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THE CIVIL SERVICE IN GOVERNMENT

BEHIND the less restrained and sometimes unfair criticism which has been levelled at the Civil Service as the War has continued, there has lain a vague, unformulated feeling that the Civil Service as a whole is slightly out of touch with the times, and neither in calibre nor technique quite so competent to handle the tasks with which it is confronted as was the Civil Service of a generation ago.

It is the great merit of a recent broadsheet, "The Machinery of Government", issued by Political and Economic Planning, that it brings such uneasiness into the light of day, probes its causes, and, setting the Civil Service in its proper perspective in relation to the task of government, makes constructive proposals for removal of many of the defects revealed.

In the first place, as the broadsheet points out, there is no peculiar 'democratic virtue' in incompetent administration ; modern government is increasingly a matter of determining the right priorities in the broadest sense, of educating public opinion to those priorities, and of adjusting organization and methods to give them the fullest and most immediate effect. The failure of our executive machinery of government to plan ahead, its failure continuously to adjust its working structure and technique to the problems with which it is called upon to deal, its continued domination by financial and accounting aspects, its neglect of scientific and technical advances and its timidity in accepting responsibility, all flow from a failure to renounce the old conception of government as a regulatory, policing and taxing mechanism ; and openly to adopt the conception of government as the nation's common instrument for expanding its social and economic welfare in all those spheres where individuals or private associations cannot achieve equally effective results.

Although some improvement is being effected through the creation of new organizations and the elimination of weak spots, apart from the important exception of Mr. Eden's proposed reforms at the Foreign Office and in the Diplomatic Service, there has been little sign of the radical change of outlook involved in this new conception of government. Moreover, in reviewing the complex machinery of central government, as the broadsheet points out, it is important to consider Parliament, Ministers and the Civil Service, not in isolation but in their mutual actions and reactions. The Minister, for example, is to a very great degree dependent on the advice of the full-time professional officers of his Department for the policies which he submits to his colleagues in the Cabinet. In the execution of these policies he can do little to secure more vigorous or effective action if the machine of which he is temporarily in charge is rusty or otherwise defective. No individual Civil Servant should be blamed for the consequences where advice he has given has been ignored by the Minister or by the Cabinet, but the Civil Service as a body must bear a fair share of the responsibility if the techniques for obtaining information and for shaping and presenting policy are such that too high a proportion of decisions prove to be ill-advised. The Civil Service, as a body, given the knowledge and the will to do so, is in a position to alter those techniques : generally speaking, the individual Minister is not.

The P E P broadsheet, leaving for a later statement the political and ministerial elements in the problem, discusses the main weaknesses of the Civil Service and how they might be corrected. It carries into constructive detail the ideas to some extent outlined by Dr. W. A. Robson in his introductory essay in "The British Civil Servant" some four years ago, and forms an admirable complement to the study of the growth of the British Civil Service, 1780–1939, by Emmeline W. Cohen*. There is indeed no simple or magic remedy. The solution lies partly in the change in the basic attitude to the task already emphasized, partly in some changes and developments of organization, partly in the modernization of methods and the use of available resources and techniques which have hitherto been neglected. Behind it all lies the problem of choosing the right men and using their abilities to the full.

It will readily be conceded that in present circumstances it would be impossible and highly dangerous to attempt a complete reorganization of the Civil Service. Modification of the recruitment, training and development of a great professional body is a long-period undertaking, which can only take effect over several decades. Fortunately, however, the measures which are immediately possible do not appear to conflict with the long-range measures required to equip the country to face the tasks which will meet it at the end of the War.

The analysis of the Civil Service in this broadsheet points once more to the weakness of the Service in knowledge of social and natural science, and in grasp of scientific method or technique. Training is in general political and administrative rather than executive. There is little knowledge of the new techniques of large-scale organization and management which have been developed in the last forty years, and an imperfect appreciation of the fact-finding method of approach to problems of administration on which these techniques are based. Even less than in industry the distinction of staff from line functions is not properly recognized, and there is no conception of holding any of the strength in reserve for emergencies—a criticism which equally applies to a large part of industry.

*The Growth of the British Civil Service, 1780-1939. By Emmeline W. Cohen. Pp. 222. (London : George Allen and Unwin, Ltd., 1941.) 10s. 6d. net.

These severe criticisms find support in a recent important study of the advisory bodies, on which the Haldane Report laid such stress ; indeed the analysis reiterates not a few of the criticisms contained in that Machinery of Government Committee's report of twenty-three years ago. The emphasis laid there on the need for further provision for the continuous acquisition of knowledge and the prosecution of research, and on the desirability of establishment departments keeping themselves acquainted with what is being done in the business world are at once recalled by comments in the present broadsheet.

At the same time, it should be remembered that the adoption of a fact-finding technique by the Civil Service has sometimes been checked or discouraged rather than welcomed. The rebuke administered in the *Times Educational Supplement* to the Board of Education regarding a memorandum compiled by officers of the Board as a basis for discussion on the nation's next moves in educational planning is a recent example. If responsible opinion is to stigmatize such initiative as a grave constitutional novelty it is unlikely, to say the least, that the type of administrator now so urgently needed will be forthcoming.

The truth is that the weaknesses of the Civil Service are due, not to incapacity, but to a group of inhibitions and an absolute conception of government, which must be overthrown by the force of public opinion. That is the first step to securing that the Civil Service recognizes its function in safeguarding and developing the collective inheritance and the social and economic welfare of the nation, as well as that of preserving and assisting to enrich the individual liberties of its citizens. Only public opinion can secure the change from an agenda of public business, determined by external pressures, to one determined by the needs and facts of the situation, based upon thorough intelligence, careful forecasting and continuous analysis of the problems affecting the particular branch of government, and of the best ways of meeting them within the limits of general policy decided by Ministers and approved by Parliament. That change involves a radical alteration in the criteria applied in public administration—a shift in emphasis away from reliance on precedent, consistency and the avoidance of trouble from minority groups, towards action based on a thorough survey of the situation, a sound judgment of its implications and a clear perception of both in the minds of all the officers and departments concerned.

The first main conclusion of the P E P survey, then, is that this new conception of the function of government, with all that it implies for the Civil Service in changes in outlook, organization and methods, and in its relation to Ministers, should be fully and frankly faced. This conception was in fact equally implicit at the recent Conference on Science and World Order, not merely in the session devoted specifically to science and government, but also in those devoted to the relation of science to human needs and to post-war relief. The speeches of Mr. Eden and Mr. Morrison in connexion with the Conference indicate that the Government in Great Britain is now alive to these implications, and scientific workers may well be encouraged by the Conference to further efforts towards the formation of the public opinion essential for Parliamentary support.

From this it follows that the Cabinet secretariat must somehow be permanently strengthened in powers and personnel in co-operation with the departments concerned, to exercise the three functions of planning, personnel management and budgetary control, which are of decisive importance in determining the scope and efficiency of the machinery of government. This involves keeping continuously under review the main strategic conditions affecting government in the economic and social fields, presenting and examining the possible alternative courses, and putting them up for decision in order to elicit from Ministers the necessary directives on policy and priorities affecting groups of departments. The organization would also be responsible for working out with departmental officers the application of such directives to particular circumstances, for seeing that action is taken and for recording and circulating suitably digested information regarding it. Such an organization would not only supply the machinery for central planning and co-ordination ; it would also supply the equally important mechanism for following up and seeing that approved policies are effectively and promptly put into operation.

The same fundamental conclusion regarding the Treasury is reached by the P E P broadsheet as in the Haldane Report. The recommendation that this should become purely the Department of Public Finance and the Budget, with a modernized outlook and methods, is the reflexion of criticism of the traditional attitude of antagonism between the Treasury and other departments. It is a reminder of the comment in the Haldane Report that the obligation of spending departments to formulate a full and reasoned statement of their proposals places upon the Treasury a corresponding obligation not to assume a negative attitude in the first instance towards suggestions for improving the quality of a service or the efficiency of the staff which administers it.

In the same train of thought follows the recommendation that the management and control of personnel matters should be delivered from finance, but the P E P broadsheet goes far beyond the Haldane Committee in recommending the formation of a central personnel office by transfer to a reconstituted Civil Service Commission with a suitably qualified membership, not limited to Civil Servants, of the establishment and office organization function of the Treasury. In political matters this Commission should be directly responsible to the Prime Minister. This step should be taken immediately, even if some of its long-term implications cannot be worked out until after the War.

This and other recommendations, like those for the establishment of a staff college for the higher training of men and women destined for high administrative or executive responsibilities, and the introduction into each department of the organization and techniques necessary for effective forecasting and planning ahead, or again the modification of methods of recruitment, training and grading so as to bring the ablest men rapidly to the top and eliminate the waste of good material, are in harmony with modern scientific administration and the best practice of large-scale industry. So, too, is the suggestion that the scope normally assigned to scientific workers and to technical experts should be enlarged. The broadsheet in fact reflects the essential criticism contained in many recent discussions of the Civil Service.

There can be no doubt that this searching analysis goes to the root of the troubles which have prompted much recent criticism of the Civil Service, fair or unfair. If it seems disappointing to find so little effect has been given to authoritative recommendations formulated more than two decades ago, Emmeline Cohen's book provides an admirable corrective. For all its weaknesses, the British Civil Service is a growing service, adapting itself continuously to changed conditions. The rate of change may lag behind what is desirable, but that can be accelerated by the pressure of public opinion. The suggestions in the P E P broadsheet would go far to secure the greater flexibility required within the Service, the increased mobility between it and the external world, the new conception of the task confronting the Service and the dissemination throughout the Service of a new outlook and new methods. What is required to secure the adoption of such methods and the placing of new men in key positions is the steady pressure of public opinion, in the formation of which scientific workers themselves have an important part to play.

PSYCHOLOGY OF WAR AND CRIME

War and Crime
By Hermann Mannheim. Pp. ix+208. (London: Watts and Co., Ltd., 1941.) 10*s*. 6*d*. net.

The Education of Exceptional Children
Its Challenge to Teachers, Parents and Laymen. By Prof. Arch. O. Heck. (McGraw-Hill Series in Education.) Pp. xviii+536. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 26*s*.

Genius in the Making
By Herbert A. Carroll. (McGraw-Hill Series in Education.) Pp. xi+307. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 19*s*.

IN his latest book, Dr. Mannheim has amplified the course of lectures which he was recently invited to give at the London School of Economics on the relations between war and crime. Formerly professor of criminal law in Berlin and a judge in the German Court of Criminal Appeal, later Leon research fellow and lecturer in criminology in the University of London, he is almost uniquely equipped to discuss the problems he has taken up.

War, as is well known, commonly increases the frequency of certain types of crime, but Dr. Mannheim shows that it may also diminish the frequency of other types, thus in some measure acting as a substitute. This in turn suggests that, from a psychological point of view, war may be regarded as itself a form of crime. He is thus led to examine the various analogies between an unjust war as an anti-social action committed by nations, and an illegal offence as an anti-social action committed by an individual.

Writers who have discussed the origins of war or crime have often advanced, seemingly without recognizing the parallel, much the same causal theories. Lombroso and his followers have put forward a biological explanation of crime; similarly Steinmetz and others have put forward a biological explanation of war, attributing it to the innate aggressiveness possessed by the more vigorous nations that have been brought to the fore in the struggle for survival. Other criminologists have argued that, not heredity but environment, not inborn degeneracy but external poverty, is the main factor in crime; similarly sociologists have argued that the main causes of war are not biological but economic. Finally, psychiatrists have sought to explain both war and crime in terms of whatever psycho-analytic doctrine happened to be in fashion at the moment: the followers of Freud attribute them to the social repression of the common human instincts; in their view, the Œdipus complex, with the love-hatred situations, the consequent defence-mechanisms, and the curious symbolic processes that it involves, will account for the behaviour alike of belligerent nations and of the individual offender; Adler's disciples prefer to trace both war and crime to an inferiority complex, leading, in nations as in individuals, to over-compensation and a morbid desire for power.

Dr. Mannheim has no difficulty in criticizing these one-sided and somewhat speculative theories. As he points out, they are the views of amateurs who have strayed into psychology from other fields of work rather than conclusions reached by scientific psychologists themselves. Those who have investigated the causes of delinquency at first hand have almost unanimously agreed that crime in the individual is due "not to a single universal cause, but to a multiplicity of converging factors, the nature of the factors and of their varying combinations differing widely from one individual to another". In much the same way, Dr. Mannheim concludes that, in war as in crime, not one cause but a number of causes are operative, the causes being different in different cases. From the numerous analogies in respect of causation he draws a practical corollary in regard to remedies: the psychological methods that have proved so successful in the treatment of crime might profitably be adopted to prevent war and to secure peace.

The inferences, as Dr. Mannheim develops them, prove most suggestive. But one principle he perhaps does not sufficiently stress. Recent investigations into the after-careers of criminals treated at psychological clinics and elsewhere, indicate that by far the most hopeful method of reducing crime is to deal, not with the hardened adult, but with the younger generation: the education of the young is at once easier and more effective than the re-education of the old. Moreover, to be successful, methods of education must be adapted more closely to the needs of the individual. Dr. Mannheim himself has shown that it is the exceptional individuals—the highly intelligent, the highly excitable, the relatively phlegmatic and most of all the relatively dull—who most frequently succumb to crime. This suggests that one of the most important items in post-war reconstruction should be an improvement of educational methods in catering more particularly for the exceptional child.

Dr. Heck's book provides an admirable survey of this problem as it arises in the United States. He describes in turn the special needs of those who are handicapped socially, physically and mentally, and of those who are intellectually gifted; and his chapters summarize in considerable detail the existing provision for these children in the cities and States of North America, and reviews the basic principles that emerge from psychological inquiries on the various questions involved.

In Great Britain a long series of psychological researches has been carried out on the mental characteristics and the educational requirements of the mentally subnormal; but little has been done in regard to the intellectually gifted. We have a scholarship system; and the efficiency of scholarship examinations has been subjected to critical investigation. But few British psychologists have attempted a systematic study of the gifted child as such.

Prof. Carroll's book brings together in compact and readable form the results of the work carried out upon this subject, chiefly in the United States. Many of the conclusions that he cites as fairly well established are still insufficiently appreciated in Great Britain. Prof. Carroll shows, for example, that high ability is nearly always recognizable in childhood: the exceptions so commonly cited are not enough to invalidate the rule. At the same time, eminence in later life is not determined by intelligence alone. Among the intrinsic factors, he lays most stress on temperamental qualities: "ambition" (in the sense of a determination to become eminent), "drive" (in the sense of emotional energy), "singleness of purpose", "fluency" (especially in speaking or writing), and finally emotional and moral stability. Physical factors, such as appearance, size and health, often play a contributory and sometimes an undue part. The popular notion that the genius is an unhealthy weakling, an unsociable recluse, a misfit who cannot get on with others, and so ill-balanced in character as to verge on actual insanity—all this, though widely held, is shown to be derived from an unfair selection of rare but sensational cases. Among extrinsic factors, Prof. Carroll lays greatest stress on the economic status of the child's family, on the competition which the budding genius meets as he grows older, and finally on a congenial marriage. But here it is necessary to remember that social and environmental conditions may operate very differently in Great Britain and in the United States.

On all these problems there is an urgent need for further psychological research; and such investigations should unquestionably form part of present preparations for post-war reconstruction.

A DICTIONARY OF PHOTOGRAPHY

Wall's Dictionary of Photography: and Reference Book for Amateur and Professional Photographers.

Edited by F. J. Mortimer. Sixteenth edition, revised and largely re-written by A. L. M. Sowerby. Pp. v+701. (London: Iliffe and Sons, Ltd., 1941.) 12*s*. 6*d*. net.

The first edition of this book was published in 1889, since when a great deal has happened in the world of photography, and the size of the "Dictionary of Photography" has increased accordingly. The sixteenth edition, as mentioned in the preface, has been published largely because of the unexpectedly rapid exhaustion of the previous edition; but the opportunity has been taken to correct errors and generally bring the subject matter up to date, though relatively little advance has been made during the interval.

The book is essentially a reference book for the amateur and professional photographer, and is confined mainly to the theoretical principles and practical details of all generally used photographic processes. Sufficient details are in most cases given to enable the photographically minded reader to grasp the mechanism of processes, such as those of colour photography, and sufficient working details, including formulæ, to enable anyone experienced in the technique of general photography to carry them out. The physicist or chemist interested in photography will find the book extremely useful from the practical point of view, but will naturally be disappointed in many cases in the superficiality of the theoretical treatment.

It is not possible to mention all the alterations and additions that have been made since the previous edition, but the following are the most striking examples. The section on "Aerial Photography" includes an account, chiefly of topical interest, of the present technique used by the Royal Air Force. The section on "Photoelectric Exposure Meters" has been improved considerably by including a sub-section on the use of the meter, relating to the method of directing the meter towards the subject and thereby assessing the value of the 'subject' and 'light intensity' factors. It is unfortunate that no mention is made of the

Smethurst high-light meter, which has certain advantages over the more usual type of meter, especially when dealing with reversal processes, and most particularly reversal colour processes, where accuracy of exposure is of first importance. The section on "Latent Image" has been re-written to include a very brief account of the Gurney-Mott theory. It is, of course, impossible to convey even an impression of the scope of the theory in the ten lines devoted to it, and it is interesting to note that in the first edition of the Dictionary nearly a page was devoted to the theory current at the time based on the formation of a sub-halide.

As a reference book the "Dictionary of Photography" will be found extremely valuable to the general photographer, though its value might be further increased by the inclusion of more references to fuller accounts of processes and theories which, owing to limitation of space, cannot be dealt with adequately in a volume of this size. It is always difficult to discover omissions, but there appear to be few, with the exception of 'reciprocity' and 'intermittency' failure, which do not seem even to be mentioned. Surely reciprocity failure, which can manifest itself under certain conditions in ordinary photography, is worthy of mention !

APPLICATIONS OF ELASTICITY IN ENGINEERING

Theory of Plates and Shells

By Prof. S. Timoshenko. (Engineering Societies Monographs.) Pp. xii+492. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 42*s*.

PROF. TIMOSHENKO is one of the outstanding exponents of the mathematical theory of elasticity and of the application of this theory to a variety of practical problems. He has written on these topics for thirty years, and his books have become indispensable to every engineer who has to apply mathematical principles and methods to such problems.

As is so often the case, mathematical theory becomes very much simplified when approximation becomes possible, and as indicated by the title of the present book, Prof. Timoshenko discusses here the theory of elasticity as applied to problems of two dimensions, that is, to problems in which the thickness of a plate or shell can be neglected in comparison with the other dimensions.

The importance of this type of problem in practical application is too obvious to need elaboration. The hulls of ships, the walls of tanks, the domes of buildings, the boilers in engines of all kinds, and above all the vitally important light structures that can withstand great pressures necessary for the development of modern transport, particularly in aeronautics and especially in air-fighting—all these topics represent problems that come within the purview of the present book.

The development of the topics discussed in the book is in itself an interesting picture of the evolution of an engineering structure. The author begins by dealing with the bending of plates into cylindrical forms and the symmetrical bending of circular plates. The boiler or container or aeroplane fuselage begins to appear. The study of supported rectangular plates with various edge conditions portrays the placing of a structure into position. Finally, the study of shells as cylinders and as surfaces of revolution takes us into the more detailed applications to daily needs.

The author devotes only moderate attention to general theory, but deals in considerable detail with a number of definite problems which are of special importance. The mathematical treatment is very full and exhaustive, but is always clear and easy to follow. What adds greatly to the value of the book is the fact that the mathematical solutions obtained are not left in their general form, but are discussed both graphically and numerically, so that the engineer who is not a professional mathematician is shown exactly how to use the mathematical methods practically and how to get the results that he needs for his professional purposes.

At a time when the main attention of humanity is directed towards the epic struggle which is taking place in Russia, it is naturally of interest to see how Russian thought and research have contributed to general human progress. The thick and high wall of prejudice and hostility, due to mistakes and intolerance on both sides, that was set up after the War of 1914–18 between the Soviet Republics and the Western democracies, had the effect of blocking the current of scientific influence between the Russians and the world outside. But Russian science and technology, as well as Russian thought and literature, have meanwhile made great strides, and the breaking down of the wall by recent events can lead to results of great advantage to all. Prof. Timoshenko has been working in the United States for many years, but he began his important contributions to the literature of mathematical methods applied to mechanics and engineering in the Russian language nearly thirty years ago. It is a pleasure to welcome his latest book in English as a further contribution from his competent pen to this important subject.

S. BRODETSKY.

RELATIVE NUTRITIVE VALUE OF DIFFERENT FORMS OF MILK

By Dr. S. K. Kon

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RECENT Government pronouncements make it clear that during the forthcoming winter there may not be enough fresh milk to go round in Great Britain, and that priority for this milk will be given to certain classes of the population, such as expectant mothers and infants. Adult consumers will receive as part of their national basic share, in addition to liquid, also some concentrated form of milk.

A brief account of the relative nutritive properties of milk in its different forms may hence be timely.

It should be realized at the outset that, from the point of view of nutritive value, milk is a variable food. Though its 'major' constituents, protein, fat, carbohydrate and ash, change but little throughout the year, some of its vitamins are subject to marked fluctuations according to the season and the nutrition of the cow. Unless this is understood, any comparison of separate types of milk of different origin would be clearly misleading, especially as concentrated forms of milk are manufacted mostly in summer and early autumn.

The importance of milk in human nutrition rests primarily on its content of first-class animal protein of high biological value, its exceptional richness in calcium, and its valuable contribution of vitamin A and of riboflavin and other water-soluble vitamins. It is generally agreed that even in peacetime, when all foods are plentiful, it is difficult to plan an adequate diet without the use of milk or milk products, and with war-time limitations this is an admitted impossibility. The unique value of milk for children, adolescents, pregnant and lactating women is now universally recognized.

With the development of our knowledge of vitamins and of methods for their accurate estimation much work has been done on the effects of commercial processing on the food value of milk, and it may be said broadly that these have proved much less drastic than was formerly believed. The idea that raw cow's milk possesses unique nutritive properties which are lost if it is exposed to any form of heat treatment is certainly not supported by the bulk of modern evidence. Losses undoubtedly occur ; some are avoidable and should be prevented, others can be made good by intelligent planning of the diet.

Of the milk constituents the proteins and certain vitamins are most liable to heat injury and the extent to which this takes place can best be judged by taking raw fresh liquid milk as a base line. Typical analytical figures are given in the accompanying table, and little comment is needed on the 'major' constituents. It is probably superfluous to remind the reader that the quantity of fat varies markedly according to breed, and that the Channel Island breeds produce milk especially rich in this respect. The proteins of milk consist of casein, lactalbumin and lactoglobulin, which are almost completely digestible, and have a high biological

COMPOSITION OF DIFFERENT FORMS OF MILK[1]

Form of Milk	Calories per 100 gm.	Grams per 100 gm.					Vitamin A[2] activity		Vitamin D[2]		Vitamin B_1		Riboflavin[2]		Vitamin C[3]	
		Water	Protein (N. × 6·38)	Fat	Carbohydrate	Calcium	I.U. per 100 gm.	loss in manufacture	I.U. per 100 gm.	loss in manufacture	I.U. per 100 gm.	loss in manufacture	mgm. per 100 gm.	loss in manufacture	mgm. per 100 gm.	loss in manufacture
Raw	66	87·6	3·3	3·6	4·7	0·120	70–200	—	0·5–3·0	—	12	—	0·1–0·2	—	0–2·5	—
Pasteurized...	66	87·6	3·3	3·6	4·7	0·120	70–200	None	0·5–3·0	None	11	10%	0·1–0·2	None	0–2·0	20%
Sterilized ...	66	87·6	3·3	3·6	4·7	0·120	70–200	None	0·5–3·0	None	8	30%	0·1–0·2	None	0–1·2	50%
Spray dried whole ...	512	3·0	25·0	27·5	37·5	0·910	550–1600	None	3·9–23	None	85	10%	0·8–1·6	None	0–16	20%
Roller dried whole ...	512	3·0	25·0	27·5	37·5	0·910	550–1600	None	3·9–23	None	80	15%	0·8–1·6	None	0–13	30%
Dried skim ...	357	4·0	36·0	0·5	50·0	1·250	Trace	Most	None	All	115	10%	1·2–2·4	None	0–20	30%
Condensed whole—unsweetened (evaporated)[4]	169	68·5	8·4	9·2	12·0	0·300	180–500	None	1·3–7·6	None	18	40%	0·25–0·5	None	0–2·5	60%
Condensed whole—unsweetened (evaporated)[5]	144	73·0	7·0	8·0	10·0	0·260	150–430	None	1·1–6·5	None	16	40%	0·22–0·44	None	0–2·2	60%
Condensed whole—sweetened ...	344	25·0	8·8	9·5	53·5	0·325	190–530	None	1·4–8·1	None	29	10%	0·27–0·54	None	0–5·7	15%

[1] The composition varies from sample to sample ; the figures given in the table may be taken as representative.
[2] Varies according to season.
[3] Varies according to the handling of the liquid milk.
[4] Product hitherto made in Great Britain in accordance with 1923 Condensed Milk Regulations.
[5] Suggested composition for product manufactured in accordance with the recently reduced standards (Condensed Milk Order, 1940) and corresponding with U.S.A. Standards.

value, that is, they can be efficiently utilized to build or replace body protein. As judged by animal experiments, this efficiency may reach some 90 per cent for raw milk.

Regarding the so-called 'minor' (on a weight basis) constituents, milk is a rich source of vitamin A, which is partly present as the provitamin, β-carotene. It is well known that milk produced on pasture is much yellower and also contains more vitamin A than milk of stall-fed cows. Under south of England conditions milk is high in vitamin A from May until November or December, when it contains some 150–200 I.U. per 100 ml., and low during the rest of the year, when the concentration drops to about half this quantity. Vitamin D, of which there is little in milk, also varies with the season, but normally it depends not on the feed, but on the direct action of the sun on the cow. There is a steep peak, therefore, around the summer solstice, which drops away sharply on either side. In May, June, July and August there are about 2·5 I.U. of vitamin D in 100 ml. of milk; during the rest of the year the content falls to one half to one fourth or even less of this figure.

Of the water-soluble vitamins riboflavin is richly represented in milk, which contains some 100 μgm. per 100 ml. during the stall-feeding period, and 150–200 μgm. when the cows are on pasture.

The vitamin C content of milk varies but little throughout the year, and is independent of the feed of the cow. The amount present in milk as it leaves the udder is appreciable, 2·0–2·5 mgm. (40–50 I.U.) per 100 ml.; one pint of such milk would supply one quarter to one third of the daily requirements of a child. Vitamin C is, however, easily destroyed in milk by exposure to light; it is at first converted into a labile form, dehydroascorbic acid, which in turn decomposes spontaneously or under the action of heat. For this reason commercial milk generally contains only a fraction of the vitamin C originally present. In any event, care should be exercised not to expose bottled milk unnecessarily to bright light.

The level of vitamin B_1 in milk is also independent of the feed, and remains constant during the year at about 12–15 I.U. per 100 ml.

Several other vitamins belonging to the vitamin B complex are also present in milk. Some of them, like nicotinic acid and vitamin B_6 are heat-stable, and are not likely to be affected by processing; the fate of others has not yet been sufficiently studied.

Milk should not be consumed raw unless it is established that it is bacteriologically safe. Rapidly brought to the boil to ensure freedom from infection, it loses little or nothing of its nutritive properties. A large part of the commercial supply of milk in Great Britain is now pasteurized by the holder method. It has been satisfactorily established that the only nutritive effects of this treatment are a loss of some 20 per cent in the vitamin C content (and this due, rather, to previous exposure to light than to heating in the course of pasteurization), and a 10 per cent decrease in the vitamin B_1 value.

In certain towns in the Midlands, such as Birmingham, and also in London, there is a demand for yet another form of liquid milk—sterilized milk. Though there is no legal definition of what sterilized milk is, it is customary to apply this term to milk which has been heated to at least 212° F. (and generally higher) for varying lengths of time. This product, usually sold in swing-stoppered bottles, has the advantage of keeping for long periods of time, and is also liked because of its 'richer' taste. Before the War it was being increasingly used in infant feeding. The drastic heat treatment to which the milk is exposed in the process of sterilization brings about a loss of some 50 per cent of the vitamin C and of about 30 per cent of the vitamin B_1 originally present. The biological value of the proteins is also slightly decreased—by about 6 per cent. There is no evidence of nutritive impairment of other constituents. Sterilized milk remains, therefore, a most valuable foodstuff, though it is not the equivalent of raw or pasteurized milk, and its shortcomings for infants and children must be recognized and repaired by the addition of necessary supplements.

The stable, concentrated forms of milk are, broadly speaking, prepared in three different ways. The moisture may be removed as completely as possible, giving dried milk powder; or it is only partly removed, and the condensed milk is either sterilized by heat treatment to ensure bacteriological purity or enough sugar is added in the process of manufacture to inhibit bacterial growth. All three methods in various modifications are applied to separated as well as to full-cream milk.

Most of the 'major' and some of the important 'minor' constituents of milk are relatively stable, and these are not affected by the various commercial processes. Thus, vitamin A and carotene, vitamin D and riboflavin survive the various methods of preservation of milk without appreciable loss. Other more labile factors suffer to a greater or lesser extent, according to the severity of the treatments.

Of these treatments drying by modern methods is generally quite mild in its effects. Spray-drying consists in principle in forcing an exceedingly fine spray of milk into a heated chamber, where it dries almost instantaneously. Spray-dried milk is nearly completely soluble in water, and 'reconstitutes' readily. In drying, it loses about 20 per cent of the vitamin C present in the raw milk and one tenth of the vitamin B_1. The proteins are only very slightly affected, and the 'biological value' is decreased by probably not more than 5 per cent. The significance of such loss may be trivial, as in a mixed diet the various proteins supplement each other, and the biological value of the mixture need not necessarily change. The availability of the minerals of milk, and especially of the valuable calcium it contains, is not affected by the heat treatment. It is clear, therefore, that spray-dried milk retains to a remarkable extent the nutritive qualities of the fresh product.

Another method of drying consists in rapidly dehydrating a thin film of milk on steam-heated revolving metal cylinders, from which it is removed by means of a stationary scraper. First-quality roller-dried milk is, from a nutritional point of view, only slightly inferior to the best spray-dried product, though its solubility in water is generally lower. As a rule, the loss in vitamin C is slightly higher, nearer 30 per cent, and the deterioration of the proteins is rather more noticeable. In some less satisfactory samples up to one third of the vitamin B_1 may be lost. Occasionally spray- or roller-dried milk is encountered in which the losses in vitamin C are much more severe than those just quoted. This is largely due to the practice obtaining in some factories of mixing the bulked milk before drying by bubbling air through it. Full-dream dried milks keep quite well when properly packed in hermetically sealed containers. They ceteriorate, however, on exposure to the air.

Cream has proverbially been considered as the most valuable part of milk, and milk from which the fat had been removed has borne a stigma of inferiority. Even now, when the full food value of milk is much better understood, there is still widespread prejudice against the use of skim milk in human nutrition. In the liquid state it was seldom used for this purpose in Great Britain before the War. Dried, it went into consumption concealed in bakery goods, ice cream, confectioneries and breakfast cereals. Even in the United States, where its use as human food is much more widespread than in Great Britain, some 40 per cent of the dry skim milk was used as animal fodder. Yet, when its limitations are properly understood, it is a most valuable food. The absence of fat and of vitamins A and D make it totally unsuitable as a food for babies, and in Great Britain it must be clearly labelled to this effect. All the other important constituents of milk remain, however, unimpaired, and for that matter, proportionally increased at the expense of the missing fat. The high content of animal protein, calcium and riboflavin makes skim milk a most valuable addition to war-time dietaries. Vitamin C and vitamin B_1 are higher than in full-cream milk, and the important, though less well-defined other members of the vitamin B complex are also there in relatively increased amounts. If protected from moisture, dried skim milk keeps almost indefinitely and without need for special packing. Relative cheapness and ease of transport emphasize its value in war-time, and it is to be hoped that as much of it as possible will be made available for general consumption.

Of the milk products from which water is only partly removed, unsweetened condensed milk, generally known as evaporated, is exposed to the more drastic heat treatment. The concentration itself is carried out *in vacuo* at low temperature, but the milk is then placed in tins which are sealed and sterilized by heat at a temperature of 240° F. This exerts noticeable effects on the more labile components. Some 60 per cent of the vitamin C, and 30–50 per cent of the vitamin B_1, are lost. The digestibility and biological value of the proteins decrease slightly but unmistakably. Other factors, so far as is known, remain unimpaired, and the good record of evaporated milk in the feeding of infants and children shows that when its known defects are remedied it remains a food of outstanding value.

Sweetened condensed milk is not exposed to temperatures above the boiling-point of water, and frequently the maximum temperature is well below this. Sugar, which is added before condensing, reaches a final concentration of about 40 per cent and effectively prevents the growth of micro-organisms. In up-to-date sweetened condensed milk the losses of nutrients are quite small. Thus, a good specimen may contain only 15 per cent less vitamin C, and 5–10 per cent less vitamin B_1 than were originally present in an equivalent quantity of the fresh milk before manufacture.

In assessing the food value of different types of milk it should be remembered that dried milks are concentrated about $7\frac{1}{2}$–$7\frac{3}{4}$ times in comparison with fresh milk, and unsweetened condensed milk about $2\frac{3}{4}$ times. Hence, the amount of milk solids varies in the different products, but the composition of these solids remains the same. It is altered, however, in sweetened condensed milk by the presence of large amounts of sugar, and this type of milk is richer in total solids than evaporated (unsweetened condensed) milk, though the concentration of the milk solids is roughly the same in both. Such assessments show that the alternative forms of milk which may be offered to the adult population will be perfectly satisfactory from a nutritional point of view, even though their use may entail some readjustment of established food habits. The essential point is to ensure the maximum possible supply of milk in any form for adults, and to reserve a full quota of liquid milk for children and expectant and lactating mothers.

J. A. KOMENSKÝ (COMENIUS), 1592-1670

By Dr. Gerald Druce

THREE hundred years ago there arrived in England a Czech exile, Jan Amos Komenský, better known by the Latinized form of his name, Comenius. This refugee from an earlier persecution of his nation came at the invitation of Parliament in order to lay before contemporary men of learning his views on education and the organization of science in the service of mankind. It was, therefore, appropriate that the tercentenary of Comenius's visit was commemorated at Cambridge on October 24.

Convened by Dr. Joseph Needham and under the presidency of the vice-chancellor, Dr. J. A. Venn, the meeting was attended by representatives of the U.S.S.R., Holland, Poland and Sweden, as well as by Czechoslovak and British men of science and learning. Papers were read by President Beneš ("Comenius' Plans for Peace Leagues and his Place in History as a Great European"), Mr. J. L. Paton ("Comenius as an Educational Pioneer"), Prof. J. D. Bernal ("Comenius' 'Pansophic College' and the Rise of Scientific Societies in the 17th Century") and Prof. E. Barker ("The Debt of Europe to Czechoslovakia and to Comenius"). Others present also paid tribute to the personality and achievements of the great Czechoslovak pioneer (see Nature of November 1, p. 518).

Born of Protestant parents at Uherský Brod, Moravia, in 1592, Comenius had a local schooling which was followed by residence at Herborn, a Calvinist academy in Nassau. Before returning home he visited Amsterdam and Heidelberg. He became a teacher in 1614 and in 1618–19 he was headmaster of a school at Fulnek in north Moravia. These were critical years in Czech history, parallel with 1938–39. Disaster followed, Bohemia lost its independence and persecution set in. Comenius first moved to the estates of Charles of Žerotīn, in east Bohemia, not far from the frontier over which he escaped to Leszno, in Poland, in 1627. Here he started a very successful secondary school for the Czech colony in this part of Poland.

He was also able to print tracts and works that he had written earlier. In 1622 he had completed the first accurate map of Moravia. Then came his "Labyrint Světa a Raj Srdce" (Labyrinth of the World and the Paradise of the Heart), an allegory written in an endeavour to escape from mental depression during anxious years. It describes a pilgrimage to an imaginary city, a method that the author adopted to direct attention to the social injustices, cruelty and dishonesty of his time. Remedies are suggested, and the consequences likely to follow, if the evils are allowed to continue, are foreshadowed.

At Leszno Comenius produced a new type of Latin grammar, "Janua Linguarum Reserata" (1631). Its plan was to impart, as well as Latin, useful general knowledge concerning everyday life and simple science. Instead of giving grammatical rules and exceptions, Comenius's method was to begin with simple phrases and gradually progress to complex sentences. The method was very successful and the "Janua" was translated into twelve European and four Asiatic languages. Some thirty of its sections are devoted to natural history, sixteen to arts and crafts (gardening included), twenty to learning and culture, five to social affairs, ten to ethics, eleven to politics and six to religion.

Comenius began to formulate his pansophic plans as a student at Herborn under the influence of J. H. Alsted. He printed the first part of his "Great Didactic" at Leszno in 1627 under the title, "Didaktika čili umění umělého vyučovaní" (Didactics or the Art of Teaching), with a supplement relating to the establishment of schools in Bohemia when victory came. Though Comenius probably obtained some of his ideas from Alsted and from J. V. Andreæ (whom he met at Heidelberg) and was also influenced by the works of Francis Bacon, the comprehensive conception of this educational scheme was his own and shows how much he was in advance of the times. That he possessed modern notions of the purpose and methods of education, to develop intelligence and to impart real knowledge and to maintain a progress from the known to the unknown, is apparent from the earliest edition of this work, which reached its final form and appeared in Latin as "Didactica Opera Omnia" (Amsterdam, 1657).

Comenius divided schooling into four grades: (1) In the family up to six years of age. (2) In the mother-tongue (primary) school from six to twelve. (3) In the higher (grammar) school from twelve to eighteen. (4) At the university after eighteen.

This system of education was to be available to all children without regard to station or sex, but higher education was to be based only upon merit. At school Comenius had been taught one subject, Latin, and that badly. He lamented that much useful knowledge was never taught or new discoveries (for example, those of Copernicus) even mentioned. Therefore, in his mother-school curriculum he included observations on common objects and phenomena in most of the sciences. He claimed that in his first six years even, a boy can be brought to know something of water, earth, air, fire, rain, snow, frost, stone, metals, trees, plants, birds, fishes, etc. He can learn something of his own body and so be ready for systematic science at the grammar school. Comenius applies the same reasoning to his method of introducing the pupil to optics, astronomy, geography, history and mathematics and mechanics.

According to Comenius, the training to be completed at the university should be really universal and include every branch of knowledge. Positions of honour should be given only to those who have completed their university course and shown themselves fit to be entrusted with the management of affairs. For this final stage of education Comenius aimed at a compilation of all established facts from every branch of the sciences. The first part was published at Leipzig in 1633 under the title, "Physicæ at lumen divinum reformatæ synopsis". It included contemporary alchemy, cosmology, astronomy and anthropology, while current superstitions were not excluded. This work, in which Comenius emphasized the unity of all knowledge, was eventually translated into English by John Dury (1651). But the pansophic plans of Comenius became known here much earlier through Samuel Hartlib, a Pole from Elbing, who spent much time in England. Hartlib published two tracts, "Prāeludia conatuum pansophicorum Comenii" (Oxford, 1637) and an "Essay towards Compleat Wisdom" (London, 1639), so that the ground was prepared for Comenius to come to England. He was now widely known in Europe—and indeed in the New World, for there is a legend that he was invited to Harvard, and certainly his advice was sought concerning the education of American Indians, a matter in which Robert Boyle also was interested.

Comenius arrived in England in September 1641, and became acquainted with the leading men of learning, including Bishop Williams of Lincoln (later Archbishop of York and a great patron of science), Lord Brooke, John Pell, Theodor Haak, Sir Cheney Culpeper, Robert Boyle and John Selden, all of whom showed an interest in his plans. They discussed schemes for establishing an international academy or pansophic college (three sites were considered) which was to be "a living laboratory supplying sap, vitality and strength to all". The work of compiling a comprehensive encyclopædia of science was to be conducted by a number of specialists and assistants working under Comenius's direction.

At first there seemed every prospect of success, but the outbreak of the Civil War in 1642 caused the scheme to be abandoned, and Comenius returned to the Continent. It would, however, be incorrect to suppose that Comenius's visit had been in vain. His views and objects had been well received and he continued to correspond with Hartlib, Boyle, Dury and others. When the Royal Society was founded in 1662, Comenius was overjoyed and hastened to dedicate his "Via lucis" to the fellows, whom he addressed as "the torchbearers of this enlightened age", especially urging them not to neglect metaphysics. It may be pointed out that the expression "Invisible College", applied to the periodical meetings of those who later founded the Royal Society, may have originated from Comenius's reference to the projected pansophic academy as a "Collegium Lucis".

After further visits to Sweden, Poland and Hungary, Comenius eventually settled in Holland, writing alternately educational and pansophic works. Besides his country's persecutors he had philosophical adversaries. Thus, Descartes criticized his works on the ground that he mixed theology with philosophy. This refers, no doubt, to the fact that since 1631 Comenius had been a bishop of the "Unitas Fratrum", or Bohemian Brethren. Others contended that he attempted to spread Calvinism under the cloak of pansophy, while Samuel Desmarets, a Dutch contemporary, went so far as to describe him as "a mystical beggar with a commercial instinct". Comenius replied to these unfair charges by further explanations of his pansophic principles. His intention was to organize knowledge and apply it for the moral and material benefit of his fellow-Europeans.

The Thirty Years' War came to an end in 1648 when the exhausted belligerents signed the Peace of Westphalia. The terms left the kingdom of Bohemia (which included Moravia) in the hands of her enemies. For this Comenius bitterly reproached Oxenstiern, the Swedish plenipotentiary, who had promised that Bohemia would not be forgotten. But if he had lost his fatherland, Comenius found that he had become a citizen of the world. To his Czech compatriots he addressed a "Last Testament of a Dying Mother" (Kšaft umírající matky Jednoty bratrské) in which he made his famous prophecy, "I believe that, after the tempest of God's wrath . . . shall have passed, the rule of thy country will again return unto thee, O Czech people".

It was in these circumstances, too, that he wrote ("Panegersia"), "We are all fellow-citizens of one world, all of one blood, all of us human beings. Before our eyes there is only one aim—the good of humanity". The claim to regard Comenius as a great European can also be illustrated from his "Angelus Pacis" (Amsterdam, 1667), addressed to English and Dutch plenipotentiaries, which contains a plea to all nations to abandon war and establish courts of peace for international consultations and the direction of human affairs. Whether a pansophic academy would have achieved the objects that Comenius had in view may be doubted. He was in advance of his age, and, apart from the far-seeing savants who founded the Royal Society, there were few who showed enthusiasm for his projects. No one on the Continent was prepared to do more than support the printing of his books and, indeed, it is only in modern times that international organizations have begun to function.

G. W. Leibniz (1642–1716), who was of Slav origin, showed a sympathetic interest in Comenius and assimilated his ideas regarding encyclopædic compilations and scientific societies, restating them and implementing them as completely as the unsettled state of Europe allowed.

Nor were Comenius's educational endeavours to meet with immediate success. He was a realist at a time when his contemporaries still learned their natural history from Aristotle and Pliny. Problems were 'settled' by reference to the writings of the authorities even after Comenius had asked, "Do not we ourselves dwell in the garden of Nature as well as the ancients ? Why should not we use our eyes, ears and noses as well as they ? Why should we need other teachers than these our own senses ? Let the children touch, feel, see, hear and find out by experiment for themselves, draw the object, measure it and understand it".

To generations of his own countrymen Comenius has served as an inspiring example. They named the new University of Bratislava and also the Czechoslovak secondary school in Vienna after him. His energy and fortitude can serve to-day as a stimulus to us all to continue steadfastly working for those same ideals which we know to be true.

The papers read at the Cambridge tercentenary meeting are to be made available in a permanent form. Other recent works on the life and activities of Comenius are the following: "Comenius in England" by Dr. R. F. Young (Oxford University Press, 1932) ; "Comenius and the Red Indians of New England" by Dr. R. F. Young (1929) ; "Comenius" by W. M. Keatinge (McGraw Hill, 1931) ; and "Johannes Amos Comenius" by Dr. J. Jakubec (Orbis, Prague, 1928). Prof. R. J. Kerner's "Czechoslovakia" (University of California Press, 1940) also contains references to Comenius.

SCIENTIFIC KNOWLEDGE AND ACTION*

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

IN the study of man and his activities three types of cultural development may be recognized ; and they are all measured by different standards. In the fine arts the imaginative qualities of the mind appeal primarily to the emotions through stimulation of the æsthetic judgment ; material culture is the province of the industrial arts ; and science—the domain of reason—is systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political.

Natural science, or natural philosophy, is only one division of science as thus defined, yet, in general usage, the single word 'science' signifies verifiable knowledge acquired by observation and experiment. The history of civilization from this point of view is a history of intellectual development in which science has been the chief factor in changing habits of thought from superficial observation and magical theories of causation to clear concepts, rational conclusions, and progressive principles in the advancement of man and society.

It is common in these days to think of progress in terms of material development and to leave out of consideration the contacts of science with what is known as 'polite' learning—literature, religion, and other expressions of the human spirit. The noblest works of man are not, however, represented by great industrial advances, but by the search for the truths upon which they are based, and by the influence of this effort upon personal and social ethics.

In the pursuit of natural knowledge, the common object is to solve problems of life and thought; and all additions to knowledge thus gained contribute to the world's store, whether they admit of immediate practical application or are deposited in the archives of science for safe keeping. There can be scientific knowledge without action, and action without scientific knowledge ; and the two are combined in applied science for practical service. There are, however, many aspects of Nature

* From the Hinchley Memorial Lecture delivered before the Institution of Chemical Engineers on October 24.

which appeal to the human mind, in addition to those in which usefulness is the measure of achievement. Purely scientific studies may claim to represent this attitude towards knowledge for its own sake and to be responses to a stimulus more exalted than that derived solely from material aims. So long as this spirit prevails, the influence of the high ideals of truth-seeking associated with scientific research will be extended : without them, science becomes a business in which the highest attributes and needs of human nature take no part.

Concepts of natural causes and phenomena must change with increased insight and inquiry, whether the interpretations represented by them are myths or scientific theories. Science asks for no faith in theories, except as reasonable explanations based upon verifiable observations, or as suggestive schemes which may or may not be found true when tested by further knowledge. Its duty is to observe with open eye and unprejudiced mind the picture presented by Nature, and to get nearer and nearer to the view. No loss of the sense of beauty need be involved in the analysis of the details which create the picture. The scientific mind is not satisfied with distant views and is critical of itself and its conclusions. It must, however, record faithfully what it perceives, knowing that the value of the record will be measured by its approach to permanent truth. True to Nature is the highest tribute that can be paid to a scientific testimony, as it is also to reflexions of Nature expressed in art and literature.

Observations carefully made and precisely recorded may be used or explained in various ways, but they are part of the permanent structure of natural knowledge. Whether undertaken with direct practical service in mind, or purely in the spirit of interest in natural objects and processes, is unimportant in comparison with the perception they afford of natural truths. In this respect, all who contribute to the store of verifiable knowledge increase the useful and the intellectual heritages of the human race.

Man is, indeed, more than an animal needing food and shelter and other essential means of existence : he seeks also to understand the nature and meaning of these things, usually with the view of deriving advantage for himself and for others from his discoveries, but often also with the desire to satisfy his curiosity in the object and operations of Nature. The common aim is to obtain information by inquiry and experience, though the motive in one type of observer is application of the knowledge gained, while in the other it is to explore the unknown and explain the mysterious. The standard of value of one is use and of the other intellectual satisfaction ; and the difference between the two is that between practical service and philosophy.

The discovery that certain natural events were repeated in orderly succession, and that their reoccurrence could be predicted, was a practical generalization from systematic observations, and revealed, therefore, a natural truth or law. If a generalization is well founded, it remains true independently of speculations as to the powers or causes which create and control the natural phenomena observed.

At all times, Nature has created wonder in the human mind as well as the desire to use and understand the proximate or ultimate causes of what is perceived by the senses. Knowledge of natural properties and effects was first acquired to supply needs of the body, and their interpretation as influences of spirits in the empyrean had mystery as its basis. The separation of the study of Nature from that of personal deities may be said to have begun with the Greeks. In the sixth century before the Christian era, Thales, Xenophanes and Pythagoras first opened up those veins of speculative philosophy which occupied afterwards so large a part of Greek intellectual energy. It is in their philosophies that the idea of an impersonal Nature was considered as a subject of study apart from mythical conceptions. They defined the scope of natural philosophy with its objective character and invariable laws, discoverable by the exercise of human intellect, and they first used the word *phusis*, signifying Nature and surviving in the words physics, physiology, physiography, and similar derivatives, to distinguish such studies from theology.

When early Greek philosophers began to speculate upon the nature of the universe and the meaning of life they introduced the spirit of liberty of thought in inquiring into all things—sacred, social or political—independent of authority, and thus established the principle of intellectual freedom essential for the advance of science, art, literature, or any other aspect of civilized culture. Many of their speculations were crude in the light of modern knowledge, but they all represented attempts to apply reason to the problems presented to human senses, and some have proved to be of fundamental significance. The particular contributions of the Greeks were not in the technical arts and crafts, or in knowledge gained by observation and experiment, but in generalized thinking about universals. Their characteristic was creative thought and theory on intellectual planes as far removed from needs of the body as mind is apart from matter. They used knowledge of natural properties and processes, acquired by observers and craftsmen before the classical period, not as useful applications of science but to construct philosophic systems which were logically sound and therefore required no other proof. It was believed that truth in Nature could be revealed by abstract thought, without the slow and laborious process of learning by experience what things or circumstances in earth or sky could be applied to useful human service. Passive contemplation has an appearance of dignity not usually associated with the active exercise of either hands or brain.

When manual work of any kind began to be regarded as a menial occupation, and meditation became the characteristic of a higher social class, a distinction was created between useful knowledge and academic or philosophic thought. Pure science has thus come to mean natural knowledge acquired for itself alone, and studies without particular useful purposes in mind. Similarly, a pure chemist is said to be one whose active interests are confined to chemistry, while a pure biologist has physical life as his field of study. The word 'pure' used in this sense is objectionable for several reasons. Chemistry and biology, like other sciences, cannot be sharply separated from the main body of natural knowledge, but often merge into one another and lead to new productive branches, so that pure biochemists come into being, and members of the families of physics and chemistry, long separated by verbal distinctions, unite to produce the fertile line of physical chemists.

In general, however, it may be said that the main distinction between pure and applied science arises from exclusive attention to theory and practice respectively. Applied science is concerned directly with theory only as a generalization or principle which relates natural causes to consequences and enables new effects to be predicted. It is based upon observation, and its aim is the production of new agents or powers for the service of man. In most scientific societies, the passport to publication in their records is obtained by observational inquiry of a practical kind or original conceptions suggested by them. In their pursuit of natural knowledge by methods of observation and experiment, independent adventurers and practical prospectors meet on common ground, whether the purpose of inquiry is knowledge itself or its application.

In one of his aphorisms, Francis Bacon said that "All knowledge should be referred to use and action". On this narrow view, the value of scientific work is measured in terms of application to human service, without consideration of the dignity of knowledge and the intellectual aspiration to attain it. It is true that the main object of Bacon's new philosophy was to enlarge the dominion of man by increasing his knowledge and control of operations of Nature; and in this sense the standard of scientific achievement is service. Whether his philosophy was limited to this outlook is, however, unimportant in comparison with his advocacy of independent observations of natural operations and events, and legitimate inferences from them, free from prejudice and to be judged only by their faithfulness to natural truth. Whatever views may be held as to the inter relationships between science and society, civilized life is shaped by the uses to which scientific discoveries are put; and the spirit and method of scientific inquiry are now accepted as essential principles in the pursuit of truth through verifiable evidence of any kind.

Theories based upon such evidence are mental models of structures and actions for use as stepping-stones to further knowledge, and they have to be modified or discarded when they fail to satisfy crucial tests of their validity. Most natural philosophers are content to base their understanding of Nature upon the solid ground of observed facts, and to leave ultimate meanings to metaphysical minds. They are constructional engineers continually building bridges to cross into new territories and using materials of which they have discovered or created properties of practical value in the execution of the design. As the traffic of science increases, such bridges have to be replaced from time to time by others of newer designs and better materials; but the purpose is, as it is in all forms of organic life, the efficient adaptation of structure to function.

Artists and poets may use their imaginations to construct scenes and cities having no factual foundation; and without deliberate intention they sometimes anticipate designs and developments which eventually come to pass. Such conceptions of truth belong, however, to mysticism rather than to realism. The anticipations of expanding applications of scientific discoveries and their social consequences, made by Mr. H. G. Wells in many of his outlooks upon life, are of a very different character. They are similar in nature to scientific theories in which new relationships are foreseen from observed reactions, and are afterwards confirmed. They represent the products of a disciplined imagination working upon existing knowledge with the wide vision and adventurous insight by which the greatest advances have been made in both pure and applied science. It is in this spirit, and by the recognition of possibilities in opportunities presented by new contributions to knowledge, that material progress is achieved in industry and in science.

In these aspects of progress, theory and practice are complementary factors of service, each being used to reconstruct the other by relating effect to cause. This is the method of Bacon's inductive philosophy; and the achievements of modern science are due to its application. It is possible, however, to arrive at generalizations about the nature of things and the structure of the universe by theoretical reasoning independently, or largely so, of observational or experimental evidence. With a few great exceptions, this was the method of approach of classical Greek philosophers towards problems of Nature ; and it takes an important place in the history of science. They gave little consideration to the practical or useful services of science represented by chemistry, mechanics and engineering, but they take a supreme place by their philosophic and mathematical contributions. Many Greek philosophers meditated upon the nature of matter and space, each conceiving theories of primary elements or substances from which everything in the universe was formed and evolved. Abstract ideas about causes were discussed as propositions to be established or rejected by logical reasoning independently of knowledge perceptible by the senses.

Following this method of interpreting Nature by thought alone, Democritus, in the fifth century B.C., conceived the theory that the universe is made up of atoms varying in size and shape and moving in a vacuum. The atoms were indivisible particles and infinite in number ; and by their motions and combinations with one another the world and all in it were produced. This atomic theory of the universe was taught a century later by Epicurus, whose philosophy was embodied by Lucretius in his great poem, "De Rerum Natura", in the first century B.C. The theory remained a philosophic conception until the beginning of the nineteenth century, when Dalton gave scientific precision to it. To Dalton, as to the Greek philosophers, an atom meant "the smallest possible quantity of any element which can combine with other substances", and the three laws formulated by him as to the structure of bodies by atoms are the foundations of modern chemical science.

These principles still hold good to explain chemical constitutions and changes, though there has been a complete revolution in conceptions of the structure of atoms themselves. In this revolution, however, theory has been used to account for observed properties and to forecast new effects from known causes. So long as the operations of the mental model thus constructed proceed according to plan it serves a useful purpose by providing points and movements of attack and defence. When opposing forces or natural obstacles reveal weaknesses in the system, adjustments have to be made to meet them. Expressed in another way, schemes of operations in the battlefield of science are not final orders to be followed without question, but working hypotheses which have continually to be modified to meet changing requirements of the front line.

In the fields of applied science, usefulness is the standard of value of both fact and theory. Natural relationships and laws represent the accumulation and collation of empirical knowledge, and nothing more is desired or claimed of them than service in action. Whether such generalizations, arrived at by theoretical and experimental research, are causally repetitional, and have no other significance, is too abstract a proposition to influence the activities of scientific workers generally in laboratory or field. When, however, the special theory of relativity, the quantum theory, the indeterminancy principle, and similar mathematical conceptions become factors which have to be taken into consideration in constructing rational schemes of structure and happenings in atoms and the universe, physical laws appear to be only convenient rule-of-thumb guides to practice and not ultimate truths.

Most scientific workers are satisfied with confirmatory experiment or observation as a test of the validity of a theory or principle. Clerk Maxwell's electromagnetic equations were of this type and were established as true by the experiments of Hertz and Lodge. Mathematical equations thus interpreted in physical phenomena often develop, however, into broader schemes and suggest that other states or conditions exist for which no objective proof may be attainable. In arriving at such equations upon purely mathematical principles, it is permissible to assume properties and relationships without reference to conscious knowledge of them. Though only a few of these revelations of the mind find contact with reality, while the rest belong to the realm of ideals, the general shape of the structure depends upon mathematical reasoning, which may be logically sound even when it does not coincide with observational knowledge.

The right of mathematicians to construct schemes of this kind, in which laws are derived from *a priori* concepts, must be conceded, however unsubstantial such flights of imagination may appear to practical minds. A physical law is not an unalterable creed, but a statement of knowledge of particular relationships of Nature derived from observation and experience. It has to be altered when cases arise which are not covered by it, and is not, therefore, a permanent statute. No scientific mind supposes that a physical law is among the eternal verities or a faith which it is sacrilege to assail.

There are other rational standards of value in Nature, in addition to those based upon scientific methods of inquiry. The inductive method is usually employed to construct theories of the nature of the universe from what has been discovered as to the constitution and distribution of the bodies in it, but such theories can obviously be nothing more than rational pictures painted in the pigments available at the time. As they must change with the expansion of theoretical and observational knowledge, they can never be more than temporary schemes which explain what is known when they are expressed, and suggest a possible past and future history from present appearances. Mathematics and philosophy are, however, not confined to known laws of Nature or to observable phenomena: though these may be used in constructing mechanical systems of the universe, they are not essential factors in mathematical conceptions, any more than they are in poetic flights of fancy. Ideas as to the origin and construction of the universe, based on logical mathematical principles, can only be refuted, therefore, by positive evidence of their untruth, and not by the apparent lack of contact with what is known when they are put forward.

Our senses determine the range of objective phenomena, but creative thought has no such limitations. It is the source of the greatest human achievements, whether expressed in music and poetry or in scientific discovery and invention. Its exercise is determined not by what is known but by what is unknown; and whether a pursuit is worth while must be measured by originality of intention and result rather than by direct intellectual or practical service. Here, then, is the common standard by which all scientific inquiries, and all expressions of human feelings, may be judged. It makes no distinction between pure and applied science, so long as the object is increase of knowledge and the endeavour is the discovery of truth.

When this is borne in mind, the pursuit of knowledge for its own sake becomes just as estimable an occupation as that in which the purpose is use or action. It is generally acknowledged that inquiries undertaken to solve purely scientific problems, and without thought of their proximate or ultimate usefulness, have been the starting points of most of the great achievements of modern science; but such problems need not be excluded in planning scientific work for the benefit of the community. Science has transformed so many aspects of modern civilization that structures of society designed in earlier times have been shaken to their foundations by it. Its sources and resources, if they are wisely used, give almost unlimited powers to construct a world in which life can be made worth living to all peoples of the earth.

Systems of planning with these objects in view have to provide not only for the full use of existing knowledge but also for efficient means of extending it. Most scientific inquiries are best advanced when groups of workers concentrate attention upon them, whether intellectual interest or industrial application is the motive. It is, however, as impossible as it is undesirable to attempt to limit creative thought to a particular pattern, or to apply the criterion of usefulness to its exercise. This is as true of science as it is of other activities in which hand and brain combine to express themselves in new products. Men of science, like musical composers and other artists, may follow their occupations as a means of living, but their most original achievements are those which depend for their expression upon inborn light rather than external influences. In every walk in life, both interest and pleasure are required for contented effort, but they are not always to be hired in the market place. They are at their best when they are exercised in perfect freedom, whether in craftsmanship or in the expression of human consciousness.

STRUCTURE OF LIQUID METALS

By DR. A. LATIN

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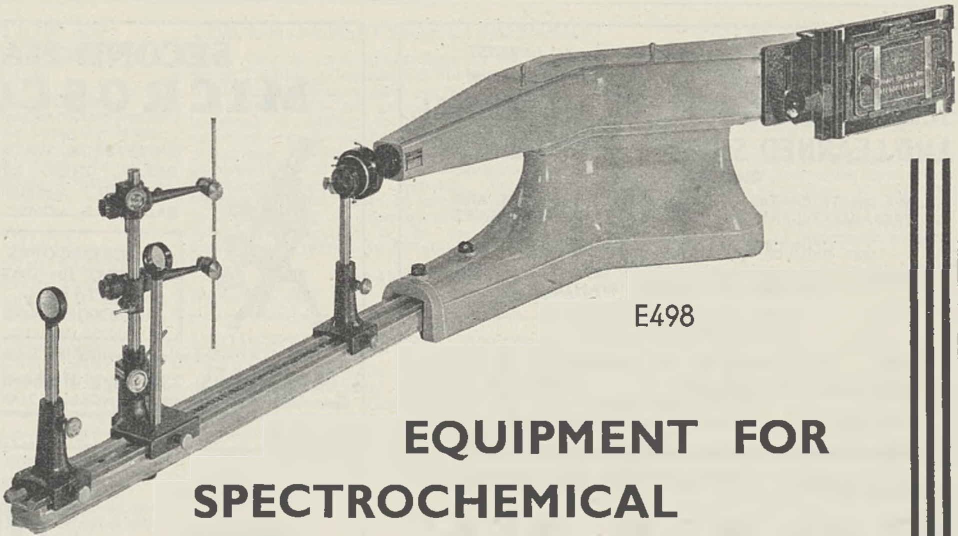
THE view that the arrangement of atoms or molecules in a liquid is not entirely random may now be considered well established. In other words, the liquid possesses certain characteristics to which the term 'structure' can be properly applied. This does not mean that a liquid possesses anything so definite as a 'lattice structure', and any reference to a 'liquid lattice' may be very misleading, if not, indeed, devoid of meaning. It would perhaps be allowable to refer to the 'ghost of a lattice. Before going on to consider liquid metals themselves, it will be as well to deal first with the general question of the structure of liquids.

There are perhaps two main types of conception of liquid structure that have proved of value. These may be termed (1) group and (2) statistical conceptions. In some ways, indeed, these con-



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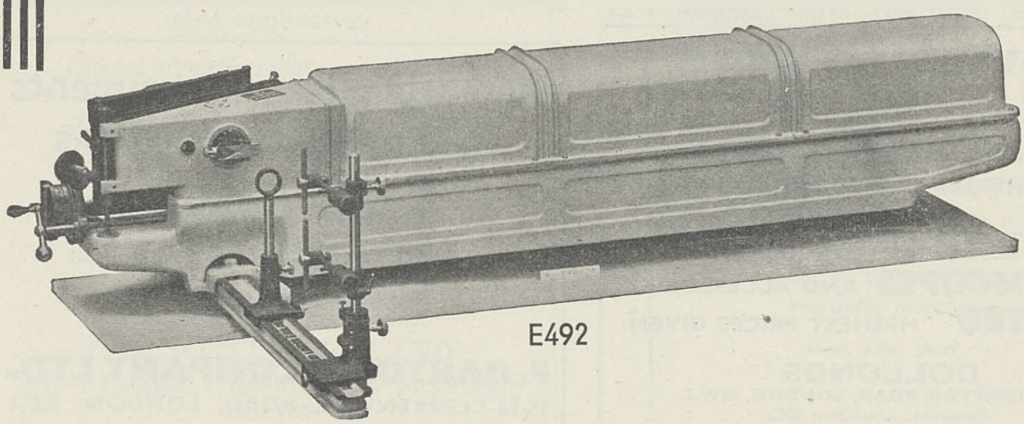

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ceptions have tended to merge into one another and perhaps their chief distinction is in the difference of mental picture that they give. Thus one view or the other may prove of the more value according to the particular case under consideration.

Theories of the first type postulate the existence in the liquid of minute groups of atoms or molecules possessing a more or less high degree of order, particularly at temperatures near the melting point. Such theories have been put forward, for example, to account for the increase in supercooling on freezing with the degree of original superheat. This implies a higher degree of order (or a greater number of 'seed crystals') in a freshly melted liquid than in one which has been superheated. There is considerable evidence, however, favouring the alternative view that the effect is due to the presence of impurities which, in one way or another, furnish nuclei for crystallization. Even in the case of the so-called 'liquid crystals', there appears to be no evidence of any very definite regularity of arrangement of the molecules, other than a common orientation. Perhaps the most elegant development of the group type of conception is Stewart's theory of 'cybotaxis'. In this the groups are considered to be of a transitory nature, continually forming and disappearing. The mental picture of the liquid is, so to speak, 'spotted' and ever-changing.

In the purely statistical type of conception, the liquid is regarded as being essentially molecularly homogeneous. There is, however, a tendency for the molecules to concentrate in certain favourable positions with respect to neighbouring molecules. In other words, there is a maximum probability of nearby molecules being situate in certain more or less well-defined positions with respect to one another. The distribution function representing the statistical radial distribution of molecules around an average molecule possesses peaks which become less marked as the distance increases. Moreover, there appears in many cases to be a distinct resemblance between the form of this function and that of the equivalent discrete function by which the structure of the crystalline solid may be represented.

A valuable insight into the nature of liquid structure can be obtained from a consideration of modern theories of fusion. These deal with fusion as a type of order–disorder process, analogous to that which takes place in certain solid alloys, but with the difference that the lattice itself, as it were, melts. In more general terms, the process of fusion may be included with the other so-called 'co-operative' processes, the statistical mechanics of which have been studied by Guggenheim and Fowler. The obvious corollary to this conception is that a certain degree of regularity must persist in the liquid. Similar considerations applied to the reverse process of freezing should be capable of giving more fundamental information into the mechanism of supercooling and nucleus formation than is obtained from either the conceptions of Miers or of Tammann, and it is obvious that much valuable work remains to be done on this side of the problem.

The most direct evidence favouring the above views of liquid structure, although there is a body of more circumstantial evidence from other sources, is that obtained by X-ray studies. The halo or haloes produced when a monochromatic beam of X-rays is passed through a liquid were early shown by Debye and Scherrer to be due to interference. Moreover, the Bragg spacing calculated from the most intense halo is in general of the same order as for the principal plane in the crystalline solid.

There is no space here to go fully into the question of the interpretation of the X-ray diagrams, but two main methods may be very briefly described: (1) a 'model' of the liquid structure, based on the influence of the thermal vibrations on the structure of the crystal, may first be proposed, the theoretical X-ray intensity diagram derived from this, and then compared with the actual diagram. (2) From what is essentially a Fourier analysis of the X-ray intensity diagram the distribution function of the liquid is obtained. Naturally, further interpretation, and even further data, are necessary for this distribution function to be made to yield a detailed picture of the liquid structure. This latter is probably the most difficult aspect of the matter.

X-ray studies have as yet been applied to only a few metals in the liquid state, but it seems already possible to draw certain tentative conclusions.

Of the close-packed metals lead, thallium and aluminium have been examined. All investigators agree that the liquids have a close-packed structure; that is to say, the atoms may be imagined as equal spheres which, while in continual motion, tend to remain always closely packed together. The inference is that there occur in the liquid, configurations bearing a relationship to those in the crystalline solid.

The body-centred cubic alkali metals have received considerable attention. Tarasov and Warren, for example, have shown that there exists a similarity between the atomic distribution of liquid and solid sodium. Their work has been followed up by Trimble and Gingrich, on the basis of whose results Wall has derived an interesting form of distribution function for liquid sodium. In his model each atom is imagined as being trapped in a spherical shell, the shells themselves being distributed in an arrangement of a 'quasi-solid' type. He shows that the chief effect of temperature is in influencing the shell radius, this being 0·60 A. at 100° C. and 0·77 A. at 400° C. One may perhaps conclude from this that a fairly high degree of regularity, related to the body-centred cubic arrangement in the solid, may be present near the freezing-point.

Coming to metals deviating more markedly from close-packing in the solid state, mercury, naturally, has been studied by many investigators. All agree in imputing to liquid mercury a close-packed structure. Solid mercury is rhombohedral, with a co-ordination number of 6, and the structure of the liquid may perhaps be most simply regarded as the result of the increased freedom given to the atoms on melting. Kratky has argued that a hexagonal close-packing fits the results best, but it seems unlikely that there can be much real difference between hexagonal and cubic close-packing in a structure so irregular as that of a liquid.

Bismuth is of particular interest in view of the large amount of work, in other connexions, of Goetz and his collaborators on this metal in the liquid state. There is some evidence of so-called 'pre-melting' in bismuth, and its melting point would appear to be not so sharp as for the close-packed metals. The results of the few X-ray investigations are conflicting. Randall and Rooksby find a band spacing identical with that for liquid lead, and consider that liquid bismuth has a close-packed structure. Solid bismuth has a structure differing widely from that of the close-packed metals, but, as Randall and Rooksby have pointed out, there are certain similarities to lead, its neighbour in the periodic system. Their view may be said to amount to the conclusion that this similarity increases on melting. They cite the changes in diamagnetism and electrical conductivity as affording more evidence in favour of this view. The results of Prins agree with the close-packed theory, but Danilov and Radtchenko consider that a 'blurred' simple cubic lattice fits their results best. The structure of solid bismuth is often considered as a slightly distorted simple cubic one.

As a result of his experiments, Goetz, particularly in connexion with his 'block' theory of the structure of crystals, has put forward the view that in liquid bismuth there persist, up to about 10° C. above the melting-point, groups of atoms, under certain conditions quite large, having a highly regular arrangement closely allied to the structure of the solid. His theory has received considerable criticism, and it would seem that more certain evidence is necessary to substantiate it. To me, it seems a possibility that the change which takes place in bismuth on melting is, from one point of view, analogous to an order–disorder change in a solid alloy, accompanied (as is not infrequent) by a change in lattice form. The possibility of cybotaxis also exists.

X-ray investigations have also been made on liquid tin, but will not be dealt with here. Of perhaps greater interest are the results on gallium, as representing a 'borderline' case, or highly abnormal metal; also because Menke has carried out an investigation on the supercooled liquid, at 18° C. (m.p. = 30° C.). The intensity diagram shows a pronounced 'ridge' near the principal maximum. A similar effect occurs with water. The structure of solid gallium is complex, and there is evidence of molecular binding. The simplest conclusion is that some degree of molecular binding and relationship to the solid, possibly with cybotaxis, occurs in the liquid. On the other hand, it also seems not unlikely that a definite change in structural characteristics occurs on melting. It is noteworthy that supercooling would seem to be more marked in those metals, for example, bismuth and gallium, in which such a change takes place, than in metals such as the close-packed ones, in which the structural characteristics of liquid and solid appear to be more closely allied.

A few alloys have also been investigated in the liquid state by X-ray methods. The results on intermetallic compounds indicate a certain degree of stability in the liquid state. Bornemann's measurements of the electrical conductivity of liquid alloys also confirm this. In view of the electron-atom ratio theory of the structure of intermetallic compounds, these results are of interest in indicating that the forces responsible for the structure of solid intermetallic compounds persist in modified form in the liquid. It seems possible also that what amounts to a form of cybotaxis is present, the compounds, as it were, continually forming and dissociating. A few eutectic alloys have also been investigated. The results would seem to indicate the possibility that there is some tendency for the eutectic components to separate in the liquid, particularly near the freezing point; that is, the structure of the solid alloy is to a certain extent 'foreshadowed' in the liquid. Again, what amounts to a form of cybotaxis, continual intermingling and separation of the eutectic components, seems possible.

It is evident that much work remains to be done. The experimental difficulties, quite apart from the difficulties of interpretation, are of course very great. Nevertheless, considering that the vast majority of metals and alloys used in industry start their existence, so to speak, in the liquid form, and that the process of freezing, as in casting, etc., is still so imperfectly understood, it would seem that there is here a useful line of fundamental research waiting to be developed.

OBITUARIES

Sir Arthur Hill, K.C.M.G., F.R.S.

THE tragic death of Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, in a riding accident on November 3, is not only a disaster for the Gardens, but also a great loss to the many societies, institutions and Government departments of which he was the chief representative of official botany for Great Britain. The twenty-odd years during which he was director saw a tremendous advance in the progress of botanical science in all its branches, and it was natural that Kew should play a prominent part in many of the activities characteristic of this period.

Arthur William Hill was born on October 11, 1875, and was the only son of Daniel Hill, of Watford. He was educated at Marlborough and at King's College, Cambridge, where he obtained a first class in both Part I and Part II of the Natural Sciences Tripos, and later took the degree of Sc.D. He was elected a fellow of King's College in 1901 and became dean in 1907, and since 1932 had been an honorary fellow. He was University lecturer in botany from 1905 until 1907. During the War of 1914–18 he was placed on the special list as adviser on horticulture to the Imperial War Graves Commission and held the rank of Captain from 1917. He was elected a fellow of the Linnean Society in 1908 and a fellow of the Royal Society in 1920. In 1926 he received the honour of C.M.G., and that of K.C.M.G. in 1931.

Hill was attracted to botany by a classical master at his school, the late Edward Meyrick, F.R.S., who was also an enthusiastic naturalist. At Cambridge he came under the inspiring genius of Marshall Ward, and later had the advantage of assisting Walter Gardiner in his work on the continuity of the protoplasm between adjacent plant-cells. His admiration for Gardiner's manipulative skill comes out in the obituary notices he has so recently written (see NATURE of October 18, p. 462). Hill continued this line of research independently, and his contributions, "The Histology of the Sieve-tubes of Pinus" (1901), and "The Histology of the Sieve-tubes of the Angiosperms" (1906), were two of his most important papers and may be regarded as the classic English accounts in this line of investigation.

After taking part in the Bisiker expedition to Iceland, Hill visited the high Andes of Peru and Bolivia in 1903 and this expedition probably made a greater impression on him than all the rest of his world-wide travels. He was particularly struck by the dwarf rosette and cushion plants—a modification displayed in very many families—which are abundant on the Andes, and of these he selected after his return the members of the Malvaceæ, with their remarkable variation in leaf-form, as a subject for detailed investigation. On these he published, some years later, "An Account of the Acaulescent Species of *Malvastrum*" and "A Revision of the Genus *Nototriche*". Many new species of these curious plants have since been discovered, and Hill, who never ceased to be fascinated by them, was planning at the time of his death an entirely new revision of the genus Nototriche to be illustrated by an elaborate series of drawings.

The appointment to Kew as assistant director under Sir David Prain was made in 1907. Hill was allotted a number of routine duties including the editorship of the *Kew Bulletin*, but in spite of these he was able to continue research and he published several taxonomic revisions and other papers. He took a share in the preparation of the great African Floras published from Kew, namely "The Flora Capensis" and "The Flora of Tropical Africa". For both of these he elaborated the difficult family Santalaceæ, which entailed careful dissection of small and inconspicuous flowers, and for "The Flora Capensis" he prepared (in collaboration with Prain) the article on the Gentianaceæ.

On Sir David Prain's retirement in 1922, Hill became director. Some years after his appointment he was successful in obtaining what was to prove of immense value to Kew for the strengthening of ties and the broadening of outlook, namely additional funds and facilities for travel by members of the scientific staff. These came in the form of grants from the Empire Marketing Board. In this enterprise he was stimulated and assisted by the boundless energy of T. F. Chipp who had succeeded him as assistant director. Hill himself took full advantage of the opportunity and visited Australia, New Zealand and Malaya, and, on another occasion, South Africa and Rhodesia, after which he attended the Conference of Directors of Agriculture of East Africa held at Amani in Tanganyika and visited Kenya and Uganda. In all these tours he was able to promote the study of the native flora and vegetation and to improve the relations which Kew already had with Government departments and herbaria throughout the Empire. The result of his visits and of those of the scientific staff led, among other things, to an enormous increase in the amount of material reaching the Herbarium for identification. With the aid of grants from the Marketing Board, additional staff was recruited; but to this day a great accumulation remains to be worked out. The two wings composing the Herbarium were already crowded to excess and after repeated attempts, extending over several years, Hill succeeded in obtaining sanction for the erection of a new wing.

A very successful enterprise which he inaugurated in association with the Forestry Commission was the acquisition of about fifty acres of land at Bedgebury for the purpose of forming a national collection of conifers, especially of those genera which did not flourish at Kew. His active support of the transplant experiments and genetical work carried out at Potterne showed further his sympathy in branches of botany which were not in his own line.

The Kew tradition of providing Colonial Floras was fully maintained under Hill's directorate. The publication of the Gramineæ for the unfinished

"Flora of Tropical Africa" was continued and an entirely new work "The Flora of West Tropical Africa" was initiated and completed. His interests were, however, not confined to the continent of Africa. Of the Indian Floras, he supervised the publication of much of the "Flora of the Madras Presidency" and was recently in correspondence as to the preparation of a final part of the "Flora of the Upper Gangetic Plain". His visit to Trinidad had given him an interest in the vegetation of the West Indies and under his sponsorship also it was arranged in 1928 that the drafts of the new Flora of Trinidad and Tobago should be checked at Kew after preparation in the Colony, and he had himself during the last few years prepared the accounts of certain families—the Sapotaceæ and Convolvulaceæ among others. Repeated attempts to secure funds for a Flora of British Guiana were unsuccessful, but Hill greatly stimulated the study of the flora of this Colony by arranging for an expert systematist from the Herbarium staff to pay visits there, and a number of papers on the flora have already appeared.

Although Hill worked on systematic problems he was not attracted to taxonomy for its own sake and still less when it involved investigation into past history or the unravelling of involved nomenclature and botanical errors. Taxonomy appealed to him as the arrangement of the phenomena presented by morphology. The cushion plants of the Andes, the curious aquatic umbellifer Lilæopsis, the bulbous species of Peperomia, the trimorphism in the flowers of *Oxalis tuberosa*, or the strange development of the basal auricles or the leaves of a southern Caltha, attracted him instantly and led sooner or later to the production of papers. His researches on the living plants at Kew also concerned morphology rather than taxonomy, and considering the wealth of material in the Gardens this was a natural and indeed eminently suitable field of research for a director whose interests had to be wide and who could not spend his days in concentrated study in the Herbarium and Library. The problem of the stony endocarp, Dicotyledons with a single or unequal cotyledons and the twisting movement of flowers and leaves are recent examples of his studies. All these papers taken together form a valuable contribution to general morphology and a fitting sequel to the work of his predecessor Thiselton-Dyer. An experimental turn of mind and an interest in physiology are shown also in not a few of his writings, and during recent years he went to great trouble to initiate and supervise experiments on purifying the air in greenhouses and providing illumination to counteract the adverse effects of London fog, experiments which unfortunately had to cease on account of the War.

As president (1930) of Section K of the British Association Hill chose as the subject of his address "Present-day Problems in Taxonomic and Economic Botany". Another important public lecture was that delivered before the International Congress of Plant Sciences at Ithaca in 1926, when he spoke on "Antarctica and Problems in Geographical Distribution". His address to the first Imperial Botanical Conference in 1924 urging the need of a complete botanical survey of the Empire was opportune and noteworthy.

To the Gardens themselves Hill became deeply attached, and he carried out a number of improvements, some of them being on a considerable scale. His highly developed artistic sense was revealed in all these changes as it was also in his horticultural interests generally. He served on the Council of the Royal Horticultural Society and on many of its committees, and, since 1934, had edited the *Botanical Magazine* for the Society. In 1919 he edited the interesting memoir of that great horticulturist Canon Henry Nicholson Ellacombe, of Bitton. He worked regularly with his own hands in his private garden and was always ready to encourage the good amateur.

Riding was a relaxation he greatly enjoyed and had retained from his Cambridge days. He would often say that so long as he could have a horse and ride a bicycle he would not buy a car. He was a man of very high and rigid principles and a devout churchman. He had an intense interest in church architecture and was a generous benefactor to the church he regularly attended. A love and appreciation of art and music also found a place in his busy life, while the genial hospitality of his official residence was known to botanists and others from all parts of the world. Fastidious in his tastes and often somewhat aloof, he was truly sympathetic and kind-hearted. His intimate friends were few and these held him in the deepest regard and affection.

For Kew the loss is very great. He held the balance almost perfectly between the interests of the Gardens and those of the Herbarium, Museums and Laboratory, while the versatility of his nature made him capable of taking interest in every aspect of the Gardens' administration. A. D. COTTON.

AMONG the many activities of the late Sir Arthur Hill not the least was his interest in the botanical welfare of the Dominions and Colonies. In the early days he had made a collecting tour of the high Andean regions of Peru and Bolivia, and this seems to have stimulated his interest in travel, for in after years he visited many widely separated regions and consequently acquired a vast knowledge of tropical and subtropical flora. His first visit to the West Indies was made in 1912, when he represented Kew at the Eighth West Indian Agricultural Conference at Trinidad; afterwards he visited Barbados and the Windward and Leeward Islands. He visited botanic gardens in the various islands, and while appreciating the many fine exotic species, deplored the neglect of native plants in the collections. He was specially impressed with the early work on cacao grafting, and urged continued work on more intensive lines. Incidentally it may be remarked that this work has been developed and is one of the main items on the programme of cacao research which has been undertaken with gratifying results by the Imperial College of Tropical Agriculture.

Sir Arthur Hill was keenly interested in agricultural education, and was one of the original governors of the Imperial College of Tropical Agriculture, being nominated by the Secretary of State for the Colonies. He visited Trinidad again in 1919 with Sir Arthur Shipley, to attend the opening ceremony of the West Indian Agricultural College at St. Augustine, Trinidad, an institution which received a Royal Charter two years later and changed its name to its present designation. He afterwards visited Jamaica, and it was during this visit that he became impressed with the seriousness of the threat to the banana industry, which was beginning to suffer severely from the ravages of disease. It was due to his proposals that the Banana Research Scheme, also centred at the Imperial College, came into being. He was firmly of the opinion that the problem could best be solved by breeding strains resistant to Panama disease.

In 1921 he visited the Cameroons to advise the Secretary of State on the Botanic Gardens at Victoria, and he afterwards toured Nigeria to study native agriculture. He attended the International Congress of Plant Sciences at Ithaca in 1926, and then visited California and British Columbia. His theme was always the necessity for preserving the native flora in suitable reservations or parks. Official tours were made during 1927–28 to Australia, New Zealand, Malaya and Ceylon, and the Botanic Gardens at Buitenzorg in Java were also visited. In all these places he was consulted on matters connected with herbaria, museums and botanic gardens, and the result of these visits was to establish closer liaison with Kew. One of the results of the tour was a scheme for the temporary exchange of botanists from Kew with those from Australia, and a somewhat similar system was devised for India and the Union of South Africa. The winter of 1930–31 was occupied in a visit to South Africa at the invitation of the Government of the Union. Here again he stressed the need for botanical reserves, especially in connexion with the preservation of the native flora. He deplored the extensive planting of the slopes of Table Mountain with exotics, and expressed the view that it should be kept sacred as a reserve for the native flora. On his return he visited East Africa and attended an agricultural conference at Amani, when he took the opportunity of reviewing the botanical work that was being undertaken by the Agricultural Research Institute.

He had been appointed a member of the Colonial Advisory Council of Agriculture and Animal Health when that body was first constituted. His unique knowledge of conditions in so many of the Colonies proved of great value, and during the period of construction that followed the end of the War of 1914–18 he served on many committees and conferences dealing with agricultural improvement in the Colonies. It is rather remarkable that the last meeting he actually attended before his death was a committee of the council which was dealing with agricultural education in the Colonies.

Sir Arthur had long wanted to visit India, and his chance came in 1938 when he visited Calcutta as an official representative of the British Association to the Indian Science Congress. It was a real *tour de force* and he received a great welcome from the Royal Botanic Gardens, Calcutta, the universities and the cinchona plantations and other gardens which were staffed by Kew-trained men. His last foreign tour was in March 1939 when he was an official representative of H.M. Government at the Eighth International Congress of Tropical and Subtropical Agriculture. The meetings were held at Tripoli, and afterwards he took the opportunity of visiting the new Fascist Colonies in Cyrenaica. In discussing the matter after his return he remarked that the work of reclaiming the desert was of great interest and value, but that the cost must prove uneconomical.

Kew has been the source of inspiration to all botanists in the Empire for the last hundred years, and Hill's many tours and his personal correspondence did much to preserve the links that tie it to so many of the botanical institutions that have sprung up overseas.

He was always particularly glad to see old Kew men when they were home on leave from their overseas stations, and his advice was valued. The advent of the present War saddened his outlook, and every bomb that fell on the Gardens was regarded more or less as an act of sacrilege. Throughout this period, however, he carried on bravely with a much depleted staff, and looked forward to the future with serenity. His private benefactions were numerous—how numerous few people can guess—but the people of Kew realize their loss. A manner which was often rather abrupt hid the kindliest nature and a heart of gold. His passing will cause a big break in the story of the Royal Botanic Gardens. He had worked there for thirty-four years either as assistant director or director, and during the last few months had spent much time in compiling a full and detailed history of the Gardens. GEOFFREY EVANS.

THE broad zone of common interests shared by the Royal Botanic Gardens and the Royal Horticultural Society afforded Sir Arthur Hill, as director of Kew, ample opportunity for rendering service invaluable to the Society. For many years, from 1919 onwards in fact, Sir Arthur served on the Society's Council and on several of its committees, thus he was a regular visitor to the Wisley Gardens and Laboratories.

To his unfailing generosity the fellows of the Society are largely indebted for the collection of plants in the Wisley temperate house. A more recent gift of uncommon hardy shrubs materially assisted in the planting of the newly acquired Battleston Hill.

The members of the Wisley staff will not fail to remember his kind concern with all aspects of their scientific work and also with their welfare; nor will those concerned with taxonomy and nomenclature forget his constant courtesy in so frequently assisting them by placing the facilities of the Kew Herbarium at their disposal.

Away from his administrative duties and cares, Sir Arthur thoroughly enjoyed his quiet but critical contemplation of the Society's decorative plants—

species, varieties and garden hybrids; and there is no doubt that he too appreciated an epicurean discussion of the virtues and failings of apples old and new. He frequently aroused the interest and envious admiration of professional and amateur fruit growers alike, less fortunate perhaps than he was in regard to frost damage to their trees, when he described the quality and quantity of the crops he gathered in his own garden.

When in South America, Sir Arthur noticed the three coloured forms of the oca (*Oxalis tuberosa*). He wished to study the relationship between the tuber colour and the structure of the flowers which proved very difficult to obtain in Great Britain, but by controlling the period of light we found it possible to obtain a few flowers at Wisley for comparison with other material grown at very high altitudes in central Europe.

During the last seven years Sir Arthur edited *Curtis's Botanical Magazine*, published by the Society, thereby maintaining the tradition so firmly established by Sir Joseph Hooker during his forty years editorship. It is deeply regretted that these activities have been so tragically terminated, but one records with gratitude the high value to us of his interest and work. M. A. H. TINCKER.

FOR nineteen years Sir Arthur Hill held with outstanding success an official position which developments of the science of botany have made very exacting. In the middle of last century the expansion of the Empire had confirmed the commanding position of Great Britain in systematic botany: Kew was its centre, and the Hookers its leading figures. But the study of botany in the universities was at a low ebb. The publication of the "Origin of Species" led to that revival of interest in the morphology and physiology of animals and plants which sprang up at South Kensington under Huxley and Thiselton-Dyer.

Hill did not himself participate in the change, for he was then too young. Even Gardiner, under whose guidance at Cambridge he acquired the finest microscopical technique, was a product rather than an agent in the revival of botanical study there in the 'seventies. Thus Hill passed on imbued with the 'new botany' already widely current. As assistant director of Kew he had under Prain an unrivalled opportunity for systematic study. The result was that, when appointed as director after Prain's retirement, he was able to give to the botanists of his time advice and help in both branches. His genial personality made him a friend to all inquirers. In fact, he was for many years an ever-ready adviser for students, whether in the garden, the laboratory or the herbarium.

Others are giving detailed accounts of Hill's life, and its widespread Imperial activities. Here a very old friend has pleasure in telling how fully he maintained the old systematic tradition of Kew, while promoting and expanding its adaptation in the widening scope of the science to meet the needs of a later time. F. O. BOWER.

OTHERS will have expressed their appreciation of Sir Arthur Hill's eminence as a botanist; I knew him best as a man and a gardener. What was most distinctive of him was the very wide circle of friends to whom he was "Arthur". He had a gift for friendship and as his official position at Kew brought him into contact with the lovers of gardens and trees, not only in Great Britain but also all over the English-speaking world, these acquaintances ripened easily and at once into something warmer and more intimate.

He knew plants as few men did; he appreciated their points of interest and he liked to draw others into his own appreciations; I remember him perhaps at his happiest when at certain dinners, where gardeners or men of science met to exchange experiences, he was explaining the special features of things he had brought from Kew. This ease of intercourse was of great value to him officially. As a Government Department Kew Gardens belongs to the Ministry of Agriculture, its expenditure requires the sanction of the Treasury, its buildings, glass houses and the like have to be dealt with by the Office of Works. It is easy for any of these great offices to adopt an unsympathetic attitude to a relatively small spending organization which does not lie within the great stream of public affairs, but Hill's tact and friendliness smoothed the way to many improvements in the Gardens and in the conditions of work of its extensive staff.

Hill's contacts with gardening were many and various; he was closely associated with the Royal Horticultural Society, from the council of which he only retired to edit on their behalf *Curtis's Botanical Magazine*, that record of new plants running back for more than a century and a half. He was long a member of the council of the John Innes Horticultural Institution, in the affairs of which his quiet judgment was always of value. No record of Hill would be complete that ignored his devotion to the Church and its social work; my last business with him was concerned with the education of two boys in difficult circumstances who had been brought to his notice through the Church.

Hill was not a player of games, his recreations were conversation and riding, and if the latter did bring him down at last, his end came instantaneously in the full tide of his enjoyment—and what better end can any man desire? A. D. HALL.

ONE evening early in 1907 Arthur Hill called at my house in Cambridge to discuss the prospects of an appointment of which he had just heard. The post in question was that of assistant director of the Royal Botanic Gardens, Kew, in itself an attractive one; but Hill was much attached to Cambridge and to King's, and the thought of leaving was disturbing. I knew of these Cambridge attachments, but I knew, too, something of the prospects offered by Kew under Sir David Prain, then recently returned from India, and I had no hesitation in strongly advising Hill to accept the London post.

I have never had any doubt, nor I feel sure had he, that this advice was right. The more one saw of Hill and of Kew, the plainer it was how well man and post were assorted. Of this, visitors to Kew had much evidence in the condition of the Gardens ; but it was not so much from the broad general picture as seen by the public as from minor indications that Hill's deep love of Kew and all that Kew stands for were to be gained. Watch him, for example, exult as a friend fails to detect on some smooth lawn the spot where a month or two before a bomb-crater yawned ; or, again, note his pleasure over the complete recovery of some tropical plant, saved from destruction by the temporary repairs effected to badly damaged glass. Or accompany him on some Sunday afternoon to the loose boxes in which were two fine teams of Suffolk horses waiting impatiently for the carrots which clearly were expected as soon as Hill was seen. Trivial things these, but pointers to conditions that make the duties of a post not merely matters to be attended to, but a worth-while job.

In recent years my own association with Hill arose chiefly from the fact that we were both members of the Council of the John Innes Horticultural Institution. Here his Kew experience was most helpful to Hill's colleagues, and his loss will be much felt.

THOMAS H. MIDDLETON.

MY first recollection of Arthur Hill is of seeing him riding through the streets of Cambridge. My next is of attending six lectures he gave on Algæ in the Easter Term of 1906 when he shared the elementary course with R. H. Biffen and A. C. Seward owing to the illness of Marshall Ward. By that time he had travelled to Iceland and the Andes and had written short accounts of their vegetation ; his chief interest was, however, in histology, his work on protoplasmic connexions being of fundamental importance. The following year he left for Kew.

I do not think that Hill seriously concerned himself with the practice of systematic botany. He had no flair for herbarium work possibly because the new order in botanical ideas prevalent in his student days apparently regarded such studies as worthless. He was, however, a keen observer of growing plants and attributed his interest in natural history generally to the stimulus of his Marlborough days. He published a number of small systematic monographs but was attracted mainly by general problems of taxonomy, particularly the origin of Monocotyledons, which interested him to the end. The plants growing at Kew provided him with material for a steady flow of notes and papers on morphology and development ; at the last meeting of the Linnean Society he exhibited a Streptocarpus with cleistogamous flowers.

The Royal Botanic Gardens were to Hill almost a religion. No improvement he carried out, so far as I recollect, did anything but enhance their beauty.

After the War of 1914–18 there was money available for schemes of imperial development, and Hill, always keen on travel, characteristically made full use of his opportunities. He believed in the eminence and prestige of Kew and pushed his belief to the utmost. The Kew collections benefited from the contacts he made and he himself gained a wide first-hand knowledge of botanical conditions overseas, and in the years that followed continued and extended his interests. The tragedy of his death is that it should have occurred now, for his experience would have been invaluable in the reconstructions that are inevitable when peace ensues.

Arthur Hill was very much the boy at heart. He was the kindest of men, showing an understanding sympathy not only in the written word but also in unostentatious generosity to those in need.

J. RAMSBOTTOM.

Mr. M. Ussishkin

PALESTINE and the Jewish people have suffered a great loss through the death in Jerusalem at the age of seventy-eight of Menachem Ussishkin. He was known as "the grand old man of Zionism", and his influence was felt in every Jewish activity in Palestine. But he had a particular love for the soil of Palestine, and for the last eighteen years of his life devoted himself to the buying of land in Palestine as the collective property of the Jewish people.

Ussishkin was closely associated with the Hebrew University in Jerusalem, which was inaugurated by the late Lord Balfour in 1925. He was a member of its Board of Governors, and attended the meetings of this body not only in Palestine, but also in many different centres in Europe. He was also a member of the executive committee of the University in Jerusalem. His enthusiasm for every branch of university life, and in particular his close personal contacts with successive generations of students, gave him a great influence on the development of the Hebrew University, which now has 1,100 students with a staff of more than 125 professors and lecturers.

Ussishkin's early training in his native land, Russia, was as an engineer, but he very soon became a leading figure in the movement for the return of the Jews to Palestine, and later in the Zionist movement. He was particularly ardent in the support of the movement to revive Hebrew as a language of daily intercourse, and as a language of literary and scientific writing.

Ussishkin's most obvious characteristics were indomitable courage and uncompromising adherence to principles. At the same time he was the kindest and the most courteous of men. When he died, 50,000 people followed his coffin to the grave, for Palestine had lost in him its greatest figure.

WE regret to announce the following deaths :

Mr. V. M. Foster, geologist in the U.S. Geological Survey, on September 2, aged thirty-seven.

Prof. A. C. Fraser, professor of plant breeding in Cornell University, on September 17, aged fifty-one.

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

Mr. J. D. Martin, assistant conservator of forests, Northern Rhodesia, on November 10, aged thirty-two.

NEWS AND VIEWS

Royal Society Medallists

His Majesty the King has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year, as follows :

Prof. E. A. Milne, Rouse Ball professor of mathematics in the University of Oxford, for his researches on the atmospheres of the earth and the sun, on the internal constitution of the stars, and on the theory of relativity ;

Prof. E. L. Kennaway, professor of experimental pathology in the University of London, and director of the Chester Beatty Research Institute, Royal Cancer Hospital (Free), for his investigations on production of cancer by synthetic substances.

The following awards of medals have been made by the President and Council of the Royal Society :

Copley Medal to Sir Thomas Lewis, physician-in-charge of the Department of Clinical Research, University College Hospital, London, for his experimental researches in the clinic and the laboratory, on the heart and the circulation, and their disorders.

Davy Medal to Dr. H. D. Dakin, director of the Research Laboratory, Merck Institute of Therapeutic Research, Scarborough-on-Hudson, New York, for his work as a pioneer in biochemical research and especially because of his fundamental contributions to the study of intermediate metabolism.

Hughes Medal to Prof. N. F. Mott, Melville Wills professor of theoretical physics in the University of Bristol, for his fertile application of the principles of quantum theory to many branches of physics, especially in the fields of nuclear and collision theory, in the theory of metals, and in the theory of photographic emulsions.

The Student Martyrs of Prague

November 17 was the second anniversary of the shooting by the Germans in Prague of ten Czechoslovak students, and was observed as an International Day of Students. On November 16 a commemoration meeting was held in the Caxton Hall, London, and was attended by students from more than twenty nations. The following stimulating declaration was made and has since been broadcast to students in all parts of the world : "We declare that November 17 shall always be for us not only the day on which free students everywhere shall pay tribute to their dead Czechoslovak fellows, and to those who are still in prison and concentration camps, but it shall also be the day when we will remember with fervent determination the ideals for which they suffered and are suffering. We free students give our solemn promise to do all that is in our power to crush this brutal Fascist violence, and to dedicate ourselves to preventing its renewal in any shape or form."

The persecution of students and intellectuals has not been confined to the Czechoslovak peoples ; neither is it ended. The Yugoslav Government in London has recently announced that ruthless atrocities against the civil population have taken place in Kragujevac, in Central Serbia. The Germans are stated to have shot in that town 2,300 civilians in the last two weeks as a reprisal for the killing of 26 German soldiers. A large number of intellectuals have been taken out of their homes and shot. The Germans, not being able to find enough hostages among the adult population, have arrested hundreds of students between the ages of sixteen and eighteen, and some of these have already been executed.

Men of Science and the National War Effort

In view of the widespread feeling that our scientific and technical resources are not being used to the best advantage in the national effort, that much valuable knowledge and experience is being wasted through sufficient responsibility not being given to scientific workers, and that a number of scientific workers have grievances, caused by irregular conditions of working, which unnecessarily discourage them from putting out their maximum effort, the Association of Scientific Workers is calling a series of regional conferences at which men of science, engineers, technicians and laboratory assistants can discuss their problems and decide on appropriate action. Much of the responsibility for improvement of the situation must be borne by all classes of scientific workers. It is therefore to be hoped that the fullest co-operation of all concerned will be obtained.

At the first of these conferences, which will be held in Birmingham on December 6 from 2.30 until 5.30 p.m., at the Royal Society of Artists, New Street, Birmingham, the discussions will be opened by Mr. D. P. Riley, who will speak on "The Responsibilities of the Scientist to the Community" ; Mr. J. A. Henley, on "The Position of the Scientist in Industry" ; and Mr. E. D. Swann on "The Rôle of the Scientist in the National Effort". The meeting will be open to all scientific workers.

Committee on Producer Gas Fuel

The Secretary for Mines has asked the committee which considered low-temperature carbonization processes last year to reassemble, and to examine the sources of fuel for producer gas vehicles, to estimate the quantities that could be made available at present, and to report on the measures that would be required to increase the supplies if necessary. The committee will also inquire whether the development of the peat resources of Great Britain would make any useful contribution to the supplies of domestic fuel in the present coal situation. The constitution of the committee is : Lord Henley (chairman) ; Mr. Gordon Macdonald, M.P. ; Dr. W. H. Mills, lately reader in stereo-chemistry in the University of Cambridge; Mr. F. B. Richards, chairman of Woodall-Duckham Company; Mr. J. Shearman, road motor engineer, L.M.S. Railway; Mr. T. E. B. Young, general manager, Bolsover Colliery Company; Mr. W. A. Macfarlane (secretary); and Dr. F. S. Sinnatt, director of fuel research (Department of Scientific and Industrial Research), and Mr. J. A. Brook, Mines Department, assessors.

Bibliography of the British Fauna and Flora

One of the difficulties facing anyone wishing to study a group of British animals or plants is that of obtaining reliable information on books and papers that will be helpful in their identification. The Association for the Study of Systematics in Relation to General Biology, one of the aims of which is to encourage wider and more serious studies in systematics, therefore decided to compile a bibliography on the subject. This laborious task has been accomplished with the help of various experts, mainly of the British Museum (Natural History) and the Royal Botanic Gardens, Kew, and the book is expected to appear shortly. It contains systematically classified lists of books and papers which may be consulted when studying any given group of British animals or plants. Brief notes on the character and contents of each book and paper are given, so that an idea can be formed as to whether it answers any particular requirements. The whole forms a most useful guide for systematic studies and is certain to achieve its purpose of stimulating scientific interest in the British fauna and flora. Further information can be obtained from the Secretary of the Society at the British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7.

American Foreign Policy

Under the title "American Foreign Policy" Prof. D. W. Brogan has given (Oxford Pamphlets on World Affairs, No. 50. 4*d.* net) a brilliant and concise interpretation of the traditional outlook of the United States on world affairs, the policy which she has followed in recent years and the machinery by which that policy is carried out. The pamphlet should make a valuable contribution to that mutual understanding by the two peoples upon which alone effective collaboration can be based. What Prof. Brogan has to say about the United States as a missionary of freedom and of American sympathy with democracy, no less than his explanation of the machinery of American foreign policy and of the real meaning of the Monroe doctrine, should go far to remove some of the difficulties which the ordinary citizen of Great Britain experiences in understanding, and still more in reconciling, the high moral line taken in foreign affairs by American public opinion, and the much more realistic attitude of the Administration. In this lucid account, written with admirable detachment, particular attention is given to the development of policy since 1918, including the "Good-Neighbour" policy, the reactions of the rise of Nazism and the collapse of France on the Monroe doctrine and its application or interpretation and the influence of the war debts on American opinion. Prof. Brogan has rendered real service to Anglo-American collaboration and all that it involves by this admirable exposition of the 'neutrality legislation' and the factors weakening extreme isolationism and bringing the two democracies to such a declaration of common policy as that contained in the Atlantic Charter.

The Genetical Society of Great Britain

During the first year of the War the British Genetical Society, which has a membership of 146, held only its annual meeting. From the summer of 1941 it may be said, however, to have resumed its normal activities. Two meetings have been held, at the Rothamsted Experimental Station and at Oxford. On each occasion papers were read and members demonstrated a considerable series of exhibits. Although winter meetings are still impossible, it is hoped to commence a full programme next year with a meeting in the early spring. The present officers of the Society are: *President*, Prof. R. A. Fisher; *Vice-Presidents*, Dr. C. D. Darlington, Prof. Julian Huxley, Dr. R. N. Salaman; *Treasurer*, E. R. Saunders; *Secretaries*, Dr. K. Mather, Dr. E. B. Ford.

Announcements

According to a Dutch correspondent of *The Times*, the German authorities in Holland have closed the University of Leyden. After November 20 no examinations are being held there, but the students will be allowed to sit for examinations at other Netherlands universities, and will be admitted to German ones. Lectures at Leyden were discontinued a long time ago (see Nature of February 8, p. 161).

The following appointments in the Colonial Service have recently been made: E. D. Bumpus, agricultural superintendent, Nigeria; A. E. Kerr, assistant Government chemist, Trinidad; J. E. Cousens, assistant conservator of forests, Malaya; A. P. D. Jones, assistant conservator of forests, Nigeria; J. J. Laurie, assistant conservator of forests, Gold Coast; G. H. Thompson, assistant conservator of forests, Gold Coast; R. J. Osborne, surveyor, Uganda; D. Westwood, agricultural officer, Gold Coast; Dr. A. W. R. Joachim (agricultural chemist), divisional and research staff officer, Ceylon.

A central sales branch has been organized for all work connected with subscriptions, sales and distribution of the journals and other publications of the majority of the Imperial Agricultural Bureaux; its offices are at the Agricultural Research Building, Penglais, Aberystwyth. The only publications not dealt with by the central sales branch are those of the Imperial Institute of Entomology (Assistant Director, Imperial Institute of Entomology, 41, Queen's Gate, London, S.W.7) and the Imperial Mycological Institute (Director, Imperial Mycological Institute, Ferry Lane, Kew, Surrey), and *Nutrition Abstracts and Reviews* (Secretary, Imperial Bureau of Animal Nutrition, Rowett Institute, Bucksburn, Aberdeen).

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.*

Auxin Production during the Development of the Grain of Cereals

IT has been shown by Gregory and Purvis[1,2], Kostjucenko and Zarubailo[3,4] and others that the developing grain can be vernalized in the ear during the period of embryo formation. It has further been suggested by Cholodny[5,6,7] and others that auxin or a similar hormone plays an important part in the vernalization process. It appeared important therefore to undertake a direct study of the auxin relations in developing grain of both spring and winter varieties of cereals. The work was carried out with pure-line spring and winter varieties of Petkus rye. At known intervals after anthesis grains were removed from the ears and the auxin content determined by Went's coleoptile method. The hormone was obtained in two ways: (1) direct diffusion into agar, (2) extraction of the ground fresh material in water and subsequent concentration under reduced pressure. Relevant details of the methods will be published elsewhere.

It was found that no diffusible or extractable hormone appears in the developing carpel until two weeks after anthesis, but from this time forward rapid production of auxin occurs reaching a maximum at some 5–6 weeks after anthesis. The maximum is simultaneous with the stage of complete differentiation of the embryo. In the interval mentioned the auxin content has increased nearly a hundredfold. The data are presented in the accompanying table and refer to (*a*) winter rye grown in the field, (*b*) winter rye grown in sand culture with controlled nutrition, (*c*) spring rye. No consistent differences are seen between the varieties; so that the different behaviour of these types with regard to their low temperature requirements for flowering cannot be accounted for on the basis of auxin production during development.

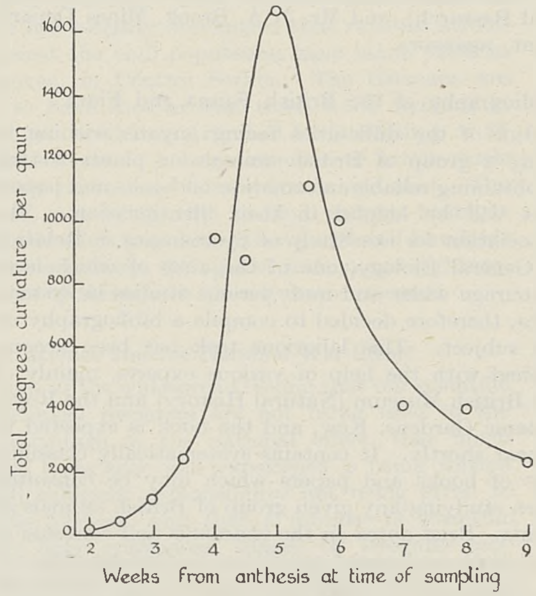
The mean values are presented graphically in the figure. It will be noted that after the maximum hormone content has been attained a rapid fall follows, so that in the completely mature grain the hormone content is so low that the diffusion method fails to detect its presence, though by extraction it can still be demonstrated. The apparent disappearance of the hormone is related closely to desiccation of the grain and has been found to be associated with its germinating capacity. It is worth noting that the hormone is confined to the endosperm and at no time is sufficient auxin present in the embryo to detect it by the methods employed. In view of the low content of auxin in the mature endosperm of rye it may be pointed out that other cereal grains have been examined. The large hormone content of dry maize endosperm first shown by Cholodny has been confirmed. Oats is found to occupy an intermediate place, and diffusible auxin from this grain has been estimated. Wheat and barley resemble rye in that no diffusible auxin could be established.

Auxin Content per Grain at Various Stated Times after Anthesis Measured by Extraction Method.

Weeks from anthesis	Winter rye in field	Winter rye in sand culture	Spring rye
2	18	—	—
2·5	—	45	35
3	96	122	116
3·5	—	240	—
4	865, 810	768	1210, 1120
4·5	—	877	—
5	1419	2301	1260
5·5	—	1113	—
6	357	789	1874
7	270	—	560
8	—	—	402
9	234	—	—

All values given in total degrees curvature per grain

$$= \frac{\text{Mean curvature} \times \text{dilution (c.c.)} \times 100}{\text{Number of grains in sample extracted}}$$



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Research Institute of Plant Physiology,
Imperial College of Science and Technology,
London, S.W.7.
Oct. 27.

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Egg-laying of Ducks as an Enforced Relaxation Oscillation

THE formation and deposition of a bird's egg can be described as a relaxation process[1], the egg material being piled up gradually and released suddenly. The sustained production of eggs can then be regarded as a series of relaxation oscillations. In an undisturbed relaxation system discharges take place when the accumulating material (energy) reaches a certain level, but the length of period may change if the stream of material (energy) varies. If a bird were an undisturbed relaxation system, eggs of fairly constant size would be expected at varying intervals according to the amount of food available. This is not the case in ducks, where eggs of varying size are deposited regularly in the morning on consecutive days, sometimes for months, with pauses of one, seldom two or more days, between each clutch.

Now constant period length and variable amplitude, although foreign to relaxation oscillations, are characteristic of the well-known type of sinoidal oscillation. A duck's egg-laying activity combines features of both types of oscillations. This is due to the synchronizing of an external sinoidal 24-hour rhythm on the relaxation system, as can be shown by the following facts. The eggs of a clutch decrease in weight so that the first egg is usually the heaviest and the last egg the lightest. The differences between the biggest and smallest egg laid by one duck are not great (*c.* 20 per cent) and extremely small eggs (35 gm.) and big eggs (double-yolked eggs more than 110 gm.) are exceptional.

Tables 1 and 2 show the decrease of egg weight from the beginning to the end of the clutch.

TABLE 1.

The mean deviation from the dam's mean egg weight of 570 eggs according to position in the clutch.

Position of egg in clutch	1	2	3	4	5	6	7
Weight of egg relative to the mean (gm.)	+3·42	+2·54	−0·09	−1·99	−2·41	−2·43	−3·12
Number of eggs	105	105	105	105	70	52	28

TABLE 2.

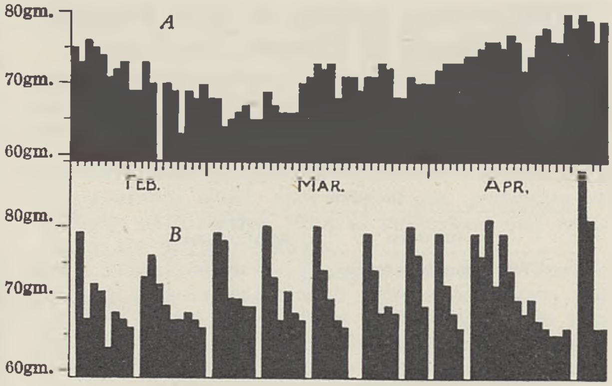
Mean weight of the last five eggs in 161 clutches of at least five eggs, laid by 24 Aylesbury × White Campbell ducks.

Position of egg in clutch	5th last	4th last	3rd last	2nd last	last
Mean weight in gm.	76·04	74·90	73·26	72·79	72·03

Some ducks lay eggs on more than two hundred consecutive days, others pause more frequently. If the egg weights of two such birds are compared, it is seen that the decrease in weight is much more rapid in the latter than in the former (see accompanying figure). It seems that the ovary or oviduct of the former cannot produce enough material completely to replace the egg laid twenty-four hours earlier, and hence the eggs decrease in weight until a limit is reached where no egg is laid at all. During the pause more material is accumulated and so the first eggs of the next clutch are again bigger.

For the occasional occurrence of pauses of two or more days only a historical explanation can be suggested. The wild duck lays two or three clutches of eggs each season, each clutch being separated by a period during which the eggs are brooded and the ducklings reared. Once the laying of a clutch ceases there seems to be some mechanism which delays the resumption of laying. In the domestic duck, which has its eggs removed and is not encouraged to brood, this blocking mechanism is eliminated, but not completely. It may be mentioned that broodiness is known to be inherited in hens[2].

The synchronizing 24-hour rhythm is probably the light rhythm, but it remains to be decided experimentally whether it produces its effect through its action on the endocrines[3,4] or by the determination of feeding periods. A diurnal rhythm of the genital tract has so far only been described for female rats[5].



WEIGHTS OF ALL EGGS LAID BETWEEN FEBRUARY 10 AND APRIL 25, 1931; *A*, BY A DUCK LAYING CONTINUOUSLY; *B*, BY A DUCK LAYING INTERMITTENTLY.

The yearly period also influences egg-laying, the weight of the ducks' eggs increasing during the laying period, as has been recently shown[6]. As can be seen in Table 3, not only heavier eggs, but more eggs are laid as the year goes on and the clutches increase in length. Probably both the stream of assimilated material and the egg-producing organs are influenced by seasonal factors.

TABLE 3.

Mean production of eggs per day, and number of days where no egg was laid. 24 Aylesbury × White Campbell ducks.

Month	Egg per day	Free days in month
October	0·04	29·60
November	0·05	28·37
December	0·09	28·13
January	0·15	26·46
February	0·50	13·58
March	0·75	7·58
April	0·70	8·38
May	0·60	12·25
June	0·37	18·79
July	0·07	28·83

The egg production of ducks as described above shows a close formal resemblance to electro-physiological phenomena, as for example, the normal or pathological action of heart and muscles[7], and to related biorhythmic processes.

I wish to thank Mr. J. M. Rendel for permission to use his data on egg weights.

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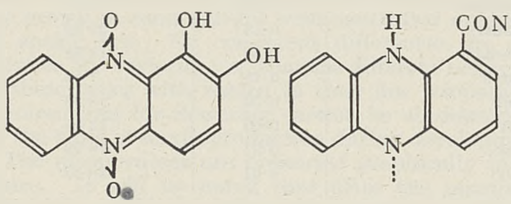
Antibacterial Action of Two Bacterial Products of Known Structure

THE importance of inhibitory compounds in normal living systems, as distinct from their artificial introduction for example, as therapeutic agents, is being increasingly realized. In particular, substances have been isolated from certain micro-organisms which inhibit the growth of other species (for detailed references see Waksman and Woodruff[1]). The structures of the majority of these compounds are not yet known, and in view of their importance as possible therapeutic agents or as models for such agents, the following results with two bacterial pigments of known composition are given.

The pigment of *Chromobacterium iodinum* was isolated and shown to be the N.N′-dioxide of a dihydroxyphenazine (probably I) in 1938.[2]



I II

In connexion with other work in this laboratory, its effect on the growth of *Bact. coli* and *Streptococcus hæmolyticus* was recently investigated. The compound was found differentially inhibitory to a marked degree, and its effect on the growth of one strain each of other organisms was briefly surveyed.

It is seen that approximately 2 μgm./ml. of the pigment prevents visible growth of *S. hæmolyticus* in liquid media ; this inhibitory power is of the order of those recorded for the more active of the natural inhibitory substances. Like other substances, its action is greatest against the Gram-positive organisms investigated ; the order of susceptibility of the organism is also that of increasing nutritional complexity. Inhibition was also exhibited on solid media : 2 μgm. of the pigment prevented growth of *S. hæmolyticus* within a radius of 1 cm. In growth, *Chr. iodinum* can produce 100 μgm. of pigment per sq. cm.[2].

A synthetic specimen of chlororaphin (II, formulated as a phenazyl[3]) which was prepared in 1934[4] in confirmation of the structure of Kögl and Postowsky[5] was also found inhibitory, but to a lesser degree. Pyocyanin is already known to be inhibitory to bacterial growth and metabolism[6]. Thus the three known types of naturally occurring phenazine compounds, which are all bacterial pigments, can be of functional value to the organisms producing them, by antagonizing the growth of competing organisms.

Inoculum		Medium	Addendum			Duration of inhibition (days)
Organism	Approx. number/5 ml.		Compound	Molarity	μgm./ml.	
Streptococcus hæmolyticus	10^6	Broth	I	8×10^{-6}	1·7	>6
,, ,,	,,	,,	,,	4 or 2×10^{-6}	0·8, 0·4	0
,, ,,	10^8	Amino acids, etc.[8]	,,	8×10^{-6}	1·7	>6
,, ,,	,,	,,	,,	4×10^{-6}	0·8	1
,, ,,	,,	,,	,,	2×10^{-6}	0·4	0
,, ,,	10^6	Broth	II	(suspension)	100	>6
,, ,,	,,	,,	,,	,,	20	0
Staphylococcus aureus	,,	,,	I	2×10^{-4}	43	3
,, ,,	,,	,,	,,	4×10^{-5}	8	2
,, ,,	,,	,,	,,	8×10^{-6}	1·7	0
,, ,,	,,	,,	II	(suspension)	100	<1
Bact. typhosum	,,	,,	I	4 or 2×10^{-4}	85, 43	<1
,, ,,	,,	,,	II	(suspension)	100	<1
Proteus vulgaris	,,	,,	I	8×10^{-4}	170	<1
,, ,,	,,	,,	,,	4×10^{-4}	85	0
,, ,,	10^3	Ammonium lactate, etc.[7]	,,	4×10^{-4}	85	0
,, ,,	10^6	Broth	II	(suspension)	100	0
Bact. coli	10^6	,,	I	4×10^{-4}	85	0
,, ,,	10^3	Ammonium lactate, etc.[7]	II	(suspension)	100	0

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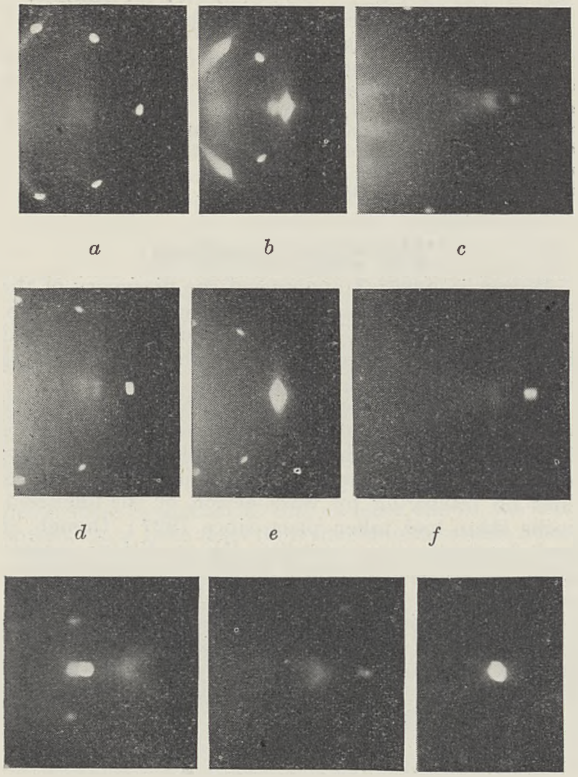
X-Ray Diffuse Reflexions from Sodium and Lithium in Relation to Elastic Anisotropy

WE have photographed the diffuse X-ray reflexions from a number of single crystals of lithium and of sodium at various temperatures. Both show beautiful and elaborate patterns of spots and streaks, which are temperature-sensitive but not structure-sensitive.

Dr. Jahn has recently[1] given an expression for the coherent diffuse scattering from a cubic crystal, based on the Faxén-Waller theory of thermal vibrations. He has applied the formula to sodium, using the known values of the elastic constants to predict the exact detail of the diffusely reflecting region around each reciprocal lattice point. One significant consequence of the theory is that for an elastically anisotropic cubic crystal (that is, when $c_{11} - c_{12} \gtrless 2c_{44}$) the *distribution of reflecting power is different for different reciprocal lattice points* while, other things being equal, the *intensity* at a given distance from any lattice point varies inversely with the absolute values of the elastic constants. A soft, elastically anisotropic substance of simple structure, such as sodium, is therefore ideal for the purpose of testing the theory. It may be deduced from Dr. Jahn's calculations, for example, that when the $[1\bar{1}0]$ axis is vertical, the copper $K\alpha$ diffuse (110) reflexion from sodium should consist of an approximately square group of four spots when the angle of incidence is considerably less than the appropriate Bragg angle, but that this square closes up and a strong vertical streak (parallel to $[1\bar{1}0]$) appears through it as $\theta \rightleftharpoons \theta_{\text{Bragg}}$. The (002) diffuse reflexion should be



a b c

d e f

g h i

(*a*) Na ; unfiltered, $\theta_{110} = 19 \cdot 9° = \theta_B + 5°$; 3·0 cm.
(*b*) Na ; unfiltered, $\theta_{110} = 14 \cdot 9° = \theta_B$; 3·0 cm.
(*c*) Na ; filtered, $\theta_{002} = 23 \cdot 3° = \theta_B + 2°$; 3·0 cm.
(*d*) Li ; unfiltered, $\theta_{110} = 21 \cdot 1° = \theta_B + 3°$; 3·0 cm.
(*e*) Li ; filtered, $\theta_{110} = 18 \cdot 1° = \theta_B$; 3·0 cm.
(*f*) Li ; unfiltered, $\theta_{002} = 28 \cdot 0° = \theta_B + 2°$; 3·0 cm.
(*g*) Na ; unfiltered, $\theta_{112} = 24 \cdot 4° = \theta_B - 2°$; 3·0 cm.
(*h*) Na ; unfiltered, $\theta_{112} = 28 \cdot 4° = \theta_B + 2°$; 3·0 cm.
(*i*) Na ; filtered, $\theta_{002} = 21 \cdot 3° = \theta_B$; 4·0 cm.
Radiation from copper target ; $[1\bar{1}0]$ crystal axis vertical throughout.

quite different, its shape being rather like that of a pair of scissors when $\theta \gtrless \theta_{\text{Bragg}}$, and like a flattened cross when $\theta = \theta_{\text{Bragg}}$. In particular, *the vertical streak parallel* $[1\bar{1}0]$ *should not be present for* (002). This difference is readily explained by the introduction of the elastic anisotropy ; it is a direct consequence of the relationship $c_{11} - c_{12} \ll 2c_{44}$. The disappearance or reversal of sign of the elastic anisotropy would completely change the detail of the individual diffuse spots, even for a crystal of exactly the same crystal structure and unit cell size.

The diffuse spot detail observed for the {110}, {002}, {112}, {130}, {222} planes of sodium, using filtered or unfiltered radiation from a copper target, is just that predicted by the theory. A few examples of Laue photographs taken in various orientations are shown to illustrate this, and exact measurements of the reflecting regions around different reciprocal lattice points will be published later.

The diffuse spot detail for lithium is very similar to that of sodium, and it follows therefore, from X-ray observations alone, that the elastic constants are roughly of the same order of magnitude and anisotropy for the two metals.

It has recently been suggested, on the basis of intensity measurements of powder reflexions, that lithium is not isomorphous with sodium, but crystallizes in a unit cell containing eight Li_2^+ molecules[2]. Laue and rotation photographs of the single crystals do not confirm these suggestions ; on the contrary, all the evidence points to a simple, body-centred cubic, two-atom unit cell of Laue symmetry *m3m*, as correctly assumed by all previous investigators.

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Rigidity and Moisture Hysteresis in Gels

Several equations have been suggested for the swelling pressure of a hygroscopic gel, of which the best known is the approximate form due to Katz[1]. Porter[2] gives an exact and general equation for the osmotic pressure of a solution. We may, for simplicity, conform to the usual conceptions of swelling pressure and restrict Porter's equation to the case where the only pressure exerted on the solvent is that of its own vapour ; giving

$$\int_{h_1}^{p_1} s\,dp = \int_{h_1}^{h_2} v\,dh \qquad (1)$$

Here p is the applied pressure ; $(p-h_0)$ is the osmotic or swelling pressure required to raise the vapour pressure of the solution to saturation h_0 from its initial value h_1, without change in concentration, s is equal to $\frac{(\partial v)}{(\partial m)_p}$ that is, the change in volume V of the solution per unit mass of solvent removed or added at constant pressure, and V is the specific volume of the solvent vapour under the pressure h. By making V represent the volume of solution containing unit mass of dry solute, m becomes identical with the moisture content defined as the mass of solvent per unit mass of dry solute. Katz's equation may be obtained from this by assuming s to be equal to the specific volume of free water and therefore a constant.

Porter's equation is valuable because the term s stresses the importance of the elastic properties of the solution (that is, its bulk modulus). Now, gels differ from solutions elastically because in addition to the bulk modulus they have rigidity and are partially plastic. They also differ hygroscopically because gels show hysteresis in the $(m\,;\,h)$ isothermal, whereas the $(m\,;\,h)$ curves for solutions are reversible. The purpose of this note is to account for the hysteresis in a gel in terms of its elastic properties.

Using a derivation similar to Porter's, but allowing for shear stresses, we can obtain

$$\int_{p_{k_1}}^{p_{k_2}} s_k dp_k + \int_{p_{n_1}}^{p_{n_2}} s_n dp_n = \int_{h_1}^{h_2} v dh \qquad (2)$$

Here p_{k_0} and p_{n_0} are the hydrostatic and shear components of the directional stresses applied to raise the vapour pressure of the gel to h_0 without change in moisture content, s_k is Porter's s involving only volume change and s_n is V times the change in shear strain per unit change in moisture content.

If the shear components contained in the second integral are elastic, the work done on the gel during adsorption is recoverable on desorption and this process is reversible. If they are plastic, the work done in shear will not be recoverable and an equal work must be done again on desorption, so that the second integral in equation (2) will not change sign.

Once the plastic shear stresses have disappeared p_{k_0} will become equal to Porter's p, so the first integral is independent of plastic shear components. The second integral is always positive so it is evident that $\int vdh$ must be greater on adsorption than on desorption, which is possible if, at any moisture content, the adsorption vapour pressure be greater than the desorption, except at the upper and lower limits of the integrated cycle.

This appears to be a valid explanation of the hysteresis in gels. If the gel is only partially plastic, hysteresis will still occur, but to a smaller extent, so the narrowing of the hysteresis loop at lower vapour pressures is thus explicable in terms of the increasingly elastic behaviour of gels as they become drier.

Some explanations of hysteresis which have been suggested, for example by Zsigmondy[3] or McBain[4], can only be valid for liquid held by capillary forces and cannot account for hysteresis in liquid held by purely molecular sorption on the surfaces of the micelles but, in wood at any rate, there is also evidence of hysteresis in molecular sorption[5]. Urquhart[6] postulates that the swelling of the gel opens up fresh intermicellar surfaces to the sorption, and this is probably true, but it is difficult to see why this effect should not be reversible if sufficient time is given for equilibrium to be established on desorption, unless the deformation is plastic.

The points in favour of the theory of hysteresis here presented are (1) that it depends only on considerations of energy, and (2) that it is accounted for in terms of those elastic properties which distinguish gels from solutions.

The work done in shear will depend on restraints imposed on the gel during moisture changes and will not be a property of the gel itself. The restraints may, however, be inherent in the form in which the gel usually occurs, so evidence is required to show that shear stresses are likely to occur during actual drying or wetting. In wood we have a material which provides definite evidence of shear stresses arising, during natural shrinkage, from the ordered change in shape of the cell structure. During drying, the shrinkage (change in volume per unit volume) of the external dimensions of the hollow cell is considerably less than that of the cell wall material, owing to the restraint imposed by the thin outer sheath (the primary wall) in which the cell is encased, and the area of the void centre therefore becomes a larger proportion of the total cross section. This introduces a shear strain in the cell wall which may be approximately determined. The gel material of other natural fibres is likely to have similar restraints imposed on it during shrinkage. In amorphous gels also, it is probable that shear stresses are introduced because they consist of a network of micelles and it seems unlikely that, by removing water, a reduction in the external dimensions of such a network would be possible without distorting the interlocking meshes. The micelles possess rigidity so some work will be done during this distortion and, if they are partially plastic, the hysteresis must result.

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The Sligo Artefacts

WHEN, in 1927[1], I announced the discovery of the Sligo artefacts, it was asserted, by certain observers, that these specimens were not of human origin, but had been flaked by wave-action which, at times, is very powerful on the west coast of Ireland.

During 1941, fourteen years after my discovery was made, I again visited Sligo, and found that no further specimens, such as I had collected originally, were visible upon the site. Indeed it was obvious that no fracturing by wave-action of the limestone rocks there had taken place since 1927; though, if such fracturing were a reality, the conditions present appeared to be admirably suitable for its successful operation.

The Sligo evidence thus disposes of the claim that wave-action is capable of fracturing hard limestone rock in a manner indistinguishable from intentional human flaking.

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[1] NATURE, 120, 260 (1927).

Symbiosis of Men and Animals

WHEN Sturt discovered the Darling River he left the following notes, for which I am indebted to Mr. Charles Daley, secretary of the Historical Society:

1. "The channel of the river was from 70 to 80 yards broad, and enclosed an unbroken sheet of water evidently very deep, and literally covered with pelicans and other wild fowl."

2. "Yet as I stood upon its bank at sunset, when not a breath of air existed to break the stillness of the water below me and saw the surface kept in constant agitation by the leaping of fish I doubted whether the river could supply itself so abundantly."

Where now are the pelicans and the fish? And we may echo, where are the vast numbers of seals that were in Bass Straits? And where are the fish which were also abundant? The fish scarcity is entirely man made, and if men act sensibly they can rectify much of the damage? It will be noted that though pelicans were abundant, so were the fish. There is a symbiosis both with regard to pelicans and fish, and seals and fish. The experience of the Priviloff Islands makes that perfectly clear.

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RESEARCH ITEMS

Archæology of Buena Vista Lake, California

The Smithsonian Institution has recently issued a volume on the "Archæological Investigations at Buena Vista Lake, Kern County, California" by Waldo R. Wedel (Bureau of American Ethnology, Bull. 130). Buena Vista Lake lies at the southern end of the great Californian valley which runs roughly north and south inland and parallel to the Pacific coast. Houses were excavated and a rich haul of finds resulted. These included objects made from steatite, chipped and ground stone, basketry (both coiled and twined), as well as skeletal remains. There were two main culture levels. It would appear that contacts with folk to the north, settled further down the San Joaquin River, can be predicted, but probably too, especially at the time of the later culture levels, some connexion was established with the folk of the Santa Barbara coast region which, though the other side of the hills, is only some fifty to sixty miles away and reached by several passes. At no time were the Buena Vista people highly civilized, indeed their economy was always elementary. Especially was this true of the earliest occupation where the mano and mealing slab occurred to the exclusion of the pestle and mortar, and the material culture was of the simplest. The dead were buried in the extended position in shallow graves near the camping-grounds. The date of this first occupation is unknown, but at least one of the sites would have been later for a time uninhabitable when, as shown by the deposits, the general level of the lake rose during a period of greater precipitation. The more recent culture shows several distinctive traits and was considerably more developed, perhaps because of its greater contact with the Santa Barbara coastal region. While the results of the investigation do not appear to be startling, they do supply important information about the archæology of a little-known area and fill in one more gap in the regional survey of Southern California.

Horticultural Development of the Cauliflower and Broccoli

An interesting paper by Walter F. Giles (*J. Roy. Hort. Soc.*, 66, Pt. 8, August, 1941) traces the horticultural history of cauliflower and broccoli derivatives from the wild *Brassica oleracea* of our sea-shores. Cauliflowers probably originated in Cyprus, but the time of their appearance does not seem to be known with certainty. The earliest literary reference to a terminal proliferation suggestive of this plant is by Dodoens in 1559. He described the "Flourie Colewort" where "the small stems grow together in the centre, thick set, and fast throng together". Switzer apparently first mentioned broccoli by name in 1728, when he had three kinds growing in his garden at Vauxhall. A great improvement took place in the early years of the nineteenth century, when the modern conception of broccoli as a hardier variant of the cauliflower maturing in winter and spring was established. The origin of broccoli from *B. oleracea* was confirmed by Prof. Buckman, who in 1863 obtained a new hardy sprouting type from the wild plant without hybridization.

Diseases and Pests of Gladioli

The recent widespread increase in cultivation of gladioli has brought a corresponding increase in the number and severity of pests and diseases of this ornamental crop. Lucia McCulloch and C. A. Weigel have recently described these maladies as they affect the plant in North America (Farmers' Bull. No. 1860, Washington, D.C., May, 1941). Some diseases have migrated from other crops, but several parasites, including *Sclerotinia gladioli*, causing dry rot, *Penicillium gladioli* and *Fusarium oxysporum* var. *gladioli*, were associated with this host before the era of its intensive cultivation. The most severe and widespread insect pest is Gladiolus thrips, which appeared in the United States in 1929, and spread rapidly, even threatening the future existence of the crop. Methods of control for this and the other maladies are described in the bulletin.

The Larger Fungi of Trinidad

Three preliminary lists of the fungi of Trinidad appeared between 1911 and 1931, but R. W. Rayner has now published a more detailed account (Memoir No. 6, Imp. Coll. Trop. Agr., Dept. of Mycol. and Bacteriol., Trinidad, April, 1941). The fungi are classified according to a North American system by Murrill. Most of the thirty-five species now listed are somewhat infrequent members of the European flora, but *Pluteus cervinus*, *Psalliota campestris* and *Auricularia Auricularia-Judæ* appear to be as common in this tropical region as they are in Great Britain.

Earthquakes in India

The seismological bulletin of the Government of India Meteorological Department for April, May and June 1940 has just been received. At Agra 82 earthquakes and tremors were registered during the quarter and at the other observatories of Bombay, Calcutta, Colombo (Ceylon), Dehra Dun, Hyderabad and Kodaikanal about the same number were recorded by the seismographs. Some of the earthquakes registered were world-shaking earthquakes from distant epicentres such as the great Peru earthquake of May 24, but a considerable number were shocks in India and the surrounding countries from Persia to southern China. The earthquakes of India and Burma, macroseismic evidence of which has been collected by J. M. Sil at Poona, numbered 7 during the quarter. The first, on April 10, was slight and had an epicentre near 29° N., 81° E. in Nepal; the second, on April 19, was felt at Gauhati, scale 5 (Rossi-Forel); the third, on April 25, was felt at Drosh (scale 6); the fourth, on May 11, had an epicentre near 23° N., 95° E. in Upper Bumar; the fifth, on May 13, was felt at Katamandu in Nepal (scale 5); the sixth, also on May 13, was felt at Dibrugarh (scale 6) and the seventh, on May 27, was felt at Srinagar (scale 6) and Peshawar (scale 4). This last had its epicentre in the Hindu Kush Mountains near latitude 36·5° N., longitude 70·5° E. and its depth of focus was greater than normal, being between 180 and 200 km. deep.

Earthquake Intensities

R. C. Hayes has recently examined the connexion between the intensities of earthquake shocks estimated by means of macroseismic data collected by 132 observers in New Zealand and the same intensities estimated from seismograms ("Measurement of Earthquake Intensity", R. C. Hayes, Bull. S. 61, Dominion Observatory, Wellington, New Zealand, 1941). In New Zealand, Jagger-type strong-motion seismographs were found difficult to standardize effectively and so Wood-Anderson torsion seismometers are being installed. Four of these latter are now in operation in New Zealand, and the logarithmic scale of intensity initiated by Gutenberg and Richter is being used in their interpretation. A plot of instrumental magnitudes so obtained against the surface intensity (Rossi-Forel scale) shows some scatter, which Hayes attributes to variations in depth of focus. In southern California the smallest reported earthquake felt was 1·5 on the logarithmic scale, but on the same scale in New Zealand the smallest felt is seldom less than 3. In New Zealand magnitude 4≡*R. F.* 4, magnitude 5≡*R. F.* 6–7 and destructiveness begins about magnitude 6≡*R. F.* 8.

Molecular Weight of Gliadin

THE molecular weights of gliadin, the protamine of wheat, determined by different methods have been discrepant. The protein is inhomogeneous but the predominant fraction has been separated. Sedimentation gave 27,000, diffusion 27,500, and the shape of the dielectric constant – frequency curve 27,000 for the molecular weight, whereas amino-acid determinations and osmotic pressures gave 42,000 and 40,000–44,000, respectively. P. P. Entrikin (*J. Amer. Chem. Soc.*, **63**, 2127; 1941) has redetermined the dielectric constant – dispersion curves with fractionated gliadins. It appears that previous results were not made over a sufficient range of frequencies, and the range 25,000–30,000,000 cycles per sec. was used. The results are accounted for quantitatively by the theoretical equations if the molecules are assumed to be ellipsoidal with a ratio of 8 for the major to minor axes. The molecular weight is 38,000. The results of dielectric constant – frequency, amino-acid, and osmotic pressure methods are thus brought into fairly satisfactory agreement, and gliadin comes into line with zein, the alcohol-soluble protein from maize, for which the molecular weight determinations are 39,000 from composition, 38,000 from osmotic pressure, 40,000 from sedimentation and diffusion, and 38,000 from dielectric constant – dispersion experiments. The high value 8 for the ratio of major to minor axis is similar to that for zein, and these are practically the only molecules belonging to the 40,000 molecular weight class with such high dissymmetry. Dipole moment calculations show that gliadin is much less polar than zein.

Mechanical Behaviour of Bitumen

A TECHNICAL report on the "Mechanical Behaviour of Bitumen", by W. Lethersich, has been issued by the British Electrical and Allied Research Association (Ref. A/T 83. Pp. 28. 15*s*.). Using the classification for bitumens adopted in B.S. No. 688, the author gives the results obtained on six samples of bitumen. He determines also the temperature at which softening occurs, and illustrates apparatus for measuring the extensions of bitumen rods under load and how these extensions are effected by heat. The variation of viscosity with temperature is explained by the fact that the asphaltenes become more widely separated as the temperature increases, thus allowing the dispersion medium to flow more readily between them. The principal conclusions arrived at are that the mechanical properties of bitumen may be represented by an equivalent circuit, either mechanical or electrical, comprising elements containing four physical constants, namely, two viscosities and two elasticities. A knowledge of these constants enables the reaction of a given material to be predicted for various kinds of stress and the regions of plasticity and brittleness to be determined. Bitumen is largely used for the insulation of electrical apparatus and of cable joints and so the problem of 'cracking' due to sudden overloads of current causing mechanical stress is both important and interesting physically. The static value of the bitumens tested over the range of temperature adopted varies little. The dynamic elasticity and the viscosity required to withstand a rapid high stress (impact) or a high alternating stress should be low. Decrease of viscosity with increase of strength (structural viscosity) would appear to be an asset.

Hydrocarbon Flames

SPECTRA of flames of methane, ethylene and acetylene and of compounds found as intermediate products in the chemical studies of their combustion have been examined by W. M. Vaidya (*Proc. Roy. Soc.*, A, **178**, 356; 1941). The flames of the Bunsen and Méker burners were also studied. A flame separator was used to get independent observations of the outer and inner cones. The outer cones gave a spectrum identical with that of the CO flame. The inner cones gave in general C_2, CH, HO and the ethylene flame bonds. It is suggested that C_2 may be produced through collisions of CH. Prevalent theories of hydrocarbon combustion are surveyed in the light of the *spectroscopic* observations.

General Classical Theory of Spinning Particles

IN a joint paper H. J. Bhabha and H. C. Corben (*Proc. Roy. Soc.*, A, **178**, 273; 1941) give the complete classical theory of a spinning particle moving in a Maxwell field. The particle is assumed to be a point, and its interaction with the field is described by a point charge g_1, and a point dipole g_2. The Maxwell equations are assumed to hold right up to the point representing the particle. Exact equations are then derived for the motion of the particle in a given external field which are strictly consistent with the conservation of energy, momentum and angular momentum, and hence contain the effects of radiation reaction on the motion of the particle. In the paper following (p. 314), H. J. Bhabha gives an exact classical theory of the motion of a point dipole in a meson field, taking account of the effects of the reaction of the emitted meson field. The two papers occupy 78 pages.

Spectrum of the Corona

ACCORDING to Edlén, the prominent green line in the spectrum of the corona is due to Fe thirteen times ionized by some unknown excitation process (*Science News Letter*, 291, May 10). The next three strongest lines, two in the infra-red and one in the ultra-violet, he ascribes to Fe twelve times ionized. Weaker lines are caused by Fe nine and ten times ionized, while eleven and twelve times ionized Ca, and eleven, twelve, fourteen and fifteen times ionized Ni account for others. The ionization energy involved is about 400 v. Boyce points out that Edlén's theory indicates that ultra-violet light of much shorter wave-length than that hitherto considered must fall on the upper part of the earth's atmosphere, a result which will obviously affect the formation of the various ionized layers.

CHEMISTRY IN IRELAND

By Prof. John Read, F.R.S.

AN interesting booklet has recently been published which shows us that, despite great handicaps several branches of science were cultivated in Ireland during the seventeenth, eighteenth and nineteenth centuries*. Among them, chemistry was closely linked with medicine, whether studied in institutions or less formally in hedge-schools or as a hereditary interest. Thus, the illustrious Robert Boyle entered chemistry through medicine; and it was during his lifetime that the institutional development of chemistry in Ireland began with the foundation in 1683 of the Dublin Philosophical Society. Richard Kirwan, when he left Ireland for France in the middle of the following century, had received his early education, including a good grounding in chemistry, from a well-known master of a hedge-school at Ballyragget, named Patsull. A century later, Cornelius O'Sullivan—"the founder of the modern science of biochemistry"—won a scholarship from his humble school in Bandon which paved the way for him to study chemistry under A. W. Hofmann in London, and later to specialize in the chemistry of brewing. These are three Irish chemists who rose to eminence at different periods and became fellows of the Royal Society; and there are many others of note in the list of sixty-three names forming the index to the booklet now under notice.

Unlike England and Scotland, Ireland had few links with alchemy or early chemistry. Perhaps the earliest connexion may be discerned in the preparation of a distilled spirit called *usquebaugh* ('water of life'), which gave its name to the later 'whisky' and is said to have been made and appreciated in Ireland so far back as 1100. Even during 1652–53 Robert Boyle found his native land so disturbed that it was "hard to have any Hermetic thoughts in it;" and except for the charlatan, William Butler, the only reputed alchemist in the list we are considering is Peter Woulfe, who invented 'Woulfe's bottle', discovered picric acid, and gained the Copley Medal of the Royal Society in 1768—so that he was not much of an alchemist after all.

Boyle and Woulfe were born in Ireland but prosecuted most of their chemical work elsewhere, and a similar statement applies to many other chemists in the list. Thus, Bryan Higgins, who is said to have almost forestalled the Leblanc soda process, opened a school of practical chemistry in Greek Street, Soho, in which he conducted research work during 1774–96; William James MacNeven, sometimes called the 'father of American chemistry', held the chairs of chemistry and materia medica during 1812–20 in the New York College of Physicians and Surgeons; and James Muspratt, born in Dublin in 1793, became the founder of the alkali industry in England. Muspratt's soda, made at Liverpool by the Leblanc process, was originally given away "so as to prejudice people in its favour", whereupon the demand rose to such heights that new works were erected at St. Helens in 1828. One of his four sons, James Sheridan Muspratt, discovered, in collaboration with Hofmann, *p*-toluidine and *m*-nitraniline, and achieved further fame through his celebrated dictionary of "Chemistry as Applied and Relating to the Arts and Manufactures", published in 1860, to the editing of which Michael Murphy (from Co. Clare) "devoted sixteen hours a day for two years".

Of those chemists who went to Ireland from outside and rendered service to Irish chemistry, Sir Humphry Davy was a veritable bird of passage: in 1810 he gave six popular lectures on electro-chemistry before the Royal Dublin Society for a fee of five hundred guineas, and followed this up in 1811 by six more lectures on agricultural chemistry for which he received seven hundred and fifty pounds. In 1813, Edmund Davy, encouraged perhaps by his cousin's account of Ireland as a sphere of operations for chemists, took up the professorship of chemistry at the Royal Cork Institute, an appointment which he held until 1826, when he succeeded William Higgins in the chair of chemistry of the Royal Dublin Society; it was ten years later that he discovered acetylene.

Chemistry in Ireland in the second half of the nineteenth century owed much to the Royal College of Chemistry, opened in London in 1845 with A. W. Hofmann as the first professor. Of Hofmann's original staff and students, Thomas Rowney, Robert Galloway, John Blyth and Edmund Rolands were all in the course of time appointed to chairs of chemistry in Ireland. In later days such men as Alfred Senier, Sir W. N. Hartley, and Sir G. T. Morgan went to Ireland and made valuable contributions to the development of chemistry in that country.

There is an impressive roll of native Irish chemists who carried out their work mainly in Ireland. Among these may be found, at about the end of the eighteenth century: David MacBride, a contemporary of Joseph Black (himself a son of Belfast parents); Richard Kirwan, author of the well-known "Essay on Phlogiston" (1787); and William Higgins, nephew of Bryan Higgins and occupant of "a place of honour in the development of the atomic theory". Sir Robert Kane, a distinguished figure in Irish scientific and academic circles, is known in chemistry for his preparation of mesitylene from acetone and as the author of a popular text-book entitled "Elements of Chemistry", first published in 1841–43. Maxwell Simpson, professor of chemistry in Queen's College, Cork, during 1872–91, studied under Kolbe and Bunsen, and afterwards worked with Wurtz, in Paris. He "takes his place among the great chemists who laid the foundations of organic chemistry in the nineteenth century". Last in chronological order, but one of the first in chemical genius, comes Hugh Ryan, who worked with Emil Fischer in his classical researches on sugars, and held the chair of chemistry in University College, Dublin, from 1908 until 1931. His death in that year, at the age of fifty-eight, was a severe loss to Irish chemistry, for it is said with truth that Ryan "was undoubtedly the leading organic chemist in Ireland in his day".

* Three Centuries of Irish Chemists. Edited by Deasmumhan Ó Raghallaigh. Pp. 30+4 plates. (Cork University Press, 1941.) 2s. 6d.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

MONDAY, NOVEMBER 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Curtin Cosbie: "Brewing, the Story of a National Industry"—2: "The Brewing Process" (Cantor Lectures, II).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—"Spitsbergen in 1941" (Geographical Film).

TUESDAY, NOVEMBER 25

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. J. L. Myres: "Nomadism".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, NOVEMBER 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Howard Robertson: "The Post-War Home, its Interior and Equipment"—1: "The Contributory Industries, What Are They, and how can they help Re-employment ?,'

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 2.30 p.m.—Dr. A. P. Cawadias: "Hermaphroditism" (Thomas Vicary Lecture).

SATURDAY, NOVEMBER 29

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 11 a.m.—Dr. G. M. Findlay will open a general discussion on "The Mode of Action of Chemotherapeutic Agents".

INSTITUTE OF PHYSICS (MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "Physics in the United States and Recent Practical Applications of Nuclear Physics".*

APPOINTMENTS VACANT

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

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Birkenhead (November 28).

SENIOR PHYSICS MASTER at the Rutherford College Boys' School, Newcastle-upon-Tyne—The Director of Education, City Education Office, Newcastle-upon-Tyne, 2 (November 29).

RESEARCH ASSISTANT IN VETERINARY SCIENCE under the Alan, Duke of Northumberland Memorial Fund—The Hon. Secretary, King's College, Newcastle-upon-Tyne (November 29).

LECTURER IN PHYSICS—The Acting Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (December 3).

SENIOR LECTURER (UNGRADED) IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (December 6).

ASSISTANT POWER STATION ENGINEER for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9746).

LECTURER IN AGRICULTURE—The Registrar, The University, Reading.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Labour Conditions in West Africa. Report by Major G. St. J. Orde Browne. (Cmd. 6277.) Pp. 149. (London: H.M. Stationery Office.) 2*s*. 6*d*. net. [2710

Medical Research Council War Wounds Committee and Committee of London Sector Pathologists. M.R.C. War Memorandum No. 6: The Prevention of "Hospital Infection" of Wounds. Pp. 30. (London: H.M. Stationery Office.) 6*d*. net. [2910

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 2, No. 11: On the Sphincter Valve of the Antennal Gland of *Marinogammarus marinus* (Leach) sens. tr. By Mary V. Schorstein. Pp. 130–137. 9*d*. Vol. 61, Part 2, No. 13: The Evolution of Continents: a Possible Reconciliation of Conflicting Evidence. By Sir Thomas H. Holland. Pp. 149–166. 1*s*. 6*d*. (Edinburgh and London: Oliver and Boyd.) [311

Other Countries

Smithsonian Institution: United States National Museum. Bulletin 82: A Monograph of the Existing Crinoids. Vol. 1: The Comatulids, Part 4a: Superfamily Mariametrida (except the Family Colobometridae). By Austin Hobart Clark. Pp. vii+603+61 plates. (Washington, D.C.: Government Printing Office.) 1.50 dollars. [2210

South African Institute for Medical Research. Annual Report for the Year ended 31st December 1940. Pp. 67. (Johannesburg: South African Institute for Medical Research.) [2410

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1940. Pp. 8. (Zomba: Government Printer.) 1*s* [2410

Proceedings of the United States National Museum. Vol. 90, No. 3110: A New Harpacticoid Copepod from the Gill Chambers of a Marsh Crab. By Arthur G. Humes. Pp. 379–386. (Washington, D.C.: Government Printing Office.) [2410

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 140: Foot-Rot in Sheep; a Transmissible Disease due to Infection with *Fusiformis nodusus* (n.sp.); Studies on its Cause, Epidemiology and Control. By W. I. B. Beveridge. Pp. 56+8 plates. Pamphlet No. 108: Studies on some Ectoparasites of Sheep and their Control. 1: Observations on the Bionomics of the Sheep Ked (*Melophagus ovinus*), by N. P. H. Graham and K. L. Taylor; 2: Chemical and Biological Studies on Certain Arsenical Dipping Fluids, by M. R. Freney, M. Lipson and N. P. H. Graham; 3: Chemical Observations on Commercial Powder Sheep Dips with Special Reference to their Arsenic Content, by M. Lipson. Pp. 44. (Melbourne: Government Printer.) [2710

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 206: The Vibration and Sound of a Revolving Thin Plate (Acoustical Model of Airscrew Flutter) (Investigations of Airscrew Flutter, Part 3). By Zûichi Obata, Yahei Yosida and Yasuo Makita. Pp. 127–164. 80 sen. No. 207: On the Nature of a Satellite in the X-ray Pattern of α-Crystals, and the Differentiation of a New Phase α′ by the Surface-Recrystallization Method in Certain Ternary Alloys, Part 1: The Iron-Nickel-Aluminium System. By Syûiti Kiuti. Pp. 165–204. 80 sen. No. 208: The Characteristics of the Aerofoil with Discontinuities along the Span, with Special Reference to the Effects of Cut-Out. By Tetusi Okamoto. Pp. 205–264. 1 yen. No. 209: An X-ray Study on the Mechanism of the Splitting Phenomenon of α-Crystals in the Interior of some Ternary Alloys, Part 2: The Iron-Nickel-Aluminium System. By Syûiti Kiuti. Pp. 265–298. 60 sen. No. 210: Resistance Welding of Light Alloys. By the Resistance Welding Research Committee of A.R.I. Pp. 299–482. 3.05 yen. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) [2710

Southern Rhodesia Geological Survey. Short Report No. 35: Geology of the Mafungabusi Gold Belt. By A. M. Macgregor. Pp. 26. (Salisbury: Government Printer.) [2710

Transactions of the San Diego Society of Natural History. Vol. 9, No. 29: The Long-Nosed Snakes of the Genus Rhinocheilus. By Laurence M. Klauber. Pp. 289–332+plates 12–13. Vol. 9, No. 30: A New Species of Rattlesnake from Venezuela. By Laurence M. Klauber. Pp. 333–336. Vol. 9, No. 31: Observations on Plants and Insects in Northwestern Baja California, Mexico, with Descriptions of New Bees. By T. D. A. Cockerell. Pp. 337–352. (San Diego, Calif.: San Diego Society of Natural History.) [2710

Contributions from the Biological Laboratory of the Science Society of China, Zoological Series. Vol. 15, No. 3: The Mammalian End-Brain, 1: The Septum. By Yii-Tao Loo. Pp. 29–70. 2.30 dollars. Vol. 15, No. 4: The Paraphysis in Adult Mammalian Brains. By Yii-Tao Loo. Pp. 71–76. 50 cents. Vol. 15, No. 5: The Paraphysis of *Megalobatrachus japonica*. By Shih-Hsing Yang. Pp. 77–86. 70 cents. Vol. 15, No. 6: The Labroid Fishes of Hainan. By King F. Wang. Pp. 87–120. 1.90 dollars. Vol. 15, No. 7: A Neurological Analysis of the Constitution. By Yii-Tao Loo. Pp. 121–136. 1 dollar. Vol. 15, No. 8: Antioxidants for Edible Fats and Oils. By David H. Jung. Pp. 137–146. 70 cents. Vol. 15, No. 9: Beneficial Influence of Earthworms on some Chemical Properties of the Soil. By Y. Chiung Puh. Pp. 147–156. 70 cents. Vol. 15, No. 10: The Effects of Partial Decortication on Gaseous Metabolism. By Y. J. Wu, T. L. Chiu and C. Ping. Pp. 157–180. (Shanghai: Science Society of China.) [2710

Proceedings of the United States National Museum. Vol. 90, No. 3116: A Revision of the Chalcid-Flies of the Genus Monodontomerus in the United States National Museum. By A. B. Gahan. Pp. 461–482. (Washington, D.C.: Government Printing Office.) [2710

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 11): Supervision of the Education of Negroes as a Function of State Departments of Education. By Ambrose Caliver. (Studies of State Departments of Education.) Pp. vi+45. (Washington, D.C.: Government Printing Office.) 10 cents. [2710

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1940. Pp. 18+2 plates. (Pretoria: Government Printer.) [2810

Ministério da Educação e Saude. Anuário publicado pelo Observatório Nacional do Rio de Janeiro para o ano de 1941. (Ano 57.) Pp. xiii+336. Suplemento. Pp. vii+124. (Rio de Janeiro: Observatório Nacional.) [2810

U.S. Department of Agriculture. Circular No. 617: Tests of Species and Varieties of Vetch for Resistance to the Vetch Bruchid. By J. S. Pinckney and R. E. Stitt. Pp. 6. (Washington, D.C.: Government Printing Office.) 5 cents. [3010

Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the Year ending 30th June 1940. Pp. iv+126. (Delhi: Manager of Publications.) 2.6 rupees; 4*s*. [3010

Bulletins of Indian Industrial Research. No. 22: Purification of Indian Glass-making Sands. By B. J. Hedge. Pp. ii+5. (Delhi: Manager of Publications.) 4 annas; 5*d*. [3010

Geological Society of America. Special Papers No. 34: Seismicity of the Earth. By Beno Gutenberg and C. F. Richter. Pp. vii+131. (New York: Geological Society of America.) [3010

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