the yield of milk is small, say ½–1 gallon a day. The capacity and appetite of a high-yielding dairy cow do not allow her to eat sufficient of such bulky foods to maintain her milk yield for very long. She is, like nearly all modern farm animals, in a state of unstable biological equilibrium. Without adequate feeding of concentrated foods she may for a short time continue to secrete large amounts of milk at the expense of her own tissues, but this process will not continue and she will eventually rapidly fall off in yield.

The main problem of feeding for milk production

* The nutrients have also to provide, in most cases, for the growth of the fœtal calf. The main demand here, however, is late in lactation when the milk yield is falling off.

in war-time is to provide the type of concentrated protein-rich nutrients required for purpose (*c*), and that despite the facts that importation of concentrates from abroad is severely cut down, that the by-products of flour milling will soon be both less in quantity and in nutritive value since 85 per cent instead of 73 per cent of the wheat grain will go into flour for human consumption, that there is a shortage of skilled labour on the farm, and that a larger area of farm land is now being used for the production of human foodstuffs such as wheat and potatoes, the by-products of which are not very useful for purpose (*c*).

Without concentrated feeding stuffs, especially in winter, and adequate husbandry the dairy cow would fairly soon revert to a low-yielding animal producing most of her small output of milk from grass in the spring and summer months, and drying off completely in the winter. But alike with the good and the poor cow, feeding presents no problem at all if grass, which if of good quality will contain all the protein needed for purpose (*c*), is abundant. Up to four or even five gallons of milk a day can be produced without difficulty or damage to the cow, and without any supplementary feeding of concentrates, if such grass is available, and fields are grazed in rotation under reasonably efficient conditions of grassland management. In most parts of Great Britain, however, an abundant supply of grass rarely persists for more than three or four or possibly five months of the twelve. For the remaining months both bulky farm foods and concentrates containing sufficient protein are essential, in addition to what the cow can pick up from the pastures, if an average, or better than average, yield of milk is to be maintained. It is particularly in December, January and February, when natural environmental and war-time nutritional conditions both for the dairy cow and for man are at their worst, that human needs for a protective food like milk are at their greatest.

It has been suggested that the nationally most satisfactory war-time plan is for the dairy farmer to go in for summer milk production from grass, and winter his cows in a practically non-lactating condition. The large excess of milk not required for human nutrition during the summer months would then, it is suggested, be dried or "evaporated" and stored, for distribution during the winter season instead of liquid milk.

Even if the requirements of only three winter months were to be met, this scheme would entail treatment of some 240 million gallons of milk, that is, a large increase in our existing milk-drying and evaporating capacity (with plants very busy during the summer and idle during the winter), a very large supply of tin plate or other material suitable for making containers to store the 130,000 tons or more of processed milk, probably an organization to reconstitute the milk in numerous depots, and certainly a formidable change in food habits. Though milk dried or "evaporated" by modern methods and properly packed for storage loses very little of its nutritive value, it is very doubtful indeed whether any extensive change over to summer milk production is either feasible in war-time or advisable at any time.

In present circumstances, the only means by which milk yield may be maintained in winter are: (1) the switching over to the dairy cow of sufficient concentrated feeding stuffs, both those produced at home and those that continue to be imported, from less essential stock such as pigs and poultry, or (2) an increase in quantity and quality of the feeding stuffs grown on dairy farms at home, so that they not only provide all the maintenance rations needed for purposes (*a*) and (*b*) mentioned above, but also meet the higher protein requirements for purpose (*c*).

Alternative (1) is the foundation of the rationing system that was introduced half-way through the winter of 1940–41. By this system the greater proportion of the available concentrates were allocated to dairy cows: farm horses and one or two other categories of essential animals received a sufficient ration, beef cattle were reduced to about 50 per cent of their pre-war requirements, and the small amount left was allocated to pigs and poultry. Alternative (2) is clearly one which needs time to achieve. It means in the first place the improvement in quantity and quality of the grass produced on the farm, an improvement which had in fact begun, if only in a small way, before the War. This entails the ploughing up, appropriate artificial manuring, and re-seeding of worn-out or indifferent pasture, the general improvement of grassland by adequate dressings of lime and phosphates, the use of suitable seed mixtures and nitrogenous fertilizers on selected fields to produce grass one or two weeks earlier in the season and possibly to induce grass to linger for about the same length of time in the late autumn, with a corresponding economy in concentrates. It also means the making of silage in the spring from young grass (the younger the grass the higher the protein content) and particularly in the autumn from aftermath, or from special mixtures of cereals and pulses which have a high protein content, improvement in methods of haymaking, to ensure that losses of feeding value are minimal, the use of green 'soiling crops' such as mixtures of pulses and cereals, or, in warm districts, maize, to supplement the grass supply during the summer and early autumn, the growing of more cabbage and kale to provide green fodder during the winter months, an additional acreage of peas and beans to provide protein-rich fodder, an increased production of root crops such as swedes and mangolds for winter and early spring feeding, the production of a valuable food, of approximately the same energy value for the ruminant as good hay, from wheat straw (a material not normally used for feeding dairy stock, but which is increased in amount over pre-war quantities) by soaking it with dilute caustic soda solution, the intelligent use both of farmyard and artificial manures. These are all aspects of good dairy farming by which dependence on purchased feeding stuffs will be steadily lessened during the present year and in the future. Many dairy farmers, after the 1941 harvest, will already have achieved this objective of self-support, and the rationing scheme for dairy cows for this winter will undoubtedly be largely based on this fact.

Little has been said about the effect of war-time conditions on milk quality. In general, quality is rather more stable to environmental changes than is yield. If yield falls, then there is normally a small increase in milk fat percentage, as was in fact observed last winter. Insufficient feeding of concentrates, in addition to its depressing effect on yield, is sometimes associated with a diminution in the percentage, of solids other than fat in the milk. On the whole, however, it may be said that the war-time diet of the milking cow will only have quite small effects on the composition of her milk.

Second only in its effects on milk yield to a shortage of feeding stuffs, and much more drastic in its effects in reducing the nutritional quality of milk than any other factor, is udder disease. Even in the sub-clinical stages mastitis produces a marked fall in the compositional quality, and therefore in the nutritional value of milk, together with an appreciable drop in total quantity secreted, and the changes become more serious as the disease progresses.

In peace or in war, until this disease—or group of diseases—is taken in hand on the national scale, these largely avoidable losses will continue to be suffered. Some authorities are of opinion that there has been an increase in udder disease during the last two or three years. This may well be, as with the unskilled labour that has on many farms replaced the pre-war skilled cowman—a process which began before the outbreak of war—early symptoms of the disease are easily overlooked and veterinary treatment delayed until irreparable damage has been done to the udder tissues. An animal even at this stage may continue to secrete a little poor quality milk without requiring supplementary concentrates in her diet, but since the food required for maintenance of a poor or indifferent animal is little if any less than that required for maintenance of a high-yielding cow, the former animal is wasting food if the criterion of milk yield divided by total food consumption is applied. At the other extreme, the very high yielder in war-time is difficult to handle successfully, as she requires highly skilled management and in some cases special foodstuffs, neither of which may be available. The desirable dairy cow in war-time is an animal giving a good, but not an immense yield.

In war-time as in peace-time, culling of the inferior yielder pays. It is possible to cull without losing milk at all if the foodstuff virtually wasted on the poor yielder is distributed among the better yielders, and—an important proviso in war-time—if rations of concentrates are provided on a basis of milk produced and not on a basis of numbers of cows. Even in war-time, a scheme for the control and treatment of mastitis, associated with a culling policy for getting rid of incurable chronic cases, would be greatly beneficial to the national milk supply.

The fall in milk-yield that was evident in the winter of 1940–41 was probably as much the result of climatic conditions highly adverse to milk production as to local shortages of feeding stuffs. The uncertain climatic factor renders any prediction as to the probable total milk yield during the mid-winter months of 1941–42 very hazardous. The yield in the winter of 1940–41 was some 7 per cent below that of 1939–40, which was itself only about 2 per cent below that of the winter of 1938–39, a winter of record output. Will this fall become greater in the most critical months of 1941–42 ? There are good reasons for hoping that it may not. Under next winter's rationing scheme, with absolute priority for the dairy cow in supplies of concentrates, and with the strenuous efforts that many dairy farmers have been making during the past twelve months to make their farms more nearly self-supporting as regards feeding stuffs for milk production and not merely for maintenance, the dairy cow should be adequately, though not generously, provided for during the forthcoming winter. Though culling of poor yielders is being officially encouraged, the national herd has not diminished. The hay crop, on which much depends, has been on the whole a fair one, with hay of good quality. Grass has been plentiful in most parts of the country, which means that the reserves of feeding stuffs for summer use have not as yet been consumed. The loss of milling by-products resulting from the increased rate of extraction of flour from wheat should be more than offset by the increased production of oats and mixed corn during the present harvest.

The labour situation is unlikely to become more serious, as experienced male agricultural workers are not being called up, and more Women's Land Army recruits are being trained for work on dairy farms. The present very high prices paid for dairy cows indicates that even if certain farmers are turning over from milk production to other less-exacting types of farming that appear to be giving, for the present at least, equally good returns, their dairy animals will not be lost from the national herd. What is less certain is whether the slight trend towards summer milk production shown during the past twelve months will be accentuated. If autumn calvings are markedly fewer in 1941 than in 1940, then there will be an increased shortage of liquid milk during the critical mid-winter months. If they are not, the winter milk yield of 1940–41 is very likely to be maintained during the forthcoming winter.

THE "HOROLOGIUM OSCILLATORIUM" OF CHRISTIAN HUYGENS

By A. E. Bell

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THREE great works laid the foundation of modern mechanics: Galilei's "Discourses on Two New Sciences" (1638), Huygens's "Horologium Oscillatorium" (1673), and Newton's "Philosophiæ Naturalis Principia Mathematica" (1687). Of these, the second is certainly the least well known, and least accessible to the English reader[1]. Yet it is more rigorous in the treatment of its subject-matter, more strictly mathematical in style than the others, and it certainly deserves more recognition than has ever been conceded to it. From Huygens's original intention to publish a work on the construction and scientific principles of his pendulum clock (employing a cycloidal pendulum), the work grew and grew over a period of about fifteen years, and finally issued forth in 1673 with much accumulated around its central theme. Unlike most of Huygens's other writings, the work is singularly free from all Cartesian influences. Huygens himself hoped that it would be in direct line with the great work of Galilei, and his hopes were not disappointed. Newton wrote to Oldenburg, the indefatigable secretary of the Royal Society, of his "great satisfaction" with the work, and said he found it "full of very subtile and usefull speculations very worthy of ye Author". Newton especially admired Huygens's mathematical style, and considered him "the most elegant writer of modern times".

Part 1 of the "Horologium Oscillatorium", "Containing a Description of the Clock", describes in detail how the various wheels and pinions of the mechanism are put together. The description is of great interest to the student of the history of clocks because in all except one particular Huygens's clock was based on the old balance clocks dating back to the thirteenth century. This particular was, of course, the pendulum, the adaptation of which (setting aside the slight claims of Galilei) was first successfully worked out in 1656; with small differences the pendulum was used in the same way in 1673, except that Huygens had in the interval discovered (1658–59) that the cycloid is the tautochrone and that consequently a cycloidal pendulum is isochronous for arcs of all magnitudes. To make the pendulum bob execute the correct curve the flexible part of the suspension hung between metal plates or 'cheeks', themselves later found to require the cycloidal form (see below). Huygens owed much indirectly to Pascal and Wren for his discovery of the tautochrone. "I am sure that geometers will value this refinement infinitely more than all the rest of my mechanical inventions", he wrote of the cycloidal pendulum. About the same time as he made this discovery, he started on theoretical researches which led to the first general solution of the problem of determining the centre of oscillation of a compound pendulum. In Part 1 the only reference to this, however, is a purely practical one: the clock could be adjusted to measure the mean solar day by moving a rider on the pendulum rod on either side of its middle position.

Huygens hoped much from the use of his pendulum clock, suitably suspended, to determine longitudes at sea. The matter is discussed optimistically in Part 1, but no dependable results were ever obtained with regularity on the various trials carried out during his lifetime. Bifilar pendulums and many others all proved unsuitable. Huygens invented a spiral spring regulator in 1665, and brought out a clock employing this ten years later. Clearly, it was only the lack of the necessary workmanship which stood between this principle and a successful chronometer. The spiral spring regulator does not enter the pages of the "Horologium", however, and this is accordingly a digression. Huygens, in fact, put his faith in the cycloidal pendulum clock equipped with a *remontoire* for greater exactness. Such clocks he considered were shown to be extremely accurate by his discovery that when two of them were in any sort of mechanical contact their pendulums (through a principle of resonance) beat perpetually together. The astronomers were impressed, and took up the clocks, but not the mariners. Hooke was a great opponent. "Sea-men knew their way already to any *Port* . . ." he naively remarked.

Part 2 of the "Horologium Oscillatorium" is entitled "On the Fall of Heavy Bodies and their Oscillation in a Cycloid". It begins with a résumé of the law of constant acceleration under gravity, and the treatment of forces as vector quantities. Among the well-known deductions obtained by Galilei and restated by Huygens, the latter gave the statement that the speed acquired during free fall from a given height will, under suitable conditions, enable a body to re-ascend to the same height (Prop. 4). Propositions dealing with descent over one or more inclined planes then follow. There is nothing here to add to Galilei's conclusions: the latter's work is merely systematized (Props. 5 to 9). In such an oscillation as that mentioned in Proposition 4, Huygens showed that the speed of a body is unique for any given height —a conclusion which in effect he traced to the change in potential energy (Prop. 10).

A good deal of arid geometry lies at this stage between the reader and the conclusion of the work. The extension of Galilei's work to cover descent over curves, combined with Cavalieri's method of exhaustions in the quadrature of these curves is of considerable historical interest, however. The work is too intricate to explain without a series of diagrams, but the principles may be indicated. Huygens first obtained limits to the length of a circular arc less than a semicircle in terms of tangential elements (Prop. 20). By reference to the generating circle this enabled him to evaluate the length of a cycloid arc in a similar manner, and to set limits to the time of descent over such an arc as compared with the time of descent over a tangent of equal vertical height and drawn to the highest point on the curve (Props. 23 and 24). By making use of the fact that a tangent to a cycloid is parallel to a corresponding chord on the generating circle (Prop. 15), Huygens was able to relate the time of descent over any cycloid arc to the lowest point with the time of descent over a chord of the circle (Prop. 25). Thus, his proof rested for its final step on Galilei's work.

Huygens did not include in the "Horologium" his proof that in a cycloidal pendulum the restoring force is proportional to the arc of displacement. This, however, was proved in 1673 or 1674, and it shows that Huygens was certainly the first to consider the theory of simple harmonic motion. The proof can in any event be obtained easily from his propositions, but it must be admitted that these are alien, in their original, severely geometrical, form, to the consideration of forces and physical conditions.

Part 3 of the "Horologium", "On the Evolution and Measurement of Curves", appears now scarcely appropriate in a physical treatise, since it deals exclusively with problems of pure mathematics. Huygens explained that he was so intrigued with the method of evolution of the cycloid that he could not resist the temptation to investigate the evolutes of other curves. As is well known, this work was completely original. Its somewhat unusual character may be traced to Huygens's habits of experiment: the idea of an evolute would occur to him when wrapping the thread along the cycloid 'cheeks' of his pendulum. Huygens showed that the evolute of a cycloid is another cycloid, and thus established a proof for the form of the metallic plates employed in the clock (Props. 5 and 6). In Proposition 7 he showed that the cycloid is four times the diameter of the generating circle.

Part 4 of the "Horologium" must be reckoned the most important, for this contained Huygens's treatment of the centre of oscillation of a compound pendulum—the first dynamical system ever studied. This problem was too complex for Galilei, and Descartes failed to do any more with "Mersenne's problem" than to give solutions for one or two special cases—and these were erroneous. Descartes imagined that the problem could be reduced intuitively to that of determining the centre of gravity of some related solid or plane. Not surprisingly, he did not give proofs for his 'solutions'.

Huygens's work, as published, gives few clues to the order of his discoveries. By 1664, however, it is clear that he knew the general formula for the length of the equivalent simple pendulum $x = \frac{I}{M\,b}$ where I is the rotational moment of inertia, M the mass, and b the distance of the centre of gravity from the axis of oscillation. Huygens began with a problem bequeathed by Galilei: to find the period of a pendulum consisting of two weights at different positions along the same thread. Huygens solved this by applying the results of his study of impact and assuming that the centre of percussion is identical with the centre of oscillation. In the course of this preliminary essay he made important use of the conception of work done or of potential energy. In the "Horologium Oscillatorium", this treatment of the linear compound pendulum is simplified by supposing the separate weights of the linear pendulum to be freed at some point in the swing; the heights to which the weights could then ascend are calculated from their speeds. Huygens's argument then is that the work done in raising each of the weights through its own height is, in the sum, equal to the work done if the sum of the weights is raised through the distance of elevation of the centre of gravity. The fundamental principle that the centre of gravity of a number of masses cannot ascend of itself through any motion of the masses under gravity was used extensively by Huygens. It followed from this that the separate masses might have their centres of gravity brought to the height of the common centre of gravity "without the expenditure of any other force besides that which resides in the system".

This direct method of attacking the problem of the centre of oscillation was not suited to the study of plane and solid figures in general, however. Huygens's account of this part of his work is very involved, and the simplest statement that can be made about it is that he was in effect applying the general formula quoted above without having a general method of computing moments of inertia. In dealing with plane figures oscillating in a plane perpendicular to their own, he adopted a geometrical "method of the wedge" to evaluate $\int v.da$ where v is the velocity of any element δa as it passes through the mid-point of its oscillation. If one imagines perpendicular ordinates erected on every element of area, each ordinate representing v for that element, a solid figure, wedge-shaped and tapering to the axis, is constructed on the plane figure as base. The treatment of the problem rested on the identity of the centres of percussion and oscillation mentioned above. Huygens's plane figures were all symmetrical about a plane perpendicular to the axis, and containing the centre of gravity. In the course of his work Huygens made use of the equation on moments of inertia :

$$I_z = I_x + I_y ;$$

and he was one of the first to do so. Proposition 12 demonstrates that the moment of inertia, I, is given by Σmr^2 and that this is constant for a given axis of rotation.

The culminating point of the "Horologium" is the determination of the centre of oscillation of a suspended sphere. Combining this with the result for a uniform rod, Huygens obtained the approximate radius of gyration for a clock pendulum, and worked out the equation for the effect of placing a small mass on the rod in the manner of a rider. The clock pendulum was in practice a compromise. A flexible ribbon at the top of the rod enabled the pendulum to follow a cycloidal curve for a small arc. It was assumed that the centre of oscillation travelled in this curve.

Scarcely remembered nowadays is Huygens's proposal (Prop. 25) to base a universal measure of length on the pendulum. The *pes horarium* was to be a third part of the distance from the axis to the centre of oscillation of the bob of a simple pendulum beating seconds. The size of the bob would, of course, be immaterial provided that the centre of oscillation was known. There is, however, in the "Horologium Oscillatorium" no indication that Huygens reckoned with the variation of the length of the seconds pendulum with latitude. At the date of publication Huygens was presumably uncertain about the conclusion to be drawn from the observations of Picard at Cayenne (1671–72). This expedition first brought back evidence on the shape of the earth. "The thing would certainly be very important and constitute a remarkable property of our pendulums . . ." wrote Huygens[2]. Hooke was quicker in perceiving the bearing of the observations on Huygens's proposals : the variation of the earth's gravitational field with latitude quite nullified the idea he emphatically stated.

This part of the "Horologium Oscillatorium" curiously enough, ended with an account of a method for determining g—a method which is greatly inferior to the use of a pendulum. In this a pendulum of known period is released simultaneously with a falling weight attached to a long strip of paper. The pendulum bob, blackened with soot, makes a mark on the paper strip after swinging through one half of its arc. This gives the distance fallen and the time interval taken. Huygens's result came out at $g = 30$ ft. 2 in. per sec. per sec. where 1 ft. = 1 *pes horarium*.

The fifth and last part of the "Horologium" is famous for the statement of thirteen theorems on centrifugal force. These, as is well known, influenced Newton, who, rather disappointed that he had not pursued his own work to the same conclusion, remarked : "What Mr. Huygens has published since about centrifugal force I suppose he had before me." The first five theorems in effect state the equation $F = \frac{mv^2}{r}$, and the last eight deal with the conical pendulum. A form of this pendulum is described in Part 5.

Huygens constructed clocks employing conical pendulums in 1659 and 1667, the latter when he had more fully investigated the laws of motion involved. Controverting Hooke's claims to the invention, he pointed out, what Hooke certainly did not know, that the conical pendulum should be so designed that all revolutions of the bob describe horizontal circles in the surface of a parabolic conoid with the axis vertical. Only then would all revolutions be isochronous.

The great contributions of the "Horologium Oscillatorium" may be summarized as the introduction of work and energy considerations in the solution of the problem of the centre of oscillation, the proof that the cycloid is the tautochrone, the study of evolutes and the theorems on centrifugal force. One might go so far as to say that Huygens recognized implicitly all the laws which Newton made explicit in dynamics : the work on centrifugal force required a grasp of the second law, the compound pendulum illustrated the third law applied in a difficult example. Not until the time of D'Alembert, remarked Whewell[3], was the representation of the laws of motion in their most general form fully achieved. Huygens, Mariotte, the brothers Bernoulli, de l'Hôpital and Brook Taylor all took a part in the history of this advance, but of them all Huygens made the greatest inductive contribution.

[1] There is a German translation : "Ostwald's Klassiker der Exakten Wissenschaften", No. 192, and one in French : "Œuvres Complètes de Christiaan Huygens", 18, published by the Société Hollandaise des Sciences (1934).

[2] "Œuvres Complètes", 18, 635.

[3] "History of the Inductive Sciences", 2, 59 and Chap. v.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By Dr. F. R. Moulton, Permanent Secretary

Durham (New Hampshire) Meeting

SINCE 1931 the American Association for the Advancement of Science has held two meetings each year, the annual meeting during the Christmas holiday week and a summer meeting, usually in June. The large annual meetings are held in cities able to provide accommodation for several thousand men of science and about sixty rooms for holding scientific sessions. The summer meetings are usually held in smaller cities offering exceptional attractions. In June 1938, the Association met in Ottawa, Canada. This year it held its meeting in Durham, New Hampshire, during June 23–27, in connexion with the celebration of the seventy-fifth anniversary of the founding of the University of New Hampshire. It will strike British readers as curious that the seventy-fifth anniversary of the founding of a university should be the occasion for a celebration. However, in September the Association will participate in the symposia organized by the University of Chicago in celebration of its fiftieth anniversary.

In certain respects the Durham meeting resembled some of the meetings of the British Association. It was held at a university in a small town surrounded by a delightful countryside. The sea was near by in one direction, and lakes and mountains in the other. Summer was at its loveliest and the vacation period was at hand. There was an air of leisureliness that is unusual in American meetings. There was music, and there were social functions and many tours and excursions.

Stated statistically, about a thousand persons attended the meeting and fifty-one sessions were held at which two addresses were delivered and two hundred and ten papers were presented. In addition, there were several round-table discussions, eleven special luncheons and dinners at most of which addresses were delivered, five demonstrations and exhibits, and thirty-four tours and excursions for scientific purposes. Several of these excursions were continued well beyond the period of the meeting. In fact, the botanists continued their excursion through the State of Maine for a week after the meeting closed.

For several years the section on social and economic sciences has taken for the general theme of its programmes for the summer meetings the racial origins and social and economic patterns of the various peoples of the regions in which the meetings are held. Since New Hampshire is one of the New England States, the present inhabitants of New England were the subject of the programme of the section. The Pilgrims landed at Plymouth Rock in 1620 and for nearly two hundred years most of the immigrants to this region came from England. During this interval an orderly, cultured and somewhat aristocratic society developed. Then, with the rapid development of manufacturing and because of difficult conditions in Europe, wave after wave of new immigrants poured into New England—the Irish, the Italians, the French-Canadians and smaller percentages from every country from the Atlantic Ocean to the Ural Mountains. Twenty-seven papers were devoted to discussions of the human, religious, political, social and economic problems that were raised by these mass transfers of populations, and by the sudden and complete change in their occupations and living conditions.

Perhaps the most thoroughly organized and completely carried out programme was the symposium by the entomological societies on "Laboratory Procedures in Studies of the Chemical Control of Insects". The programme, which was presented at four sessions extending through two days, consisted of eleven principal topics which were formally discussed by invited leaders and informally discussed by other experts in the respective fields. It is expected that the Association will publish this symposium in the near future.

It would be erroneous and futile to pretend that the men of science who were gathered at Durham thought only of the niceties of mathematical theories, of the meteorology of New England, of the complex origin and formation of its mountains, of its fauna and flora, of the qualities and functioning of the human mind, of the complexities of society, of the progress in the medical sciences, and in agriculture and forestry. All these were considered, and although they were considered seriously they only caught the conscious attention and held it temporarily. Deep reverberations of a new *Blitzkrieg* were coming out of Russia, "nearer, clearer, deadlier than before!" Civilization was, and is, making history around a sharp curve, and freedom was, and is, being defended principally by the gallant people of one small island. In the presence of such a tide in the affairs of men the attention could not long be held fixed exclusively by the wavelets of small additions to scientific knowledge.

Yet science gives a perspective that is unique. It deals with great distances, long periods of time, tremendous forces. It sees in outline the evolution of life from amœba to man. Against the background of the struggle of all life for existence it looks on the tragic vicissitudes of human history. It finds in the lower animals the elementary characters that in more complex combinations determine the nature of man. It gathers wisdom from all the history of the world instead of from only its last illegible page. It has no early millennium to offer, but it can point out certain pathways that should be avoided and others that are promising. And this men of science of the American Association, as well as those of the British Association, regard as one of their responsibilities to society.

OBITUARIES

Prof. J. C. Philip, O.B.E., F.R.S.

JAMES CHARLES PHILIP, born at Fordoun, Kincardineshire, on February 12, 1873, was both a son and nephew of the manse. He went to Aberdeen Grammar School and afterwards to the University, where in 1895 he was Murray scholar. He was a pupil of Japp and probably went to Göttingen on the latter's suggestion to become acquainted with the new science of physical chemistry as taught by Nernst.

In 1897 he came to work under H. E. Armstrong at the Central Technical College in South Kensington. Armstrong, though very critical of the doctrines of Ostwald and Nernst, was anxious to know of them at first hand. Less than a year later he was able to place Philip at Cambridge with Heycock and Neville, then engaged on their classic work on the constitution of binary alloys, in the interpretation of which the phase rule was to prove so helpful.

Philip stayed at Cambridge for a while but seized the first opportunity to return to London to the Royal College of Science as demonstrator and lecturer in January 1900. Here he remained all his life, becoming assistant professor in 1909 and first professor of physical chemistry in 1913. This was one of the earliest chairs in this subject in Great Britain. When Prof. H. B. Baker retired in 1932 he was made director of the Laboratories of Inorganic and Physical Chemistry. He took part in the design of the new laboratories in Imperial Institute Road begun in 1906 and busied himself more and more in every form of college activity—both official and social. He served for six years, 1932–38, on the Senate of the University, and was dean of the Faculty of Science in 1934 and deputy vice-chancellor during 1937–38.

Besides his teaching, Philip was actively engaged in research largely in collaboration with a continuous succession of students. His investigations ranged over a wide field: the properties of non-aqueous solutions (especially of electrolytes in organic solvents); adsorption of dissolved substances and vapours on charcoal; determination of the dielectric constant of liquids; molecular refraction; freezing-point diagrams of binary systems; chemical fogs.

It is particularly to his credit that he left behind him a strong school of younger men who to-day make the Imperial College a prominent centre of physical chemical training and research. It was characteristic of him to encourage his younger men to follow their own varied bents, and he shared his research students among them.

He became a fellow of the Royal Society in 1921. An honour which pleased him greatly was the honorary degree of LL.D. from his old University, Aberdeen, conferred on him in July of this year.

During the War of 1914–18 he was secretary of the Royal Society War Committee and largely concerned with organizing the preparation of local anæsthetics in university laboratories. In recognition of this work he was awarded the O.B.E.

Philip threw himself wholeheartedly into the activities and organization of his profession. He was secretary of the Chemical Society during 1913–24, and held the very onerous position of chairman of the Bureau of Chemical Abstracts during 1923–32, in the formation of which he took a leading part. From 1939 until 1941 he was president of the Society of Chemical Industry, having been persuaded to occupy the office for a second year. He had taken office as president of the Chemical Society only a few months before his death. He added to his labours in 1938 by consenting to prepare a history of the Chemical Society appropriate to the celebration of its centenary. Both the Science Masters' Association (1929) and Section B of the British Association (1936) had claimed him as president.

Philip's record is one of unselfish and continuous work for others, for those causes which he judged worthy. He was a devoted and active Presbyterian and gave much time to the duties of his church. He taught and carried out researches and organized with all his ability and was happy in all he did. Of such a man Meredith says :

"You of any well that springs
May unfold the heaven of things,
Have it homely and within
And thereof its likeness win."

Perhaps Philip's greatest memorial is in the memory and affection of the students of South Kensington. He sought to know every student individually, played tennis with them, sang songs at their concerts and entertained them at his house while he inducted them into the tradition of the Imperial College. At one time or another he took an active part in the management of practically all the student activities. One could never say of him, in Milton's words :

"Above the rest
in shape and gesture, proudly eminent."

This devotion to the duty which lay at hand, coupled in earlier days with a reticence of manner, made it seem as if he matured late in life—the Philip of the last decade, secure in the highest positions of his profession, was found to have a charm and a sincerity and to possess powers of leadership which we all valued. He was never forceful or aggressive; such traits were alien to his character.

The story of what he did for the College is too long to relate here in detail—rather would we express it as in "Pilgrim's Progress" :

"This place has been our second stage :
Here we have heard and seen
Those good things that, from age to age,
To others hid have been."

Philip retired from his professorship under the age limit rule in 1938. He was given many tangible expressions of loyalty and admiration, not least by the many old students whose careers he followed and who looked to him as a friend. The recall to duty followed almost immediately : he was summoned to act as deputy rector while Sir Henry Tizard was engaged on other work. When war came this position was both arduous and exacting, the more so as the College decided to remain in London and carry on its work. Philip slept there most nights and was always to be found at his post.

His devotion to duty made him take on other, equally strenuous duties at this stage, in connexion with the allocation of scientific and technical personnel to posts in the Services and in war industries.

He became chairman of Committees of the Royal Society and of the Ministry of Labour and National Service concerned with the institution and operation of the Central Register ; he also accepted the chairmanship of the University of London Joint Recruiting Board. It is said that this last position involved his interviewing about six thousand young men for an average of fifteen minutes each during the last two years. To all these offices he brought soundness of judgment, endless patience and a firm determination that everyone should have a fair deal.

Too many tasks were piled on his broad and willing shoulders, and there is little wonder that his strength eventually failed. He was taken in the very height of his achievement, rich in all the honours of his profession, richer in the love of his friends. Perhaps it is better so, than to live on the "other side of the hill" as Walter Scott called it and see one's powers, physical and mental, growing less.

Philip's teaching and the example of his personal life was to emphasize the significance of those non-material values commonly termed moral and spiritual. As he said, "surely the finest things in human life are the most difficult to express or define".

Philip married Jane Henderson of Aberdeen and had a son and a daughter : such is the bald statement, but it conceals a bountiful married life ; he would have achieved far less without the constant help and support of Mrs. Philip. And their philosophy :

"I am content with what I have
Little be it, or much."

E. F. ARMSTRONG.

We regret to announce the following deaths :

Prof. Victor Jellos, formerly of the Kaiser Wilhelm Institut für Biologie, Berlin–Dahlem, known for his work on heredity and genetics, on July 5, aged fifty-three years.

Prof. E. Kremers, emeritus professor of pharmaceutical chemistry in the school of Pharmacy, University of Wisconsin, on July 9, aged seventy-six.

Prof. E. E. Maar, professor of the history of medicine in the University of Copenhagen, aged sixty-eight.

Prof. Paul Sabatier, For. Mem. R.S., professor of chemistry in the University of Toulouse, who was awarded the Nobel Prize for Chemistry in 1912, aged eighty-six.

Eng.-Capt. J. Fraser Shaw, chief engineer of the Fuel Research Station, Department of Scientific and Industrial Research.

Mr. W. A. Taylor, O.B.E., formerly a superintending examiner at the Patent Office, on August 18.

NEWS AND VIEWS

The British Association

A MEETING of the Division for the Social and International Relations of Science of the British Association will be held, circumstances permitting, during September 26–28, beginning on Friday morning, September 26, at the Royal Institution, Albemarle Street, London, W.1. The general subject of discussion will be "Science and World Order". At successive sessions, speakers representing science in Britain, the Empire and other countries will deal with the following topics (The international aspects will be stressed throughout): September 26, "Science in Government" (morning), "Science and Human Needs" (afternoon); September 27, "Science and World Planning" (morning), "Science and Technological Advance" (afternoon); September 28, "Science and Post-War Relief" (morning), "Science and the World Mind" (afternoon).

At the conclusion of the meeting, the President, Sir Richard Gregory, will announce a charter of scientific fellowship, which has been drawn up by a Committee of the Division and adopted by the Council of the Association. Tickets of admission (without charge), accompanied by full particulars, will be forwarded up to the limit of accommodation available, to those who intimate their wish to attend, to the Secretary, British Association, Burlington House, London, W.1. Intimation should not be given by telephone. Applicants should state whether tickets are desired for all three days, or for any particular day or days. Applications should be made as early as possible, and in no event later than September 22.

German Crimes at Lwow

NEWS has just been received in London of the death, in deplorable circumstances, of Prof. Casimir Bartel, formerly rector and professor of geometry in Lwow Technical College and prime minister of Poland in 1926, 1929 and 1930. He was fifty-nine years of age. According to *The Times* of August 27, Prof. Bartel was shot by the Germans for conspiring with the Soviet authorities during the Russian occupation of Lwow. It is, however, known that Prof. Bartel refused to collaborate politically with the Russians, but did agree to co-operate solely in scientific and humanitarian matters. It was hoped that Prof. Bartel would leave Lwow after the outbreak of war between Russia and Germany, and become chairman of a committee in Russia to deal with Polish welfare problems, but he wished to remain at his college, where he was arrested a month ago. About sixty professors of the University and the Technical College at Lwow were arrested. They included Prof. S. Pilat, professor of petroleum technology, Prof. R. Rencki, professor of internal diseases, Prof. W. Sieradzki, professor of forensic medicine, and Prof. T. Ostrowski, professor of surgery. Their fate is unknown. Thus have the Germans repeated the same persecution of men of science and learning at Lwow which they carried out at Cracow, when a hundred and fifty university professors were sent to the concentration camp at Oranienberg.

State Bursaries in Science

IN order to meet the demands of the Services and of industry for technical officers, the Board of Education has established a scheme of State bursaries tenable at universities and at certain technical colleges. The demand is particularly pressing for men and women for radio work for which physics is essential; others will be required for posts needing qualifications in engineering and in chemistry. The bursaries will cover fees and maintenance allowances to meet the full cost of residence at the university or college at which the awards are held. The qualifying standard will be a pass in physics, chemistry, or mathematics in certain combinations in the higher certificate examinations. Applications are being accepted also from boys and girls who have passed the London Intermediate Science examination in the appropriate subjects.

Applications cannot as a rule be entertained from pupils who left school before the end of last term and are now in employment, nor will students at present attending universities and university colleges be considered eligible. The minimum age is eighteen years, unless the applicant possesses exceptional qualifications. It is expected that some of the holders of State bursaries may be able to qualify for a university degree before they are required for national service; others will have to relinquish their university course at the end of a year's training. The Board has promised that in suitable cases these will be considered after the War for such assistance as may be necessary to enable them to complete a degree course. Further information can be obtained from the Board of Education, Branksome Dene Hotel, Bournemouth.

University of London

On August 25 the headquarters of the University of London administrative staff will remove from Royal Holloway College, Englefield Green, Surrey, to Richmond College, Richmond, Surrey (telephone, Richmond 2301). The Matriculation and School Examinations Department of the University will remain at Highfield, Englefield Green, until the middle of September, when it also will remove to Richmond College.

The title of professor emeritus of physiology in the University has been conferred on Prof. Winifred C. Cullis on her retirement from the Sophia Jex-Blake chair of physiology at the London (R.F.H.) School of Medicine for Women.

Miss Esther M. Killick has been appointed to succeed Prof. Cullis. She has been since 1939 lecturer in industrial physiology at the London School of Hygiene and Tropical Medicine.

University of Poznan

According to Science Service, the former Polish University of Poznan, which has now become the University of Posen, reopened this summer under German direction and for German students. The city of Poznan is in the western part of Poland, which has been set aside for permanent and total German occupation ; Posen is the German spelling of its name. Its university is one of the newest in Europe, having been founded in 1919. Before the outbreak of present hostilities, it had a student body of something more than five thousand.

A New British Scientific Journal

Imperial Chemical Industries propose to publish a new quarterly journal of science, and it is hoped that the first number will appear during the autumn of this year. The journal will be translated into at least three foreign languages and will circulate in all parts of the civilized world. Though published by Imperial Chemical Industries, it will in no sense be an advertising medium, but, by laying principal emphasis upon British contributions to science, will form part of the national war effort and as such has the approval of His Majesty's Government. Many distinguished men of science have already expressed their willingness to contribute to its pages, and the chief article of the inaugural number will be by the Astronomer Royal, Dr. H. Spencer Jones. Such a journal, especially in its translated forms, will undoubtedly contribute largely to the national war effort and we wish it every success.

First American High School of Science

The first "graduating exercises" of the New York High School of Science were held on June 26, with the commencement address delivered by Dr. Irving Langmuir. Diplomas were presented to the pioneer class of 130 boys. Every one of the graduates has signified his intention of pursuing further studies in science, leading to careers in research, engineering and medicine. The new high school was organized in 1938, with curriculum and faculty built around the idea of making science the central theme in education. Not only were science courses made the pivotal subject studied, but also such subjects as English, foreign languages, the social sciences, etc. were presented with primary reference to their relation to the natural sciences.

New York was combed for boys with special interest in, and aptitude for, science. Out of five thousand applicants, a student body of two thousand was selected. A rigorous entrance examination was held. The new school was opened in a building of the conventional school type, so that many changes had to be made, especially in the installation of additional laboratories, to adapt it to its new purpose. In addition, there is a visual instruction lecture room, a large library, an English workshop, a voice-recording studio, four mechanical drafting-rooms, a graphic arts shop, a music room, a gymnasium and a swimming-pool.

John Innes Horticultural Institution

The report of the Director of the John Innes Horticultural Institution for the year 1940 has just been issued. The War has affected all the departments, the reduction in personnel by war service and the replacement of research work by the growing of vegetables and drug crops and seed production have dislocated some of the activities. Nevertheless, the results obtained from experiments on incompatibility, parthenocarpy, production of polyploidy in plums, cherries and pears, heterosis, polygenetics and linkage, provide useful and important data. The cytological department has found that cold treatment, colchicine and starving the nucleus of nucleic acid are excellent methods for analysing the behaviour of chromosomes during division. The preparation of a list of chromosome numbers of more than a thousand tropical species will be of great value to future workers. The identification of several plant pigments has been made by the Biochemistry Department. It has been found that both the ivory and yellow forms of *Antirrhinum majus* contain apigenin, and that the yellow pigment probably is chalkone. The yellow pigment in *Papaver radicatum* is gossypetin.

A useful innovation is the publication of pamphlets —John Innes Leaflets—which explain in simple terms the lessons learnt from the experiments on composting, soil sterilization, incompatibility, sterility and time of flowering in fruit trees. Already ten thousand of the leaflets have been sold. These pamphlets, together with more than fifty scientific papers published during 1940, indicate that very creditable work has been done under adverse conditions.

Malaria in India

In a paper in the July issue of the *Asiatic Review*, Sir Alfred Chatterton states that the organization employed at the present time in anti-malarial work in India, where many millions of cases occur every year, are the Malaria Institute of India, the Indian branch of the Ross Institute, the malarial sections maintained by some of the provincial health departments, the medical departments of certain railways and a few voluntary associations, such as the Assam Medical Research Society and the Central Co-operative Anti-Malarial Society of Bengal. The Malaria Institute of India is the main centre for research and for the training of medical officers from all parts of India in anti-malarial work. By offering advice to Provincial Governments it plays an important part in co-ordinating work throughout the country. The

Indian branch of the Ross Institute, started in 1930, is mainly concerned with the control of malaria in the tea and coffee estates, rubber plantations, mines, sugar factories, cotton and jute mills and other industries in various parts of India. The chief function of the Central Co-operative Society of Bengal is propaganda, in which it has been very successful as it has 2,362 rural societies under its control. These various organizations co-operate freely both in general conferences and in joint inquiries and investigations.

Empty Space

Dr. Robert G. Aitken brings together some interesting information on this topic in Leaflet No. 148 issued by the Astronomical Society of the Pacific. The diameter of the universe made accessible by the 100-inch telescope is about 600 million light-years, and the 200-inch telescope will double the diameter of this sphere. In this smaller sphere there are 100 million stellar systems with an average content of 10^{10} stars, the diameters of which average about twice that of our sun. The stars fill about 10^{-26} part of space and it is believed that the space between the separate stellar systems—extragalactic space—is absolutely empty. In interstellar space, however, in which the stars are distributed at average distances of five or six light-years, electrons, protons, atoms, gas molecules, minute dust particles and also larger pieces of matter, ranging up to the size of meteorites, are known to exist.

There is so much space that the mass of this interstellar matter may be two or three times the combined mass of all the stars, and, with the exception of the larger pieces of matter, the interstellar particles produce a number of problems for the astronomer because of their effect in absorbing and scattering light. The light from the more distant stars passes through space laden with gas molecules, and the intensity of the stellar lines will increase with increasing distance—a fact which has been utilized in recent times to estimate the distances of these stars. Previous conclusions regarding the distances of the fainter stars based on the inverse square relationship must now be modified, and these distances may not be so great as astronomers believed a few years ago. Another important point is the greater absorbing and scattering effect upon the shorter violet rays, and in consequence myriads of stars cannot be photographed by the use of ordinary photographic plates. Many thousands of stars, the existence of which had been previously unsuspected, have recently been photographed with new red-sensitive plates—convincing evidence of the presence of interstellar matter. An enormous field for research in this direction lies before the astronomer.

Two Notable French Men of Science

On August 21 and 22 respectively occurred the centenary of the death of one distinguished Frenchman and the bicentenary of the birth of another. The first of these men is the eminent geologist and civil engineer Jean François d'Aubuisson de Voisins, who was born in the South of France on April 16, 1769, and died at the age of seventy-two on August 21, 1841. For four years D'Aubuisson was a student under Werner at the Mining School at Freiburg, and it was while in Germany that he studied the basalts of Saxony, an essay on which he published in Paris in 1803. This essay, in which the Wernerian doctrines were adopted, was reported on by Haüy and Ramond, who advised the author to inspect the basalts of Auvergne. This D'Aubuisson immediately did, with the result that in a paper "Sur les volcans et les basaltes de l'Auvergne", read to the French Institute in 1804, he abandoned many of the views he had hitherto held. "The facts which I saw", he wrote, "spoke too plainly to be mistaken; the truth revealed itself too clearly before my eyes, so that I must either have absolutely refused the testimony of my senses in not seeing the truth, or that of my conscience in not straightway making it known." D'Aubuisson's most important work was his "Traité de Géognosie", published in 1819, but he was also known for his investigation in hydraulics (1826–30) and his "Traité d'Hydraulique, à l'usage des Ingénieurs", an enlarged edition of which, published in 1840, was translated into English by Bennett and published at Boston, Massachusetts, in 1852.

The other Frenchman to whom we refer is the naval officer and navigator Jean-François Galaup de La Pérouse, who met a tragic fate following in the footsteps of Cook. La Pérouse was born at Albi, in the department of Tarn, August 22, 1741, and at an early age entered the French Navy. When serving in the *Formidable* under Conflans against Hawke, he was wounded and taken prisoner. During the peaceful years of 1764–78 he did all in his power to fit himself for his profession, and in the *Astrea* in 1782 showed much skill and resource in penetrating into the Hudson Bay and capturing several British posts. The reputation he gained led to his appointment to command the expedition comprising the ships *Boussole* and *Astrolabe*, which left Brest on August 1, 1785, to visit the Pacific. Crossing to South America, the ships rounded Cape Horn and from thence proceeded to California, China, the Philippines and Kamschatka. Sailing south again, La Pérouse reached Australia in the beginning of 1788 and from Botany Bay sent a letter to the French Minister of Marine giving particulars of the voyages he intended to make. From that time onwards for many years nothing was known of the fate of the ships. In 1791 Admiral d'Entrecasteaux in the *Research* and *Espérance* searched in vain for them, but some meagre information was secured by the ship *Hunter*, which, sailing from Bengal in 1813, visited Australasia. On board the *Hunter* was Peter Dillon (1785?–1847) who as captain of the *Saint Patrick* in 1826 discovered that the *Boussole* and *Astrolabe* had been wrecked off Vanikoro, north of the New Hebrides. Dillon made a second voyage in the *Research* and brought back to France many relics of the unfortunate expedition. For his services he was made a chevalier of the Legion of Honour. There is a bronze statue of La Pérouse at Albi, and his name has been given to the strait between Sakhalin and Yezo.

Edward Janeway (1841–1911)

DR. EDWARD GAMALIEL JANEWAY, a distinguished New York consulting physician, was born at New Brunswick, New Jersey, on August 31, 1841. He studied medicine at the College of Physicians and Surgeons, New York, and qualified in 1864. He spent some time after qualification at the Bellevue Hospital, New York, in the study of morbid anatomy, which formed an excellent foundation for his clinical work. In 1872 he was appointed professor of morbid anatomy and in 1881 of psychiatry and neurology at the Bellevue Hospital Medical College, where he succeeded Austin Flint in 1886 in the chair of internal medicine and held this post until 1892. From 1898, on union of the Bellevue Hospital Medical College with New York University, until 1907, he was clinical director of the amalgamated institution. In addition to general medicine he took a keen interest in public health, especially in the campaign against tuberculosis, and was for some time president of the National Association for the Study and Prevention of Tuberculosis. He died at Summit, New Jersey, on February 10, 1911. He made numerous contributions to periodical literature, but was not the author of any book. His son, Dr. Theodore Caldwell Janeway (1872–1917), professor of medicine at Johns Hopkins University, was the author of a book entitled "The Clinical Study of Blood-Pressure" (1914), which was a pioneer work on the subject.

The Night Sky in September

THE moon is full on September 15 and there will be a partial eclipse, invisible at Greenwich, the middle of the eclipse occurring at 17h. 47m. U.T. Venus is an evening star and is in conjunction with the moon on 24d. 00h. Mars is a morning star, crossing the meridian at 2h. 54m. and 0h. 46m. at the beginning and end of the month respectively, and is in conjunction with the moon on September 9d. 02h. Jupiter is a morning star and crosses the meridian at 6h. 32m. and 4h. 48m. on Sept. 1 and 30 ; the planet is in conjunction with the moon on Sept. 13d. 18h. and will be 5° N. of the moon. Saturn is a morning star and souths at 4h. 12m. in the middle of the month. On Sept. 11d. 22m. it is in conjunction with the moon and will be 3° N. of the moon. New moon occurs on Sept. 21 and there will be a total eclipse of the sun, invisible at Greenwich. The path of totality passes along the northern end of the Caspian Sea, Turkestan, Central China, and the western part of the Pacific. The longer evenings provide an opportunity for viewing the Milky Way, the great bifurcation occurring in Cygnus and extending along the galactic equator. The eastern portion can be seen running through Aquila, Scutum, Sagittarius and Scorpio, where the broken western stream partially unites with it. In the late evening the beautiful group of stars in the constellation of Taurus—the Pleiades—can be seen. Their rising with the sun is referred to by the Greek poet, Aratos, as the harbinger of summer, and their rising at night, that is, after sunset, indicated the coming of winter. The variable star, Algol, is well placed for observation throughout the whole night and its rapid fluctuations in magnitude are always a source of interest. The pride of the Constellation of Andromeda—the Great Nebula of Andromeda—is visible to the naked eye and can be easily recognized close to the star ν Andromedæ. It looks like a 'fleecy' star, but is spiral in structure and is a great universe like our galaxy, about 870,000 light-years away, containing hundreds of millions of stars. In the outer portions are many stars of the Cepheid variable type, so valuable for the determination of distances.

Announcements

A GERMAN scientific institute has recently been opened at Madrid.

THE Swiss Society for the Investigation of Nature will hold its 121st annual meeting at Basle during September 6–8.

DR. ANDREW F. SKINNER has been appointed successor of Prof. W. W. McClelland in the associated posts of Bell professor of education in the University of St. Andrews and director of studies at the St. Andrews and Dundee Training Centre.

THE Australian Government proposes to proceed immediately with the provision of four distilleries costing £1,250,000 for the production of power alcohol from wheat. The distilleries will be constructed in New South Wales, Victoria, Western Australia and South Australia. Each will have a capacity of three million gallons a year.

THE College of Physicians of Philadelphia have awarded the Alvarenga Prize to Dr. John J. Bittner, of the Roscoe B. Jackson Memorial Laboratory, for his studies on cancer.

THE Annual Congress of the Ophthalmological Society of the United Kingdom will be held in Cambridge on September 4 and 5, when Drs. O. M. Duthie and S. Zuckerman will open a discussion on ocular injuries resulting from the War. Further information can be obtained from Mr. Frank Law, 30, Devonshire Place, W.1.

THE Committee of Privy Council for the Organization and Development of Agricultural Research has appointed, to fill vacancies caused by normal retirement, Major James Keith, who is the chairman of directors of the North of Scotland Bank, and owner of extensive farming areas in Norfolk and Aberdeenshire, and, after consultation with the president of the Royal Society, Prof. F. T. Brooks, professor of botany in the University of Cambridge, and Prof. D. Keilin, Quick professor of biology in the University of Cambridge, as members of the Agricultural Research Council. The Council of Privy Council has also appointed, to fill two other vacancies, Prof. J. A. Scott Watson, Sibthorpian professor of rural economy in the University of Oxford, and, after consultation with the president of the Royal Society, Prof. C. R. Harington, professor of biochemistry in the University of London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

"The Philosophy of Physical Science"

If I return to this question, it is because I am so deeply impressed by its importance[1]. If Sir Arthur Eddington's theory is sound, its consequences are tremendous—to physics, to philosophy and to humanity. A peculiarity of the situation is that there can be no middle way; the theory must be either entirely right (apart possibly from unimportant details) or entirely wrong.

In his letter to NATURE (in which, incidentally, I do not find a single one of my objections answered) Eddington seems to me to have himself supplied proof that his theory is wrong. He agrees that the Michelson-Morley experiment disclosed one of the "brute facts" of Nature; thus we may, without logical inconsistency, imagine it having turned out otherwise than as it did. He then discusses "the situation which would arise if the experimenters have let us down badly and the true result is that which Michelson originally expected". He says this would indicate that "there is a strain depending systematically on the velocity". The essential point is that, however we interpreted the experiment, there would be a velocity disclosed by it, so that relativity would go up in smoke. There is no logical inconsistency in this, and yet, if Eddington's scientific epistemology had been sound, it would have been impossible to imagine such an event without logical inconsistency.

For we do not discuss the situation which would arise if someone were to discover the largest prime number, or two integers of which the ratio is $\sqrt{2}$, because we know, and can prove, that both events are impossible; we cannot imagine them happening without logical inconsistency. Eddington can only maintain his scientific epistemology by proving that it is equally impossible to imagine special relativity, Heisenberg's uncertainty, etc., being different from what they are. Instead of proving that certain events are unimaginable, Eddington starts imagining them.

Surely, however, the simplest and cleanest test case is not the Michelson-Morley experiment, but the finiteness of the speed of light. This is obviously very fundamental (in Eddington's sense), being an essential part of the theory of relativity, and it contains no jungles of "bogies" or "tail-chasing" in which to get lost. If we cannot discover any epistemological proof of this, Eddington's theory obviously falls. I cannot discover such a proof. Does Sir Arthur Eddington know of one?

J. H. JEANS.

Park House,
Wanstrow,
Somerset.

[1] NATURE, 148, 140 (1941).

It appears that scientific men are divided into two classes: the experimental type and the theoretical type. The difference would seem rather a matter of temperament than of necessity. Perhaps it would be wiser to separate them into two other classes which are rather of the same kind: those who are model makers and those who deal purely in abstract ideas and the essential relation of things.

There is no reason to place these two classes, as Prof. Stark has done, in their order of merit, and to use this order to bolster up a political creed, because it is quite clear to those who know the history of science that both types are needed in the development of physics. Both classes have their limitations, and an analysis of the subject is bound up with one's ultimate scientific philosophy.

The model makers are rather at the mercy of irrelevant analogies, which can be avoided only if essentials are related, as in the group theory, for example. The analogies, in these cases, are good servants but bad masters. Again, makers of models manufacture mistakes and difficulties. Many examples could be cited. One particular case that has come to my notice is connected with the idea of the group velocity of a set of waves. If we look at the ripples made by a stone on the surface of a pond, we often see that whereas the group of wavelets moves with one velocity, the crest of each individual wave moves with another one. A group velocity can be approximately defined which only differs from the phase velocity when this is a function of the frequency. Group velocity does not really exist, but is a close approximation in certain conditions, and becomes rather indefinite when component waves are differently attenuated.

In a definite problem, say the calculation of how a group of waves arrives at a distant point, if the problem is definitely stated, the answer can be just as definitely expressed. A difficulty is manufactured if the problem is put in the form: The group is sent out. At what time will it arrive at a distance x, say? An indefinite answer is involved because an indefinite group velocity is used in the question.

Similar examples are the quantum theory of dynamics, the mechanical theory of the ether, etc. In the former, the model of an electron rotating about a nucleus, in the same way as the earth rotates about the sun, gives rise to such questions as where the electron is at any time. This is a meaningless question, suggested by a false analogy. It is put in such a form that it implies relations that do not belong to it. It is like the question: Have you stopped beating your wife?

All observable quantities, for example, the spectra of the elements, etc., can be expressed in terms of the quantum theory in a perfectly definite manner, as in the preceding group velocity example. The questions as to the individuality of the electron, which have puzzled so many physicists, are not really relevant.

A method of procedure can be postulated by which a definite answer is given to a definite question. This is the correct theoretical basis. A freedom from the fetters of mechanics is necessary to develop many of our new theories, which are not built in the image of molar mechanics, the only ones which the model-makers can understand.

It is the theoretical side of physics which is so necessary to free us from preconceived ideas. But theory alone is not enough. It is difficult to see how the theorist could invent all the living realities which it is his business to analyse. The experimental facts must come first. Eddington seems to take rather an extreme view of this case, as if it were possible, by epistemology and epistemology alone, for the theorist to deduce all the essential relations—all the fundamental constants in relativity, quantum theory and non-Euclidian geometry—without reference to any facts. It is probably a matter of theoretical power and efficiency whether this can be achieved, but there is a tendency towards it.

Although experiment is necessary, it is encouraging to realize that a large number of experiments are very often unnecessary, inasmuch as further experiments tend to confirm the previous ones; and it is often found that an experiment on a matter which seems entirely outside the original scheme is merely the same experiment as the previous one repeated, and that if we had sufficient theoretical power, we should realize that the two experiments imply the same thing. There is a tendency, therefore, to reduce experimentation in proportion as our theoretical power increases. If we could rely on this completely, only one experiment, to find out which point the curve goes through, so to speak, would be necessary. (I have been accused of drawing curves through one point only!) All that is necessary is to fix, say, the value of the ordinate at some specified value of the abscissa.

It is encouraging to think that experimenting, although necessary at the present moment, and probably the quickest way of getting results, should become less and less necessary as our theories improve. It may be that we shall reach a final state, as implied by Eddington, in which all the constants of nature are interrelated, and can be fixed from epistemological considerations alone.

T. L. ECKERSLEY.

Weatheroak,
Danbury,
Essex.

A CORRESPONDENCE between two men of such astronomical mental calibre as Jeans and Eddington, firing long-range shots at each other, should, I suppose, be read in silence and with respect by the ordinary man in the street. It is indeed very enjoyable in these days to have such a discussion, but first of all we must thank Jeans for the very human confession that he had been "re-reading" Eddington's book. It is comforting to think it was not just our fault we did not get it all the first time.

Jeans sums up Eddington's contention in paragraph 2 by saying that "all those laws of Nature that are usually classed as fundamental, as well as the values of the constants of Nature, can be foreseen 'from epistemological considerations, so that we can have *a priori* knowledge of them' ". "*A priori*" knowledge is given, quoting Eddington again, as "knowledge which we have of the physical universe prior to actual observation of it". From this it is fair to say that Eddington claims that fundamental laws are objective, yet in his answer towards the end he states that there is no such thing as a truly objective law. Eddington should, therefore, challenge Jeans's summary of his main contention, yet he does no such thing.

I have always regretted the Michelson-Morley experiment. Things were perfectly satisfactory before their distressing negative results. I feel we are not at the end of this story, just as we are not at the end of the story that the red shift in the spectrum means receding speed, unless we tie ourselves to the Hilaire Belloc creed and "never, never let us doubt, what nobody is sure about". To say that without the Michelson-Morley experiment we should find ourselves "faced with a universe far more complicated than we have lately imagined" can only be agreed to by those who can dart with such facility from physics to metaphysics.

Finally, a protest against 'plugging' the word 'epistemological'. It is neither pronounceable nor understandable.

J. T. C. MOORE-BRABAZON.

81 Albert Hall Mansions,
S.W.7.

SIR JAMES JEANS proposes the finiteness of the velocity of light as a test case. I answer: Certainly this is *a priori* knowledge, but of a rather trivial kind. We know *a priori* that the velocity of light is not infinite, just as we know *a priori* that the velocity of light is not blue or hexagonal or totalitarian; it is not the sort of thing to which these terms could apply. The alternatives "exceedingly large" and "actually infinite" concern only the abstract quantities which are the theme of pure mathematics; this is equally true of the alternatives "exceedingly small" and "actually zero". No such alternatives exist for physical quantities defined in terms of observation. When an *observer* sets out to determine the velocity of light, an infinite result is not among the possible alternatives; and if he announces that he has found the velocity to be, not merely exceedingly large, but actually infinite, we know *a priori* that the announcement is untrue.

In so far as the existing relativity theory rests on the assumption that the velocity of light is not infinite it is safe from experimental contradiction. In regard to the aspect in which it is not so immune, Jeans's remarks seem to me mainly reiterative, since he again ignores the difference between identification by description and identification by pointing. It is a logical impossibility that the Michelson-Morley experiment should give a null result in the conditions *described*; but the possibility imagined is that a bogey, supposed to have been laid, has come to life again, so that the conditions described are not those which have been *pointed out* to the experimenter. Similarly, it might have turned out that the velocity of light did not agree with the ratio of electrical units; in that case we should have had to await the discovery of Hertzian waves before we could see how electromagnetic wave theory applied. When Dirac's "holes" were first put forward they were identified with protons; but brute facts were discordant, and the hole theory went up in smoke. That was because the hole described was not the proton pointed out. Later the positron was discovered, and it was seen how the hole theory applied.

Since these letters will be read by many who are unfamiliar with the basis of the epistemological theory, it seems desirable to explain briefly why a scheme of laws arrived at in an *a priori* way is expected to coincide with the scheme arrived at by analysis of observational knowledge. The development of fundamental physics must go on and on, either steadily or by a succession of revolutions, until the physicist has (in his limited view) reached the bottom of things. The important question is : Will he recognize "the bottom of things" when he reaches it, and can we already say what are the criteria by which he will recognize it ? If so, we can reverse the usual order of inquiry and begin with these criteria. We can, for example, work out the properties of the "particles" which, according to these criteria, could be accepted as really elementary structural units. In that way we develop a scheme of laws relating to the concepts in terms of which phenomena are ultimately to be described, confident that the physicist, who is working his way down from the top, will come to this scheme. Any other scheme could only be a temporary resting-place from which he must be driven by the intellectual urge which started his inquiry. Whether this will succeed as a practical method—whether it is the short way round or the long way round—cannot definitely be foretold ; but it is found by trial to be the short cut, unless we have been greatly deceived. If we imagine experimental results to have turned out differently, we eliminate the evidence that it is a short and (in the present state of knowledge) practicable method ; but we do not impugn its validity.

In reply to Lieut.-Colonel Moore-Brabazon, I do not see how the statements (which are, I think, a fair summary of my main contention) constitute a claim that the so-called fundamental laws are objective ; I concluded that they are subjective. I fully agree with Mr. Eckersley's letter.

A. S. EDDINGTON.

The Observatory,
Cambridge.

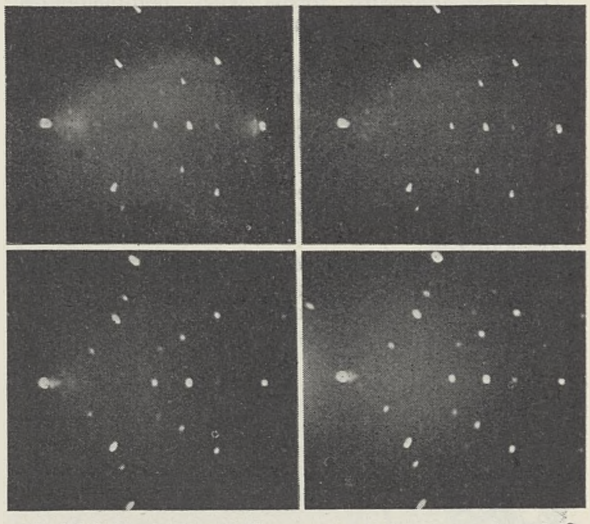
Temperature Study of the Diffuse X-Ray Diffraction by Diamonds

IN a recent letter in NATURE[1], we pointed out that all diamonds show one kind of ("primary") diffuse X-ray diffraction, associated with the ordinary {111}, {220}, {113}, etc., reflexions on Laue photographs, but that only Type I diamonds show the special ("secondary") diffraction, the characteristic appearance of which takes the form of fairly sharp streaks or triangles of spots. The suggestion was made that these two types of diffraction, though associated with each other and with the Laue reflexions, may have different origins. This is now supported by the following new experimental facts. First, in contrast to the primary diffuse spots, the *secondary* effects vary considerably in intensity even for diamonds of similar shape and size (Type I diamonds, however, always show some effect, whereas Type II show none). Secondly, it is found that, whereas this secondary diffraction is only slightly affected in intensity by a temperature change of more than 800° C., the *primary* diffraction (for diamonds of both types) is much more strongly temperature-sensitive.

The accompanying illustrations are typical of many taken using various specimens, changing crystal orientation, time of exposure, etc. Photographs (*a*) were taken with a small octahedral diamond of Type I, at 650° C. and at 30° C. respectively, under similar conditions of position and exposure time. The primary diffuse spots corresponding to (111) copper $K\alpha$ and β, and (113) copper $K\alpha$ reflexions are clearly much stronger at the higher temperature ; the secondary diffuse spots (three (111) copper $K\alpha$, three (111) copper $K\beta$ and two (113) copper $K\alpha$) show definite, but less marked enhancement. It is interesting to note that the third point of the (113) "triangle" does not appear even at high temperatures.

Photographs (*b*) were taken with a very thin diamond plate, also of Type I, at 30° C. and at — 180°C. The crystal orientation was changed a little from the (*a*) position, in order to intensify the primary diffuse spot in the room temperature photograph ; this, however, weakened the (113) diffuse reflexions, which are no longer reproducible. For the low-temperature photograph the specimen was completely bathed in a direct, continuous stream of liquid oxygen. In order to allow for absorption and scattering of the incident X-rays by the liquid oxygen, the exposure was increased until the Laue spot and background intensities were obviously stronger than those of the room temperature photograph. Even so, the primary diffuse spot has practically disappeared, the secondary spots being weaker than before but still quite distinct.

(*a*) 650° C. 10 min. $\theta = 18°$ (*a*) 30° C. 10 min. $\theta = 18°$



(*b*) 30° C. 10 min. $\theta = 18{\cdot}6°$ (*b*) – 180° C. 15 min. $\theta = 18{\cdot}6°$.

Similar experiments on Type II diamonds showed the same weakening of primary diffuse diffraction at low temperatures, and other photographs verified this for {220} and {113} diffuse reflexions. All these temperature changes were reversible.

Sir C. V. Raman and others[2,3] have reported a negative result for low-temperature experiments on diamond, but without the publication of photographs or of data which would indicate whether they were, in fact, observing primary or secondary diffraction.

The *primary* diffuse spots, observable and temperature-sensitive for both types of diamond, would appear to correspond closely to the diffuse spots observed for all other crystals under suitable conditions of temperature, orientation and wave-length of incident radiation. It seems obvious, however, that the *secondary* spots and streaks on photographs of Type I diamonds, however interesting in themselves, can scarcely be taken as typical of diffuse diffraction in general, since the counterpart of the triangles has not yet been observed for any other substance, while streaks are relatively uncommon. It is noteworthy that the selective Bragg reflexions from diamonds giving strong secondary effects were relatively weak, being barely visible on a fluorescent screen; those from diamonds giving very weak or no secondary diffraction were much stronger, the (111), (220), etc., reflexions being visible on a fluorescent screen in broad daylight not only in the "characteristic" position but also throughout the entire range of Laue reflexion. This confirms the observation that strong secondary diffraction is associated with powerful extinction effects.

K. LONSDALE.
H. SMITH.
Davy Faraday Research Laboratory,
Royal Institution,
London, W.1. July 28.

[1] Lonsdale, K., and Smith, H., NATURE, 148, 112 (1941).
[2] Raman, C. V., and Nilakantan, P., *Proc. Ind. Acad. Sci.*, 11A, 396 (1940).
[3] Raman, C. V., Nilakantan, P., and Rama Pisharoty, P., NATURE, 147, 805 (1941).

Determination of Sex in Scalpellum

SEXUAL conditions in the Cirripedia are very varied[1]. They comprise such species as:

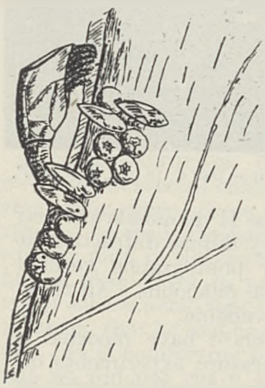
(1) Hermaphrodite forms with 'complemental' males, for example, *Scalpellum scalpellum*, *Ibla cumingii*;

(2) Hermaphrodites with sterile complemental larvæ, for example, Rhizocephala;

(3) Hermaphrodites only, for example, most Pedunculata (Lepas, Pollicipes, etc.), Operculata (Balanus, Coronula, etc.), Ascothoracica;

(4) Females with complemental males, for example, *Scalpellum velutinum*, *S. ornatum*, *Ibla quadrivalvis*, Acrothoracica.

The chromosomes of *Lepas anatifera*, which falls into group 3, were examined by Witschi[2]. He found the diploid number to be 26 and showed that no distinguishable sex chromosomes were present.



GROUP OF COMPLEMENTALS ATTACHED TO THE MANTLE OF A HERMAPHRODITE *Scalpellum scalpellum*, INCLUDING FOUR CYPRIS LARVÆ, NINE DWARF MALES AND ONE QUASI-HERMAPHRODITE. (× 12.)

I have examined the chromosomes of *Scalpellum scalpellum*, which falls into group 1. The diploid number of 32 was found in spermatogonia of complemental dwarf males and of hermaphrodites. No sex chromosomes can be distinguished at meiosis, the haploid number being 16.

Gruvel[3] observed oogonia in the complemental males of *S. peronii*, which also falls into group 1. I have seen the same in *S. scalpellum*. Moreover, one hermaphrodite of *S. scalpellum* which I received from Plymouth had an unusually large number of complementals. Of these four were unmetamorphosed cypris larvæ, nine were typical degenerate dwarf males, and one excluded from the male-containing pocket of the hermaphrodite, had the structure of a small hermaphrodite (see accompanying illustration).

The absence of sex chromosomes, presence of oogonia in the complemental males and this odd hermaphrodite-like complemental point to an environmental control of sex determination such as that existing in Bonellia[4]. I would suggest, therefore, that in *Scalpellum scalpellum* and Cirripedes of its type all larvæ are potential hermaprodites (instead of female as in Bonellia), but those which become parasitic on adult hermaphrodites develop as functional males only and go no farther. Since the breeding system involving complementals is widespread in the Cirripedes, it may further be suggested that this type of sex determination is primitive for the group.

H. G. CALLAN.
John Innes Horticultural Institution,
Merton, S.W.19. Aug. 2.

[1] Darwin, C., "A Monograph of the Sub-class Cirripedia" (London, 1851 and 1854).
[2] Witschi, E., *Biol. Bull. Woods Hole*, 68 (1935).
[3] Gruvel, A., "Monographie des Cirrhipedes" (Paris, 1905).
[4] Baltzer, F., *Mitt. Zool. Stat. Neapel*, 22 (1914).

Albert Hall Acoustics

THE changes made to house the recent season of Promenade Concerts have affected the appearance more than the acoustics of the Albert Hall. The subject has been discussed periodically ever since the Hall was built, but the oval ground plan and the great height are insuperable difficulties with reflecting surfaces. Most of the changes proposed, including that of Bagenal and Wood illustrated on p. 65 of their "Planning for Good Acoustics", showing the source of sound placed far above ground-level, attempt to preserve the full seating capacity of the Hall. Recently conditions have changed considerably. For some time pugilists and politicians have been the chief users of the full capacity of the Hall. But now there are a number of recognized sporting-centres in London and politicians can address even larger audiences through the radio. Musicians have, however, lost the Queen's Hall and other concert halls.

It would appear, therefore, that, when construction takes the place of destruction, the principle of 'divide and rule' could with advantage be applied to the recalcitrant acoustics. One half of the building could be used for a concert hall seating about five thousand, the number said to be needed for unsubsidized orchestral concerts in London. The remainder could be cut up to house smaller concert and recital halls, studios, a musical library, cafés, cloak rooms, ventilating plant and other needs of a musical centre. The volume of the Hall is adequate for all these needs. Although the fan shape is one of the simplest to plan acoustically, suggesting a division into wedge-shaped sections, like cutting a cake, the actual details of the division would be more a matter of structural engineering. Drastic changes of ground plan are essential. The most difficult acoustical problem would be the sound insulation of the different halls so that, if needed, they could be used at the same time. The division of the Hall would provide excellent support for roof gardens, like some of those in New York, where music and drama could be enjoyed out of doors in the summer time. The gardens would be well out of the range of appreciable traffic noise, and carefully planned stone wall screens could act as sound reflectors as in the typical Greek theatre.

Success would probably be best ensured by employing engineers and physicists under the direction of a fanatically functional architect.

W. H. GEORGE.
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Chelsea Polytechnic,
S.W.3.

A PHOTOGRAPHIC METHOD OF ESTIMATING THE MASS OF THE MESOTRON

By Dr. D. M. Bose and Biva Choudhuri
Bose Institute, Calcutta

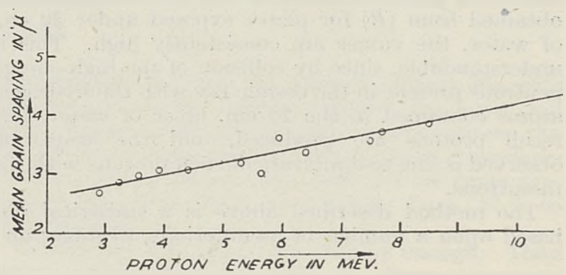
In a communication in Nature[1] it was concluded that the heavy ionization tracks found in Ilford New Halftone plates kept exposed to cosmic rays at Sandakphu (12,000 ft.) were chiefly due to mesotrons. The basis of this conclusion was a comparison of the mean grain spacing and curvature of tracks due to cosmic rays with tracks due to protons of known energies on similar plates.

In the present communication an account is given of a method of estimating the mass of these particles, presumably mesotrons. Usually three independent measurements are necessary to specify completely a moving charged particle, namely, its charge, mass and velocity. We start with the assumption that these particles are singly charged. We have determined the energy of these particles from their mean scattering and also their velocities as function of the mean grain spacing along their tracks. For the first we have made use of the formula recently given by Williams[2] connecting the mean energy W and the mean scattering $\bar{\theta}$ suffered by fast charged particles in a thickness t of a medium containing N atoms per c.c. with nuclear charge Ze. As will be seen later, the energies of such particles vary between 0·4 and 1·6 Mev., and the nuclear charge is low, so that the scattering is taken to be due only to Coulomb forces and that the use of Born's approximation is valid, and that the non-relativistic form of the equations can be used.

The mean deflection

$$\bar{\theta} = \{3\cdot69 + 0\cdot28 \log_{10} (Z^{4/3}\rho t/A\beta^2) \frac{Ze^2}{W} \sqrt{Nt} \ldots (1).$$

Since the photographic emulsion is heterogeneous in composition, we have assumed that the actual distribution of atoms of different kinds in it is replaced by one kind of atom of mean nuclear charge Ze and mean atomic weight A. These are estimated from a knowledge of the density ρ of the emulsion and its percentage composition as given by Wambacher[3]. It is found that $\rho = 2\cdot89$, $Z = 6\cdot2$ and $A = 12\cdot6$. We have measured the total deflection θ suffered by a group of particles having a given mean energy and traversing a total thickness of emulsion varying between 0·33 and 0·09 cm. For the large number of encounters which take place under such conditions, $\frac{|\theta - \bar{\theta}|}{\bar{\theta}} \ll 1$; that is, for θ in equation (1) we can write θ. Having thus determined the value of $W = \frac{\mu}{2}\overline{v^2}$ of the mesotrons corresponding to a given mean grain spacing, we proceed for the second part of the investigation to determine the kinetic energy of protons having the given mean grain spacing along their tracks, in the same kind of emulsion. Our procedure is based upon the assumption that in such emulsions particles of different masses, but with the same charge and the same initial velocity will have the same mean grain spacing along their tracks. According to the accepted theories, the ionization loss of different particles with the same charge in a given medium depends only on their velocities. Such particles may have different ranges, but the mean grain spacing along their tracks will be the same, if they start with the same initial velocity.



We have prepared a calibration curve showing the mean grain spacing along the tracks of protons as a function of their initial energies. For this purpose we have produced recoil protons in the emulsion using neutrons of different energies produced by a radium-beryllium source. It has been found[4] that these neutrons have several discrete energy values; our own results are in general agreement with those of Blau[5], who also used the photographic plate. We have used proton tracks with ranges in air of 10–90 cm. and of energies between 2·25 and 9 Mev. After several trials we found that the most satisfactory calibration curve could be obtained by plotting the mean grain spacing along the proton tracks belonging to each energy group as a function of the corresponding energy. The calibration curve in the accompanying graph was found to be a straight

	(i) No. of tracks	(ii) (a) Mean grain spacing μ	(ii) (b) Mean μ	(iii) Total track in emulsion	(iv) Total Scattering	Energy in Mev. (v)(a) Mesotron	(v)(b) Proton	Mass of Mesotron
A.	1–20	6·9—4·9	5·7	0·25 cm.	22° 33′	1·575	18·5	$173m_0$
	21–49	4·8—3·7	4·2	0·33 cm.	52° 2′	0·776	10·5	$149m_0$
	50–86	3·6—2·5	3·3	0·29 cm.	86° 16′	0·434	5·65	$158m_0$
B	1–16	5·8—3·9	4·3	0·108 cm.	16° 37′	1·40	10·7	$265m_0$
	17–58	3·8—2·5	3·5	0·26 cm.	55° 1′	0·652	6·7	$198m_0$
C	1–6	6·3—4·8	5·4	0·086 cm.	16° 14′	1·273	17·0	$153 m_0$
	7–18	4·5—2·8	3·5	0·100 cm.	40° 6′	0·555	6·9	$167m_0$

Mean of A and C $(160\cdot2 \pm 4\cdot3)\ m_0$

A : Plate kept in Sandakphu (12,000 ft.) under air.
B : Plate kept in Sandakphu (12,000 ft.) under 20 cm. of water.
C : Plates kept at Phari Jong (14,500 ft.) under air.

line, and we felt justified in extrapolating it to the values of mean grain spacing found in the cosmic ray plates.

In the accompanying table are the data from which the mass of the mesotron has been estimated. We have divided the tracks on the plates into groups, the range of variation of the mean grain spacing in each is given in ii (a) and the resultant mean in ii (b). The total length of tracks in each group is given in (iii), and their total deflection due only to multiple scattering in (iv). The mean energy of each group of mesotrons as calculated with the help of formula (1) is given in v (a) and of protons with the same mean grain spacing as obtained from the accompanying graph in v (b). The last column gives the calculated values of the mesotron mass. It will be seen that fairly consistent values of μ are obtained from (A) and (C) in plates exposed under air, while with those obtained from (B) for plates exposed under 20 cm. of water, the values are consistently high. This is understandable, since by collision of the high-energy neutrons present in the cosmic ray with the hydrogen atoms contained in the 20 cm. layer of water, fast recoil protons are produced, and the scattering observed is due to a mixture of such protons with the mesotrons.

The method described above is a statistical one based upon a number of assumptions, averages and extrapolation. The presence of protons cannot be entirely excluded from such measurements. It is surprising, therefore, to find how the measured values of μ fall within the range of the best determinations by other methods[6]. It remains to be investigated whether the photographic method can be further improved into a precision method of determining the mass of μ. The results obtained are important in other respects; it has enabled us to verify our previous surmise that the star-like tracks found in our photographic plates are due to secondary mesotron showers produced chiefly by cosmic ray neutrons. This and the presence in such showers of three-, four- and five-star tracks in approximately equal numbers are results which do not appear to be capable of interpretation in terms of existing theories.

A detailed account will appear in the *Transactions of the Bose Institute*.

[1] NATURE, 147, 240 (1941).

[2] Williams, E. J., *Proc. Roy. Soc.*, A., 169, 539 (1939).

[3] Wambacher, *Phys. Z.*, 39, 888 (1939).

[4] Dunning, *Phys. Rev.*, 45, 586 (1934); Bonner, Mott and Smith, *Phys. Rev.*, 46, 258 (1934).

[5] Blau, *J. Phys. et Rad.*, 61 (1934).

[6] Bethe, *Phys. Rev.*, 57, 260 (1940) estimates that the most reliable measured values of μ lie between 150 and 220 m_0. When certain corrections are made, it is expected that the former will be increased by at least 10 per cent.

FOOD AND INCOME

By D. CARADOG JONES

UNIVERSITY OF LIVERPOOL

A REPORT, published under the title "Food and the War", by the Edinburgh Branch of the Children's Nutrition Council*, gives an account of a study of the expenditure of a sample of families of the unskilled labouring class, made by voluntary workers during the period April–November, 1940. The object of the inquiry was to determine whether their incomes sufficed to purchase for these families an adequate diet as judged by two well-known standards, the first defined in the Report of the British Medical Association's Committee on Nutrition (1933), the second in the League of Nations Report on the Physiological Bases of Nutrition (1936, II B.4). Since the families were chosen solely on the ground of readiness to co-operate and lowness of income—43 per cent had less than 50*s*. a week coming in and only 11 per cent had £4 or more—the main result of the investigation might be regarded as a foregone conclusion. Despite this fact and the small size of the sample studied, the figures and the inferences drawn from them are not without interest.

Of the 103 families visited 12 were on public assistance; in 38 the head was absent from home on war service, in 25 the wage earner was a labourer; the remainder are classed simply as "others". By means of a questionnaire particulars were obtained from all but two of these families as to their composition by sex and age and as to their expenditure on certain "fixed charges": rent and rates, lighting and heating, insurance and any regular payments to a doctor. The total sum thus accounted for was in each case deducted from income and the balance was compared with the amount of money needed to feed the family adequately at 1940 prices according to the British Medical Association standard. It was discovered that 51 out of 72 families which supplied full information on this point, that is, 71 per cent, would have had insufficient money to pay for an adequate diet even if all the remaining balance had been spent on food. Actually, when the purchase of other necessities is brought into the account, only 10 per cent of the families sampled had enough money left to purchase an adequate diet. Using an American rating scale of somewhat doubtful accuracy a further estimate was made to the effect that the diets of 40 families out of 53 tested were less than 50 per cent adequate. The report itself gives tables, but the above are the broad conclusions.

*Children's Nutrition Council, 37 Esslemont Road, Edinburgh, 28 pp., 3*d*.

Detailed records of their expenditure were kept for periods of one to three weeks by 76 families. Analysis of these budgets revealed that rather more than one half of the families sampled over-spent their income each week. This is on the perhaps doubtful assumption that all sources of income were disclosed to the investigators. Some ran up bills, paying a little off as they could and the debt growing bigger each week; others, in particular those with a member of the family in the Forces, received help from relatives.

In the majority of families the proportion of income spent on non-essentials was very small, but it increased as the income rose. Expenditure on necessities other than food included relatively large instalments towards the hire-purchase of clothes and furniture. The temptation to buy wardrobes is said to be strong on account of the lack of proper provision for hanging clothes in houses put up under recent schemes. One instance is quoted of instalments paid by the same family on three wardrobes in two years : two were removed owing to failure to continue the weekly payments. About three out of every four families investigated also paid regular premiums to meet the cost of burial, in some cases amounting to more than 7*s*. a week. This is a serious drain on slender resources—enough to "pay for a funeral every year".

Returning to the main theme of the inquiry, the writers suggest that, apart from education in regard to the value and preparation of different foods, much might be done to solve the diet deficiency problems raised in this study by a wide extension of communal feeding, of the national milk scheme, and of all social services relating to food.

USE OF GLASSES AS AN AID TO VISION

By R. Weatherall
Eton College

As part of an investigation to discover whether physical defects among children increase with age, M. V. Marshall organized a survey of the use of glasses by children attending school in a representative American city.[1] In all, the survey covers 8,204 children ranging in age from kindergarten to the twelfth grade ; that is, 5–17 years. The results show an almost uninterrupted increase in the use of glasses, from 2·7 per cent among the youngest, to 15·7 per cent around the age of twelve, and 23·7 per cent by the time the pupils are leaving school. An additional proportion of the children, ranging between 2 per cent and 7·5 per cent, had been advised to wear glasses, but were not doing so.

Children do not take kindly to wearing glasses when they first begin to take an active part in school games, and when they become conscious of their own personal appearance. Allowing for such personal factors, there are unexplained checks in the use of glasses around the ages of ten and fifteen. Also, personal factors alone can scarcely explain the wide discrepancy in the separate figures for boys and girls. Between the ages of twelve and seventeen the proportion of boys wearing glasses varies irregularly between 12 and 18 per cent, while for the same age-groups the girls show an increase from 17·7 to 32·8 per cent.

Altogether, the figures are striking enough. They show clearly that the need for glasses increases rapidly during a pupil's school life, so that by the age of sixteen about 1 in 7 of the boys, and 1 in 3 of the girls, are using artificial aids to vision. Even so, it is very probable that a still higher proportion of these children must be considered as having eyesight below normal. The figures revealed by this survey agree fairly well with those obtained by a smaller one which I carried out on boys attending a school in England. They give some measure of the magnitude of the problem of defective eyesight at the present time.

[1] *School and Society*, 53, No. 1375 (1941).

FATIGUE TESTS OF WELDED JOINTS

The publication by the University of Illinois Engineering Experiment Station of the results and conclusions derived from an investigation carried out there on welded joints in structural steel plates is but the first instalment or progress report of the proceedings*.

The primary object of those responsible was to obtain reliable information on which to base specifications governing the design of welded structural members subjected to reversed or pulsating stresses. The lack of knowledge of the fatigue strength of welded joints has been the principal deterrent to their adoption in the fabrication of bridges, and it was clear that tests on the largest practicable scale would have to be made before this method of construction could be placed on a satisfactory and reliable basis. Realizing this, the Welding Research Committee of the Engineering Foundation organized a special committee representative of all engineering interests to plan and carry out the work.

As used in this report, the term fatigue strength of a member refers to the maximum stress in the stress cycle which caused its failure at a stated number of cycles when the ratio of the minimum to the maximum stress had a stated value. While it is not possible to specify the stress which will cause failure at a predetermined number of cycles, it was practicable to estimate the stress cycle which would disrupt the specimen at the desired stage in the test. This was the procedure adopted and three kinds of cycle were used : (1) from a tensile stress to an equal compressive stress ; (2) from zero stress to a maximum tensile stress ; (3) from a maximum tensile stress to a minimum tensile stress of half the value. These gave ratios r, of -1, 0 and $+0{\cdot}5$ respectively, and for each value of r, seven identical specimens were tested: three so as to fail at 100,000 cycles, and three at 2,000,000 cycles, the seventh being a spare to be tested as desired after the other six tests had been completed.

* University of Illinois Engineering Experiment Station. Bulletin Series No. 327: Fatigue Tests of Welded Joints in Structural Steel Plates. By Wilbur M. Wilson, Walter H. Bruckner, John V. Coombe and Richard A. Wilde. Pp. 86. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1941.) 1 dollar.

In this way, four different investigations were carried out, namely, fatigue tests of butt welds in carbon-steel plates; comparisons of the strengths of welded and riveted joints in low-alloy steel plates; the effect of periods of rest upon fatigue strength of butt welds; and the influence of transverse fillet welds upon fatigue strength. Tests were made of specimens in the as-welded condition and of others with the reinforcement planed flush with the plate and of others again with it ground flush. In each category there were specimens which were stress-relieved by being heated to 1,200° F. for one hour and then cooled in the furnace while others were not stress-relieved.

Considering that the welds under test may be fairly regarded as having been made under as nearly as possible ideal conditions, the results indicate that when suitable allowance is made for variations in quality, the dependable strength of welded joints and plates weakened by transverse welds is still quite moderate. The details are too numerous to summarize, but as examples, some of the results at 2,000,000 cycles may be cited. Butt welds in $\frac{7}{8}$-in. carbon-steel plates in the as-welded condition gave 14,400, 22,500 and 36,900 lb. per sq. inch in the three classes of cycle. The corresponding figures for machined-off specimens of classes 2 and 3 were 28,400 and 43,700 and for ground-off specimens of class 2 were 26,300. Stress-relief did not appear to affect fatigue strength, and periods of rest showed no advantage. Carbon-steel plates with one transverse fillet weld gave an average of 18,900 and with two welds 13,100 lb. per sq. in. The character of the bead had some effect on the figures, but for a given base metal the variation did not exceed 5 per cent.

FORTHCOMING EVENTS

Saturday, August 30

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Federation of British Industries, 21 Tothill Street, London, S.W.1), at 3.15 p.m.—Mr. G. A. V. Sowter: "Applications of High Permeability Magnetic Alloys to Electronic Devices".

APPOINTMENTS VACANT

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

DISTRICT EDUCATION OFFICER (man or woman)—The County Education Officer, County Hall, Hertford (September 6).

PUBLIC ANALYST and an OFFICIAL AGRICULTURAL ANALYST—The Clerk of the Berkshire County Council, Shire Hall, Reading (September 9).

LIBRARIAN—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (September 10).

CONSULTANT PSYCHIATRIST and an EDUCATIONAL PSYCHOLOGIST—The Director of Education, Education Office, Chapel Street, Salford 3 (September 13).

COLLEGE LIBRARIAN (woman)—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 13).

POWER STATION SUPERINTENDENT—The Town Clerk, Town Hall, Halifax (September 15).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Woolwich, London, S.E.18 (endorsed 'Appointment of Borough Electrical Engineer') (September 15).

LECTURER IN BOTANY, with subsidiary Zoology—The Principal, Technical College, Kingston-upon-Thames.

LECTURER IN ELECTRICAL ENGINEERING—The Principal and Organizer of Further Education in Rugby, College of Technology and Arts, Rugby.

POST-GRADUATE TEACHING SCHOLAR (Experimental Zoologist) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, The University, Edmund Street, Birmingham 3.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Scottish Marine Biological Association. Annual Report, 1939–40. Pp. 32. Annual Report, 1940–41. Pp. 32. (Millport: The Marine Station.) [118

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Tin Through the Ages: in Arts, Crafts and Industry; Handbook to a Temporary Exhibition, July–December 1941. By Dr. F. J. North. Pp. 38. (Cardiff: National Museum of Wales.) 3*d*. [118

Ministry of Agriculture and Fisheries. "Growmore" Bulletin No. 3: Preserves from the Garden. By B. Alice Crang and Margery Mason. Revised edition. Pp. 28. (London: H.M. Stationery Office.) 4*d*. net. [118

Experiment and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Twenty-sixth Annual Report, 1940. Pp. 72. (Cheshunt: Nursery and Market Garden Industries Development Society, Ltd.) [118

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 12, No. 2, September 1940. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+75–146. 4*s*. 6*d*. net. Vol. 12, No. 3, December 1940. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+147–226. 4*s*. 6*d*. net. (London: H.M. Stationery Office.) [128

Canteen Catering. Prepared and issued by the Ministry of Food. Pp. 84. (London: Ministry of Food.) 6*d*. [148

Other Countries

Memoirs of the Geological Survey of India. Vol. 74, Part 1: The Cretaceous and Associated Rocks of Burma. By Dr. E. L. G. Clegg. Pp. iii+102+xx. (Calcutta: Geological Survey of India.) 2.4 rupees; 3*s*. 9*d*. [68

U.S. Office of Education: Federal Security Agency. Vocational Division Bulletin No. 210 (Occupational Information and Guidance Series No. 4): Working Your Way through College and other Means of providing for College Expenses. By Walter J. Greenleaf. Pp. v+175. (Washington, D.C.: Government Printing Office.) 20 cents. [118

Ministry of Agriculture: Central Agricultural Research Institute, Sofia, Bulgaria. Polyploidy and its Role in Evolution and Plant Breeding. By Dontcho Kostoff. Pp. 85. (Sofia: Central Agricultural Research Institute.) [128

U.S. Office of Education: Federal Security Agency. Leaflet No. 60: Choose a Book about Things to be Conserved. Compiled by Helen K. Mackintosh and Effie G. Bathurst. Pp. 20. (Washington, D.C.: Government Printing Office.) 5 cents. [128

Publications of the Dominion Astrophysical Observatory. Vol. 7, No. 12: The Determination of the Magnitude Difference between the Components of Spectroscopic Binaries. By R. M. Petrie. Pp. 205–238. Vol. 7, No. 13: The Spectrographic Orbit of H.D.207826 (Boss 5620). By Andrew McKellar and C. G. Patten. Pp. 239–244. Vol. 7, No. 14: The Spectrographic Orbits of H.D.207650. By R. M. Petrie. Pp. 245–250. (Victoria, B.C.: Dominion Astrophysical Observatory.) [138

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 40: Grape-Growing in Baluchistan. By A. M. Mustafa and M. Asghar Ginai. Pp. 16+5 plates. (Delhi: Manager of Publications.) 1.2 rupees; 1*s*. 9*d*. [148

Catalogues, etc.

Rotenone Lotion B.D.H. Pp. 2. (London: The British Drug Houses, Ltd.)

The Wild-Barfield Heat-Treatment Journal. Vol. 4, No. 29. Pp. 47–54. (Watford: Wild-Barfield Electric Furnaces, Ltd.)

The Nivoc Supplement. No. 20, July. Pp. 16. (London and Birmingham: W. and J. George, Ltd.)

B.D.H. Standard Stains specially prepared for Microscopical Work, with some General Notes upon the Use of Stains. Pp. 40. (London: The British Drug Houses, Ltd.)

A Catalogue of Books, including works on Botany, Costume, English History and Literature, Medicine and Surgery, Natural History, Science, Shipbuilding and Naval Affairs, Wales, Addenda. (No. 590.) Pp. 60. (London: Bernard Quaritch, Ltd.)

Dunns Seed Wheats: a Guide to Autumn Cereals and Forage Crops. Pp. 12. (Salisbury: Dunns Farm Seeds, Ltd.)

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