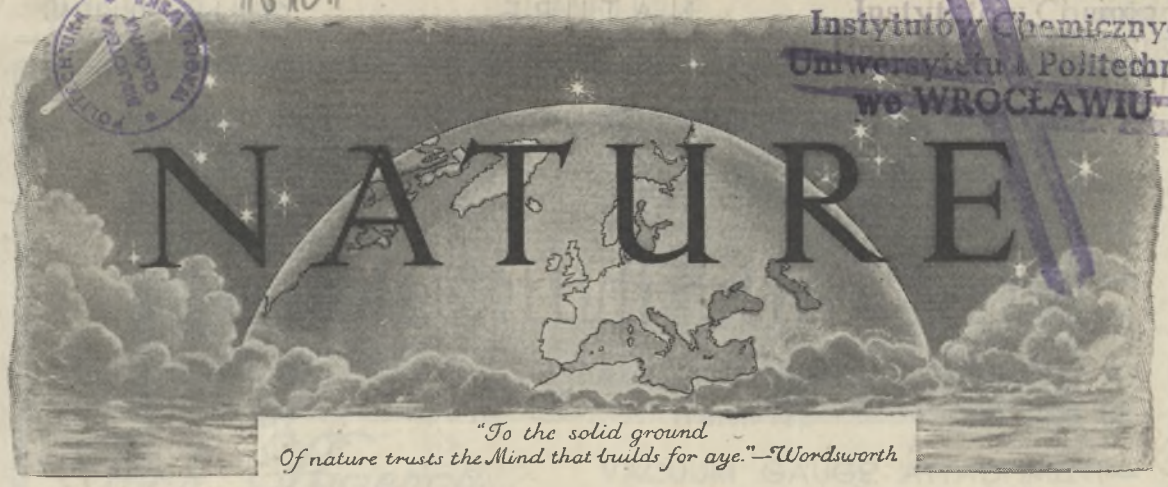

NATURE

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

Vol. 156, No. 3964 SATURDAY, OCTOBER 20, 1945 ONE SHILLING & SIXPENCE

NATURE

No. 3964 SATURDAY, OCTOBER 20, 1945 Vol. 156

CONTENTS

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SCIENCE AND NATIONAL DEFENCE

THE debates in both Houses of Parliament on the Charter of the United Nations on August 22 and 23 showed how widely it is realized that the secret of the atomic bomb cannot be kept indefinitely by any one nation, and that the only alternative to pooling knowledge is a further competition in armaments research of a new type which must inevitably plunge the world into disaster. The Lord Chancellor very rightly said that to try to keep the secret would encourage research in the methods of destruction in every country of the world. The debate further demonstrated that the Government is endeavouring to formulate a rational policy towards the new development, and that the new policy must be based on the full and free exchange of fundamental scientific knowledge. As Prof. Niels Bohr has pointed out, no control can be effective without free access to full scientific information. President Truman has, in effect, lent his support to that same condition by his executive order of August 27, calling for the earliest possible release and free dissemination of scientific and industrial information gained from Germany and Japan. This order covers all information concerning scientific, industrial and technical processes and inventions, in enemy countries or in liberated areas, if such information is of enemy origin or has been acquired or appropriated by the enemy. This means that the details of Germany's experiments with atomic bombs will be shared and made public when the chiefs of staff decide that it is safe to do so.

While the full meaning of the order is perhaps open to question, it points to a situation which calls for an early meeting of the Powers to discuss the whole problem of atomic energy and its control. The pressure in the House of Commons debate for some form of international control in relation to research and to production and through a system of inspection, scarcely took account of the fact that no appropriate international authority yet exists, and that even the Security Council at present scarcely meets the requirements. Preliminary discussions between the United States, Great Britain, the U.S.S.R. and at any rate China could do much to prepare the way ; the respite of two or three years will be none too much to elaborate the essential structure of the control and inspectorate required and to secure the approval and support of all the nations concerned.

Meanwhile, it is essential that there should proceed as a matter of urgency the full re-evaluation of the whole structure of the defence of Britain in the light of these considerations, and particularly of the means for watching and controlling new developments in the technique of scientific warfare. From this point of view the statement relating to the atomic bomb issued by the Department of Scientific and Industrial Research demands close study, and Lord Hankey's recent book is also opportune*. In the Lees Knowles Lectures which form the basis of his book, Lord Hankey gives a brief synopsis of the development of

* Government Control in War. By the Rt. Hon. Lord Hankey. (Lees Knowles Lectures, 1945.) Pp. 90. (Cambridge : At the University Press, 1945.) 4*s.* 6*d.* net.

government machinery in Britain for the formulation and co-ordination of defence policy, from the establishment of the Committee of Imperial Defence at the beginning of the present century up to the delivery of the last lecture of the series on March 9, 1945. The basic principles he establishes and the lessons he draws for the future cannot be disregarded by any who seek to appraise the new situation. Although the fact could not be disclosed in his lectures, Lord Hankey had himself been in touch with many aspects of the development of the atomic bomb, and in a letter in *The Times* of August 11 he supplemented the official accounts in respect of the part played by the Scientific Advisory Committee of the War Cabinet in 1941.

Lord Hankey's story will be to many people unexpectedly reassuring. Within the narrow interpretation of a defensive policy, both in 1914 and in 1939 our preparations were sounder, more thorough and complete than has been generally realized or believed, for all that, like the other peace-loving nations, the outbreak of war found Britain with armaments totally insufficient in numbers and efficiency to withstand the enemy. That unpreparedness resulted from a failure, not of our system of imperial defence, but of the political working of the constitutional system of Government by Parliament and people. This is the fundamental lesson, and Lord Hankey insists that the only real check on a recurrence of our past unpreparedness is the spread of greater knowledge and understanding among the people as to the importance of national defence.

The challenge of the atomic bomb at least presents us with an unrivalled opportunity for that task of educating public opinion as to what is involved, and raising the question of national defence above party politics. Lord Hankey in his concluding lecture appealed specially to the universities to play their part in the task of promoting a better understanding of the lessons of history in their application to imperial defence; and the part which men of science have played in the development of the atomic bomb adds weight to Lord Hankey's emphasis on the responsibility even of undergraduates in this matter. Speeches in the House of Commons and correspondence in the daily Press provide abundant evidence of the work yet to be done to build up a sound and healthy public opinion, and combat the shallow, if not thoroughly unsound, thinking on national service and like issues that has already found expression.

The first governing principle laid down by Lord Hankey, that final control must remain in the hands of statesmen, working in the closest co-operation with the Service chiefs, with the Prime Minister of the day alone as head, was in fact firmly asserted by Mr. Bevin when he stated that he is not prepared to see control of the atomic bomb handed over to the military authorities at all. Control is the responsibility of the Government, and military authorities must remain the Government's advisers. Again, Lord Hankey points out that, while in the grand strategy of the War the views of the Service chiefs must usually prevail, even here the last word must rest with the statesmen, who are responsible for policy and for distributing the resources of the country in the manner best calculated to win the war. Relations between statesmen and commanders-in-chief should be conducted on the principle of selecting the best men available, giving them a free hand, and backing them up to the hilt with a minimum of interference. Governments are entitled to ask their commanders-in-chief to consider alternative plans to their own, but should rarely ask them to carry out plans in which they do not believe. In time of peace, the Prime Minister, whether with or without a deputy, but in association with some of his colleagues, should always be responsible for, and well acquainted with, our preparations for war.

It is because, as Lord Hankey shows, these principles were observed very closely in practice by Mr. Asquith and Mr. Lloyd George in the First World War, and by Mr. Chamberlain and Mr. Churchill in the Second World War, and that for forty years our Prime Ministers, as presidents of the Committee of Imperial Defence, have been responsible for preparations for war, that it can be claimed that we in Britain have evolved a system which is superior to that of our enemies or of any nation in the previous history of war. Lord Hankey not only pays a handsome tribute to Mr. Lloyd George as the founder of our modern system of control; he also maintains that our administrative preparations in 1939 were as complete as they could be, within the limits of our policy and the finances made available; and while he prefers on the administrative side the more flexible system adopted in 1916–17, he insists that our chiefs-of-staff organization to-day is the best example the world has ever known of a great joint general staff to cover and combine all aspects of inter-Service operations. We already possess a Combined General Staff, and in a form which permits rapid transformation from a war system to a peace system and vice versa.

As to methods, Lord Hankey concludes that the most successful form of administrative control is that initiated by Mr. Lloyd George: a small War Cabinet composed of a few Ministers of great experience, some at least of whom are free from departmental or heavy Parliamentary duties and able to give their whole time to the central problems of the war and to lift some of the weight off the Prime Minister. Furthermore, Lord Hankey suggests that as a matter of overriding principle, the Prime Minister must have the system and organization that his methods and temperament and the circumstances of the times require. Machines are made for men and not men for machines, and in urging generally the need of flexibility so that the system is adaptable to different temperaments and circumstances, Lord Hankey attributes the success of our present system largely to its flexibility.

That flexibility is attested by the development of the Directorate of Tube Alloys described in the recent paper of the Department of Scientific and Industrial Research. Indeed that statement in itself might well be taken as a striking testimony to the adaptability of our existing system. Lord Hankey's long experience largely endorses some of the observations in the final report of the Select Committee on National Expenditure for the Session 1944–45; but although

it is not in accordance with the principles that he enunciates to place on scientific men as such the executive responsibilities which Dr. Haden Guest suggested, Lord Hankey, like the Select Committee, considers that further measures are required to secure in future a much greater use of science in all its branches. It is understood that the Office of Scientific Advisers to the Ministry of Production has already been allowed to lapse, and this step should not be allowed to pass unchallenged. A most important part of the central system in Britain, Lord Hankey considers, should be a strong scientific and engineering section to watch all developments in physics, chemistry, explosives, civil, mechanical, electrical and chemical engineering, metallurgy, biology, nutrition, medicine, etc., from the point of view of their possible use by an enemy and by ourselves ; to plan the measures to be taken to neutralize new developments, and to lay out research. Scientific work on defence accordingly should now be brought to the centre and coordinated by a special organization attached to the Committee of Imperial Defence. This might include a small directing committee, on the lines of the existing Scientific and Engineering Advisory Committees, with a large panel of consultants and a secretariat of whole-time specialists. Each Government department concerned in imperial defence would have its own scientific division as at present, closely linked with the central body ; and, like the Select Committee, Lord Hankey refers to the need for organizing scientific workers in advance for war emergency, and for including in our war arrangements plans for expansion and for training the large numbers required.

Whether the Select Committee was aware of the atomic bomb preparations or not when preparing its report, such developments were clearly in Lord Hankey's mind in delivering these lectures, and scientific workers would have welcomed a much fuller discussion of the scientific aspects of defence policy and organization than the page or so they receive in this book. Moreover, while Lord Hankey's letter to *The Times* was concerned to pay tribute to the part played by the Scientific Advisory Committee and to the collective influence of Sir Henry Dale, Prof. A. V. Hill, Sir Alfred Egerton, Sir Edward Appleton and Sir Edward Mellanby prior to the establishment of the Directorate of Tube Alloys of the Department of Scientific and Industrial Research, neither there nor in his book does he touch on the larger question of the combined chiefs of staff organization or the practicability of international control. These, however, are the major points of concern at the moment. The atomic bomb itself is the outcome of a remarkable demonstration of co-operative research and enterprise between the scientific workers of Great Britain, the United States and Canada, with others of the United Nations. What is in dispute is the practicability or otherwise of devising a system of co-operative international control.

As has already been noted, no international authority yet exists to which the exercise of control could be entrusted : the Security Council, as at present constituted, would in practice merely mean entrusting the responsibility to Great Britain, the United States, the U.S.S.R. and a few other Powers, and the proposal might or might not be acceptable to other members of the United Nations. Meanwhile, however, it is essential that the full implications of the situation should be brought out ; and either international control dismissed as impracticable for reasons clearly given, or a scheme worked out which will satisfy the essential conditions, even if the ultimate repository of the control yet remains to be determined.

Brigadier J. L. P. Macnair, referring to the leading article in *Nature* of July 14, has suggested that the Security Council should have at its disposal an armaments development department, staffed by scientific men and service officers of all nations and equipped with all the resources necessary to keep abreast of the results flowing from basic research. It should be in the power of the Security Council, on the advice of this department, to call on any nation for details of technical advances in war-like stores, and refusal to comply with such a request should be regarded as evidence of intended aggression. If the Council succeeds in establishing a reputation for impartiality, such details would probably be readily made available in the cause of peace, certainly up to a time sufficiently close to that of a threatened aggression for the armaments development department to keep abreast of the work, using its own resources.

It may, of course, be maintained that secrecy in the development of full-scale experimental equipment for the manufacture of any new weapon of war is still possible, and this objection applies equally to any proposals for the control and international inspection of the armaments industry as a whole. On the pessimistic view, international control of research into atomic energy would mean nothing ; any powerful nation with a large hinterland could break the convention, leaving out of account the possibility of further developments.

Sir Arthur Salter, who in the debate urged that the military provisions of the Charter have become obsolete in the light of this new weapon unless we succeed in controlling it effectively, stressed the factor of speed, and did not minimize the difficulties in achieving adequate control. Like Prof. Niels Bohr, he recognizes that control measures may demand the abolition of barriers hitherto considered necessary to safeguard national interests, but now standing in the way of common security against unprecedented dangers. Sir Arthur thinks it may involve some restriction of research that may be distasteful to all the traditions of science. Research on atomic energy, he believes, will have to be conducted under conditions of public scrutiny which will take adequate steps at every stage to control its application. Regarding the Atomic Energy Advisory Committee as a first step in this direction, he suggested that the secret of the atomic bomb should only be shared as a counterpart to an assured international control in each country which is given possession of the secret.

Sir Arthur is thus thinking on similar lines to Sir John Anderson, who has already stated that the essential features of such a control are, first, an undertaking by each nation to submit all relevant

information in its possession to a central authority having unrestricted rights of inspection, and secondly, the possession by such central authority of the means of enforcing the undertaking against any recalcitrant nation. Such an international and predominantly foreign control in each country of the most important weapon of war clearly runs counter to every national prejudice and tradition, and the handling of this precarious situation will demand the utmost goodwill of all nations. Could agreement be reached, however, the contribution it would make to the removal of obstacles to mutual confidence and the promotion of harmonious relations would be incalculable.

The House of Commons was clearly fully alive to the dangers of attempting to preserve secrecy. Mr. Price pointed out that a barrier between the Great Powers of the Security Council in military secrecy and scientific research would intensify political barriers, and might lead to division into two camps rigorously guarding their military secrets and scientific inventions, in complete contrast to the spirit of free inquiry, untrammelled by secrecy, relentlessly searching after truth, which is the mainspring of science. Nor was it forgotten that the Charter establishes no effective international authority, and that we are still faced with the task of creating an instrument of unchallengeable power which at the same time will secure liberties under the reign of law that men will make great sacrifices to maintain. Mr. Boothby pressed very strongly for the establishment of a scientific section of the Economic and Social Council ; but while Mr. Bevin, in winding up the debate, added very little to what had been said, his speech indicated that the Government is viewing the whole question realistically and in the right perspective.

We have to consider control, said Mr. Bevin, not merely of the atomic bomb but also of the whole advance of science in the field of war, and it is the aim of the Government, through the world organization, to eliminate the desire to exploit the discoveries of science for the purposes of war, and turn them into channels which will serve human welfare. Consideration of disclosure of the secret of the atomic bomb should be postponed until the world organization is established and the whole question of control of dangerous weapons can be discussed, including that of the essential raw materials. So far as it is necessary to implement the work of the world organization to control scientific research or the manufacture of weapons, we should endeavour to direct our policy so that such weapons become unnecessary, and keep a careful watch to ensure that no Government starts out with war-like intentions.

The debate on the United Nations Charter clearly affords no ground for undue optimism as to the achievement ; nevertheless it was recognized that science itself is not to be blamed for the prostitution of scientific effort in such developments as the atomic bomb, and speaker after speaker referred to the necessity for a moral basis for the new effort to achieve world order and international control. Man's intellectual and scientific attainments have far outdistanced his achievements in the moral sphere, and even if there is built up in an international technical inspectorate a tradition, as Dr. J. B. Conant has suggested, in which professional loyalties are anchored to the United Nations, control will still be ineffective without some advance in the whole standard of national and international morality which will accept the sacrifices of national independence involved.

That must be largely a matter of creating an informed public opinion, such as Lord Hankey stipulates and to which Mr. Bevin also referred in the close of his speech. The Government is clearly moving along the right lines, and the statements relating to the atomic bomb should do something to assist in this fundamental task of educating public opinion in this vital matter. More might well be done by the appointment of a committee to consider appropriate means of parliamentary control of public expenditure on research, as recommended by the Select Committee on National Expenditure ; and it is to be hoped that these new developments will lead the new Parliament to give close attention to this whole question of research and development as recommended in the final report for last session of that Committee.

The challenge to scientific workers in the debate, as in Lord Hankey's book, is unmistakable. If the broad structure of the nation's organization for defence is on right lines, there are still ways in which it can be further improved, and the full contribution of science in national defence facilitated and made more effective. Besides criticisms from the Select Committee on National Expenditure, there are wise suggestions made by Prof. A. V. Hill to the Parliamentary and Scientific Committee for breaking down departmentalism and the traditional secrecy of science in the Services, and bringing the departments into closer touch with the wide horizons and most recent developments in science which are still pertinent.

But Lord Hankey's reminder of the special responsibility which lies upon the man of science in the task of forming an educated public opinion has been reinforced by a noble appeal from Prof. Niels Bohr. The scientific man, more than most men, is in a position to appreciate the constant and dire peril of civilization unless some effective international control can be devised and operated. On him must fall, too, some measure of responsibility for devising and operating that control. He knows that the march of science cannot be stopped, and that the foundation for any international control must be full and free interchange of fundamental scientific knowledge. He may indeed never have a more favourable opportunity of pressing for the removal of all the restrictions that in the last thirty years have been imposed upon such communications. But he knows, too, the truth of General MacArthur's words at the Japanese surrender ceremony, that man needs a growth in his spiritual powers to equal the almost matchless advance in science ; scientific workers are prepared to assist in any way possible to solve the present crisis of humanity in a manner worthy of the ideals for which science through the ages has stood. The first practical step to that end must be the establishment of full freedom of communication and dissemination of knowledge.

WILHELM DILTHEY

Wilhelm Dilthey
An Introduction. By Prof. H. A. Hodges. (International Library of Sociology and Social Reconstruction.) Pp. x+174. (London: Kegan Paul and Co., Ltd., 1944.) 10*s.* 6*d.* net.

As Prof. H. A. Hodges says in the beginning of his introduction, this is the first book on Wilhelm Dilthey to be published in England, and it is overdue. Why Dilthey did not attract attention in England earlier is puzzling. The reason is possibly that the most interesting parts of his work only appeared after his death in 1911. Eleven volumes of "Gesammelte Schriften" came out between 1914 and 1936. The challenging "Einleitung in die Geisteswissenschaften" ("Introduction to Human Studies", as Prof. Hodges translates it) was indeed published so long ago as 1883, but that remarkable work is more the statement of a problem or a challenge than an answer.

Still, the challenge was one which should have been taken up in Britain. For in that book, Dilthey shows that what is wrong with the *Geisteswissenschaften*—human studies—is that it has been continuously assumed that they either ought to be sciences like physics or be philosophy. Quite obviously, he maintained, they are neither one nor the other. Attempts to reduce history to a natural science in the manner of Buckle or to reduce it to philosophy are equally ridiculous. It clearly has its own methods and its own standards.

Now that was very much a challenge to us. We had gone so far in Britain in the direction Dilthey deplores that we have no word corresponding to the German *Wissenschaft*—any systematic thorough discipline with approved methods and standards. Science means in English natural science. Our study of politics and morals has either been predominantly philosophical and therefore not sufficiently empirical or historical, or had its facts falsified to make them fit into an atomism impressed by the example of physics; it had to follow the example set by Hegel or by Bentham, the specific German or the specific English pattern. Karl Marx made a gallant attempt to unite these two sources; but the German and the Hegelian in him conquered the empirical.

Dilthey's attempt is more interesting and far more promising. He was a Kantian. He started with a firm belief in Kant's criticism of metaphysics. The side of Kant which attracted him was the empirical. He wanted only to consider historical studies with the same impartial scrutiny as Kant had given to physics. He held, and rightly, that the rise and progress of historical study in the nineteenth century was in its way as remarkable as the rise of physics before. He proposed in his thoroughgoing empiricism to take history as he found it; not to say it ought to be like physics or like philosophy, but to discover what it was. So he set himself to write a critique of historical reason to be set out against Kant's critique of pure reason.

Can one recognize that the understanding of human beings and society requires a certain imagination, a sympathy, a power of putting oneself in the place of others, which the understanding of the physical world does not, and yet give to this very different kind of understanding the systematic thoroughness and the objectivity of the physical sciences? That is Dilthey's problem. He never completed his critique of historical reason, but he wrote a great deal towards it. Prof. Hodges gives an admirable account of the conclusions to which he came: his far-reaching contributions to psychology and to sociology as well as to historical method.

As Prof. Hodges points out several times, there is considerable similarity between Dilthey's thought and that of the late Prof. Collingwood. There is, however, this important difference. Collingwood was a philosopher and historian. He was primarily interested in history, in which he was an authority, and not in the other human studies like psychology and economics. Dilthey recognized that mind and body, man and Nature, being so closely knit, the 'human studies' merge at one end of the scale into the natural sciences; but he always maintained that they must all be taken together. The inquiry which co-ordinates them all gives the *Weltanschauung* which is the goal of our understanding and must itself be one of the *Geisteswissenschaften* and follow their methods.

What is the final co-ordinating inquiry which will give what Dilthey calls the *Gesamtaufbau*? Is it sociology or history? Dilthey seems sometimes to have put one and sometimes the other of those two in pride of place. Prof. Hodges thinks that he should have come firmly down on the side of sociology. I should myself press the other alternative.

I hope I have said enough to show the extreme interest of the issues raised and the conclusions set forth in this long and masterly account of Dilthey's thought, supplemented as it is by selections from the most important of Dilthey's discussions. I hope the book will be widely read. A. D. Lindsay.

A FLORA OF FAMILIAR ENGLISH PLANTS

Common Wild Flowers
By John Hutchinson. (Pelican Book A.153.) Pp. xxx+222+14 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1945.) 9*d.*

This admirable little book should supply a long-felt want by all lovers of the English countryside. Handy in form and size, it can be carried comfortably on country rambles, and with its aid many of the wild plants found can be easily identified. As an experienced botanist Dr. Hutchinson brings a skilled experience in dealing with the identification of plants by those having no botanical knowledge.

The introduction deals briefly with the salient features of floral structure and then goes on to describe the use of the key. The key is divided into three sections dealing with the Gymnosperms, the Dicotyledons and the Monocotyledons respectively. These are very clear, and the layman should have no difficulty in determining the genus and species of any plant described in the book. The plants selected number 202, and these are well chosen and represent familiar plants most of which may be found on country rambles in almost any part of Great Britain. Only six Monocotyledons are listed; perhaps the number might have been extended by the inclusion of a few of the marsh plants so common in many parts of the country. Each plant has a page of detailed description and is accompanied by excellent drawings of the shoot, leaves, flower and floral structures, and in many cases the fruit and seed. These drawings are really well executed, and the reproduction is excellent. With all these aids set

down by a skilled botanist, the collector should have no difficulty in running down a specimen.

But more is given than the botanical and popular name of each species, for the habitat in Great Britain and the distribution of the species abroad is described in many cases, and in dealing with trees the characteristics of the wood and the uses to which it is put are generally given. This is a most desirable feature, and gives the layman a glimpse into the interesting features of the varied distribution of plants over the surface of the earth. In addition to the illustrations attached to each species, twelve pages of photogravures are added of some well-known plants such as the foxglove, cowslip, sweet violet. These are well reproduced; but it is a question whether this space might not have been devoted to the description of twelve more species.

Many features of biological interest are frequently introduced, as in the case of the behaviour of alder seeds after shedding. Such features make the book so much more than a mere list of plants.

This book, so well designed for its purpose, can do a great deal to promote an interest in plant life, and in many instances will lead on to the desire for a more extended knowledge of the green mantle covering the earth, whether it be in the direction of geographical distribution or the grouping of different kinds of vegetation in different parts of the country. For the reader who, after practice with this book, desires to extend his knowledge to other plants of Britain a short list of books is given.

Besides appealing to the layman interested in natural objects it should be of value in the schools. Some knowledge of classification and of plants in their natural habitat is of fundamental importance, and unfortunately it is an aspect of botany which in many British universities is treated in an inadequate fashion.

There is need for similar books on geology constructed on a regional basis, so that a general knowledge of earth structure and its varied plant cover may become a common possession of all educated people.

F. J. Lewis.

STEAM TABLES AND STEAM POWER

The 1939 Callendar Steam Tables

Compiled and edited by G. S. Callendar and A. C. Egerton. (Published for the British Electrical and Allied Industries Research Association.) Second edition, with New Appendix on Properties of Compressed Liquid Water. Pp. 70. (London: Edward Arnold and Co., 1944.) 12*s*. 6*d*. net.

THE successful design of improved steam power-cycles utilizing high pressures and temperatures depends entirely on an accurate knowledge of the properties of steam. An increase in the efficiency of the steam cycle by 1 per cent represents a large annual saving in the coal cost for a modern power station; but this degree of accuracy in the calculations can only be attained if the tabulated properties of steam at extended pressures and temperatures are reliable. Practical evidence was obtained of the inaccuracy at high pressures of the earlier steam tables when high-pressure boilers were first constructed, for the calculated heat transferred to steam plus the measured losses in the boiler was greater than the heat supplied by the fuel. Since the losses in a modern boiler are small, and can be measured with a high degree of accuracy, it was clear that the tabulated total heats of steam were greater than the true values.

The work of the late Prof. H. L. Callendar is outstanding in the measurement of the properties of steam, and this research has been continued by Mr. G. S. Callendar and Sir Alfred Egerton, with the support of the British Electrical and Allied Industries Research Association. Research has also been conducted in the United States and on the Continent, with close co-operation between the investigators and the holding of three international conferences.

The following table has been compiled in order to compare the values of the total heat of saturated steam at various pressures as quoted by several investigators.

TOTAL HEAT OF DRY SATURATED STEAM ABOVE WATER AT 32° F. IN B.TH.U. PER LB.

Investigator and date	Pressure in lb. per sq. in. absolute 1	15	200	500	1000	2000	3000
Mollier; 1906	1103·3	1152·1	1205·6				
Marks and Davis; 1909 and 1922	1104·4	1150·7	1198·1	1210·0			
Callendar; 1915* and 1924	1102·4	1151·2	1205·4	1222·2	1230·9	1232·3	
Mollier, translated by Moss; 1927†	1103·2	1151·3	1200·6	1202·0	1179·4	1112·9	1001·2
Callendar and Moss; 1931	1102·4	1151·2	1203·5	1213·2	1204·3	1148·8	1039·3
Knoblauch, Raisch, Hausen and Koch; 1932	1104·9	1151·0	1198·5	1202·7	1190·2	1135·1	1017·0
Keenan and Keyes; 1936	1106·0	1150·8	1198·4	1204·4	1191·8	1135·1	1020·3
Koch; 1937	1105·5	1150·3	1198·9	1205·1	1191·6	1135·1	1019·7
Callendar and Egerton; 1939	1106·0	1151·6	1199·6	1205·5	1192·9	1136·1	1016·4

* 1915 Tables limited to 500 lb. per sq. in. pressure.
† Based on additional data by Mollier and revised equations.

The general deductions which may be drawn from these above figures are as follows: (*a*) There is a slight increase in the total heat values for steam at low pressures below atmospheric. (*b*) Little change has occurred in the total heat values of steam at atmospheric pressure. (*c*) There is a decrease in the total heat values for high-pressure steam amounting to about 3 per cent at 1,000 lb. per sq. inch and to 8 per cent at 2,000 lb. per sq. inch. (*d*) Since 1932 the values over the whole range of pressure are sufficiently in agreement for practical design purposes, and within the limits of tolerances set by the Third International Steam Table Conference, 1934.

In connexion with this comparison, it should be noted that the Callendar 1939 values are based on actual measurements of total heat, whereas other tables are based on values deduced from specific heat and volume measurements. The fact that the two systems of determination are now in substantial agreement indicates that the recently published properties of steam cannot err greatly from the true values.

The numerical values in the second edition of the Callendar 1939 Tables are unaltered from those in the first edition of these tables; but a new appendix on the properties of compressed liquid water at high pressures and temperatures has been added. These tables are the result of much careful research and planning, and should meet the requirements for many years of engineers concerned with the design and testing of steam power plant or of heating and ventilating systems.

H. Heywood.

LOGNORMAL DISTRIBUTIONS

By Prof. J. H. GADDUM, F.R.S.
University of Edinburgh

A LARGE part of statistical theory is based on the assumption that measurements are distributed in normal probability curves and that the variance is constant. The normal curve was discovered by de Moivre in 1753 and developed as a useful mathematical tool by Laplace, Gauss, Maxwell and others. It has a number of interesting properties, and various attempts were once made to establish a law of Nature known as the 'normal law of errors', which implied that measurements ought always to be distributed in this way. These attempts were undeservedly successful. The use of the adjective 'normal' in connexion with this law implies more than is justified by the facts, whereas in fact the adjective is established by custom and provides a convenient label for distributions of this type.

Referring to the normal law in the introduction to his "Thermodynamique", H. Poincaré (1892)[1] quotes the remark that "Everybody firmly believes in it because the mathematicians imagine it is a fact of observation, and observers that it is a theory of mathematics". Since that time the mathematical conditions for normality have been firmly established[2], but the best evidence that these conditions are fulfilled in any particular case is still the observation that the distribution actually is normal. It is therefore important, either to show that observations are normally distributed, or to convert them into a form which is normally distributed, or at least has the best possible chance of being normally distributed.

In some cases the normal curve gives a very close approximation to the observed facts. These cases are the exception rather than the rule; but it is usually possible to transform the distribution by means of some function of the actual observations which is normally distributed, so that if this function is used instead of the observations themselves the subsequent calculations are simplified and their scope is extended. This device is well known to statisticians, but not used so widely as it should be. It is obviously justified in simple cases. Suppose, for example, that the original observations were measurements of the diameters of drops in an emulsion (d) and that it was found that the distribution of d was not normal, but that the distribution of d^3 was normal. This would mean that the volume of the drops was normally distributed, and would show that it would be more convenient to consider the distribution of volumes than the distribution of diameters. The size of the drops can, in fact, be measured in a number of different ways. There is no particular reason why the original observations should represent the most convenient way, and no particular reason why the most convenient way should not be used even if it is less obviously reasonable than in the example given above.

"The linear scale, since it was first cut on the wall of an Egyptian temple, has come to be accepted by man almost as if it were the one unique scale with which Nature builds and works. Whereas it is nothing of the sort" (Bagnold[3]).

Even if one method of measurement gives normal distributions, it necessarily follows that most others will not; and since it is unlikely that the appropriate method will often be chosen first, it is only to be expected that most distributions will not be normal unless care is taken to select the appropriate method of measurement[4].

The second condition for the unfettered use of statistics is that the variance of the distribution shall be constant, or at least shall vary in some predictable way. If these two conditions are fulfilled, it is easy to calculate the significance of differences, regression lines, correlation coefficients, the analysis of variance and so on; but, if not, the possibilities are very restricted. For example, if the distribution is not normal, it is unjustifiable even to assume that the arithmetic mean is the best estimate of a quantity that can be derived from a set of measurements of it. Recent developments in statistical technique have thus greatly increased the importance of methods for normalizing distributions by altering the method of measurement, or by transformation of each observation by some suitable device such as taking its logarithm. This is particularly important when the standard deviation is large compared with the mean. When it is small, all ordinary transformations of this kind have less effect, and in the limit when it is very small no such transformation has any effect at all.

The theoretical justification for using normal curves depends on the mathematical fact, which is true within certain defined limits[2], that the sum, or arithmetic mean, of a large number of variables tends to be normally distributed even when the individual variables are not. If an observation (x) depends on the sum of the effects of a large number of small causes acting at random, and if each effect is independent of x, the distribution is likely to be normal. If it is not normal, we assume that this is because x is not measured in the right way. We find that $f(x)$ is normally distributed and we therefore transform our observations of x by converting them into observations of $f(x)$. The normal shape of the distribution of $f(x)$ is presumably due to the random combination of numerous causes each of which has a small effect on $f(x)$, and this effect is independent of $f(x)$. The effect of each of these causes on x will be proportional to $dx/d\ f(x)$, and Kapteyn[5] calls this quantity the 'reaction'. For example, if $f(x) = \log x$, the reaction is x. The effect of each small cause on $\log x$ is independent of $\log x$ (and of x); its effect on x is therefore proportional to x. If x is an astronomical observation involving a reading on a dial, the absolute value of x is usually irrelevant; the reaction is likely to be constant and the distribution is likely to be normal. In most scientific observations, however, the absolute value of x is not irrelevant. A fine day which adds a given weight to a large animal is not likely to add the same weight to a smaller animal. The gains in weight are more likely to be proportional to the size of the animal. In other words, the effect of the fine day on the logarithm of the weight is more likely to be constant than its effect on the weight, so that the logarithm of the weight is likely to be normally distributed. The assumption that this will be so is not likely to be exactly true; but it is likely to give a closer approximation to the facts than the assumption that the effect is independent of the weight.

The problem has been tackled in a rather different way by Curtiss[6], who discusses methods of calculating the appropriate transformation from various assumptions regarding the relation between measurements and their standard errors, and comes to the conclusion that when the error is proportional to the measurement the use of logarithms is likely to produce normal curves.

Testing Transformations

It is usually necessary to discover the best method of normalization by trial and error. Standard statistical methods such as the calculation of goodness of fit and moments give the ultimate criterion of the success of any particular method of normalization, but a simple graphical method indicates at once not only which transformations are successful, but also in what ways other transformations fail.

This graphical method consists in first applying the appropriate transformation to the observations and then plotting the results as abscissæ either on probability paper, or against probits as ordinates. The probit is best defined in terms of the normal equivalent deviation (N.E.D.). The N.E.D. corresponding to any given percentage is calculated from the shape of a normal curve the standard deviation of which is one; it is the deviation (from the mean) equivalent to the given percentage of the area of the curve. The probit is equal to the N.E.D. + 5. This is now a standard technique[7] and need not be discussed in detail. It has been widely used in experiments on toxicity, when the data are obtained as a relation between the dose of a drug and the percentage mortality which it causes[8,9]. Each mortality is converted, by means of tables, to a probit. If the animals vary in such a way that the dose (or transformed dose) is normally distributed, the probit should bear a linear relation to the dose (or transformed dose). It is usually obvious at once whether the plotted points are distributed at random about a straight line; and, if they are, it is possible with practice to draw a straight line which fits the results well enough for most purposes. Regression lines may be fitted if necessary, and it is possible to obtain the solution giving maximum likelihood by a suitable technique using successive approximations, which was discovered after less satisfactory methods had been used[10]. Any regular tendency for the points to diverge from a straight line shows that the distribution is not normal, and how it differs from the normal curve. The reciprocal of the slope gives an estimate of the standard deviation when the line is straight, and is proportional to the 'reaction' at each point when the line is not straight.

The primary use of this graphical method is where the data are limited to the percentages corresponding to different values of the variable (for example, dose); but the same method is sometimes helpful even when fuller information is available. If n observations have been made of a given variable, one method is to arrange them in order of size and then allot to the smallest observation a percentage of $100/2n$ and to succeeding observations percentages of $300/2n$, $500/2n$ . . . $(2n - 1)100/2n$. These percentages are then converted to probits and each individual observation is plotted. If the data are numerous they are grouped and added cumulatively, and the probits are plotted against the points separating the groups. When the number in a group is very small it is best to plot individual readings, or to assume that the observations are evenly distributed in the range covered by the group. If straight lines are obtained the distributions are normal, and the mean and standard deviation can be estimated fairly accurately from the graph. When results are treated in this way, the usual technique for calculating a regression line is inapplicable. The best estimates of the mean and standard deviation will be obtained by applying the ordinary methods directly to the transformed observations, but in some cases they can also be estimated from the moments of the original distribution. This is likely to be the most convenient method when the original observations are grouped, but its scope is limited. Examples are given below.

The use of probits also provides a general graphical method of normalizing distributions without the use of any formulæ. This may be useful when the scale on which the results are measured is a purely arbitrary one. If a random sample of observations is plotted against probits and a smooth curve is drawn through the results, this curve may be used for converting subsequent observations to a scale of probits, which are, of course, normally distributed. It is important in this case to be certain that the shape of the original curve and the variance of the transformed curve are stable. This principle has been applied by Ferguson[11,12] to the results of mental tests.

The Transformation $X = \log x$

The theoretical justification for using this transformation for most scientific observations is probably better than that for using no transformation at all. The general arguments in favour of it were discussed by Galton[13], who also directed attention to the fact that the normal law predicts negative observations. The existence of men of more than double the average weight implies the existence of other men with negative weight. When logarithms are used this difficulty does not arise.

When measurements are made of the size of a number of small objects of the same shape, it is often possible to measure either their diameters or their volumes. If the distribution of the diameters is normal, then the distribution of the volumes will necessarily be asymmetrical, and vice versa. The normal law cannot be true in both cases. The use of logarithms removes this difficulty[6]. If the logarithms of the diameters are distributed normally with standard deviation λ, the logarithms of the volumes will be distributed normally with standard deviation 3λ.

These theoretical arguments thus lead to the conclusion that this transformation should facilitate the interpretation of results when the variations are large; when they are small it can at the worst do very little harm, since it has very little effect on the shape of the curve. The extra labour involved in converting the observations to logarithms to base 10 is small, though perhaps sufficient to deter those who deal with small variations. Mathematicians prefer natural logarithms, but experimenters usually prefer ordinary logarithms to base 10, and these give equally good results. The symbol λ is used[8] to denote the standard deviation of the logarithms to base 10.

One logical consequence of the adoption of this method would be that the mean of the logarithms, or the geometric mean of the observations, would be taken as the most likely value, instead of the arithmetic mean. Williams[14,15] obtained direct evidence of the value of this in experiments on the number of insects caught in a light trap. The use of logarithms had the double advantage of making the results more consistent and of preventing the result from depending almost entirely on one aberrant large catch. It is likely that this device would increase the precision of most experiments in which the variation is large.

If the original observations have been grouped on an arithmetic scale, the direct computation of the

constants of the transformed distribution may be laborious. These constants can be calculated from the mean ($\bar{x}$) and standard deviation (σ) of the original distribution, but the estimates so obtained are only reasonably efficient when λ is less than 0·14[16]. In this region λ can be estimated within 3 per cent by dividing the coefficient of variation by 231. The general formulæ are

$$\overline{X} = \log_{10}(\bar{x}/(1 + \sigma^2/\bar{x}^2)^{1/2})$$
$$\text{and } \lambda^2 = 0{\cdot}4343 \log_{10}(1 + \sigma^2/\bar{x}^2).$$

Lognormal Distributions

It is proposed to call the distribution of x 'lognormal' when the distribution of log x is normal. Lognormal distributions have been discovered in many fields of work. Kapteyn[4] quotes the example of some data by Heymans on the threshold of sensation as measured by the smallest weight which was just perceptible on the skin. Wightman, Trivelli and Sheppard[17] found that the size of the particles of silver in a photographic emulsion were lognormally distributed. The diameters and areas of projection were measured, and it appeared at first that the form of the distribution of both measurements varied in different experiments. When the logarithmic transformation was used, normal curves fitted all the measurements of both diameter and area.

The distribution of sensitivities to drugs among individual animals of the same species, as measured by the dose required to cause some definite effect, has been widely studied. The sensitivity may vary over a tenfold range or more, but in practically every case the logarithm of the sensitivity is normally distributed or nearly so[6,18]. This fact, which is now generally accepted, has proved very convenient in the design of toxicity tests and in the calculation of their errors. The values of λ range from 0·014 to 0·91.

Similar methods have been applied to the action of disinfectants[19] and it has been found that the relation between time and the death-rate of bacteria can be explained, in some cases at least, on the theory that the logarithm of the survival time is normally distributed.

Hemmingsen[20] studied the distribution of the average size of the different species in each of various phylogenetic groups and found that they were distributed approximately lognormally ($\lambda = 0{\cdot}083$–$0{\cdot}673$).

Other examples of lognormal distributions have been found in estimates of the numbers of plankton caught in different hauls with a net[21], and in the amounts of electricity used in medium-class homes in the United States[22].

Bacteriologists have to deal with wide ranges of variation, as is illustrated by the data of Brew[23], who calculated coefficients of variation up to 640 per cent in bacterial counts. Such data can only be effectively treated by some such device as that discussed here, and bacteriologists often use a logarithmic scale.

Wechsler[24] collected a large number of data relating to measurements of human beings, and had trouble with their interpretation. The distributions were sometimes normal, but when the variation was large, the curves were skew with the mode less than the mean. He found that it was best to express the range of variation in terms of a ratio, and used for this purpose the ratio of the measurement on the 999th individual out of 1,000 to the measurement on the second individual. When there were less than 1,000 individuals, he was at a loss for a method of extrapolation and took the total range actually covered by the observations. The curves obtained are just the kind which are improved by taking logarithms. A number of the distributions studied by Wechsler are, as a matter of fact, lognormal, or approximately so, and there can be little doubt that their interpretation would have been facilitated by taking logarithms. The values for λ in some of these data have been estimated as follows: height, 0·015, 0·0164, 0·0172, 0·017; blood sugar, 0·029; weight, 0·045, 0·055; blood pressure, 0·049; pulse-rate, 0·061, 0·067. It will be seen that λ for weight is about three times λ for height, as is to be expected theoretically.

Cooper[25] made a number of measurements of the size of drops in emulsions. Some of his distributions were apparently complex, but in the only example for which details are given the diameters (and volumes) are distributed lognormally to a close approximation ($\lambda = 0{\cdot}17$ for diameter).

Cochran[26] discusses various transformations and comes to the conclusion that the logarithmic one is particularly effective, but that it makes no significant difference when the coefficient of variation is less than 12 per cent. He gives evidence that the standard deviation was proportional to the mean in measurements of the reaction time of human beings in a word test, and concludes that the distribution is likely to be lognormal.

Williams[15,27] has applied the same transformation successfully to data in which the variable was not an actual physical measurement but a count of the number of insects caught in a light trap, or the number of words in a sentence by G. B. Shaw.

Some of the effects of drugs on enzymes, and of oxygen on hæmoglobin, can be explained on the theory that the molecules of a protein in a solution show continuous variations among themselves, and that certain of their properties are lognormally distributed[28].

The Transformation $X = \log(x + x_0)$

If the probit is plotted against log x and the points diverge from a straight line, it is sometimes possible to find an explanation in such factors as a failure to allow for the mortality occurring when no drug is given, or a failure to count drops too small to be seen. In some cases it may be desirable to find a transformation giving a closer fit to the data than the simple logarithm. One convenient formula is

$$X = \log(x + x_0).$$

This is useful when the curve shows a more or less constant curvature, or with flat curves which diverge most at their lower ends. If the curve is convex upwards with probits as ordinates, x_0 is negative; if it is concave upwards, x_0 is positive. If a good fit is obtained, it suggests that the variations are proportional to the amount that the variable exceeds the value $-x_0$. If full data are available the constants of the curve can be estimated from the mean and the second and third moments of the original distribution[29,30]. Kapteyn[4] gives another method. A rough estimate of x_0 may also be obtained from a graph in the following way. Take three equidistant points on the scale of probits, such as 4, 5 and 6. Estimate from the curve the corresponding values of log x and thus of x. If these values are x_1, x_2 and x_3, then we wish to determine x_0 so that $(x_2 + x_0)$ shall be the geometric mean of $(x_1 + x_0)$ and $(x_3 + x_0)$,

so that $(x_2 + x_0)^2 = (x_1 + x_0)\ (x_3 + x_0)$, or $x_0 = (x_2^2 - x_1\ x_3)/(x_1 + x_3 - 2x_2)$. The success of this correction can be tested by plotting log $(x + x_0)$ against probits. For extrapolation at one end of the curve it may be convenient to choose x_1, x_2 and x_3 near that end.

This transformation has been fitted to observations of the value of house property and of the size of the foreheads of crabs[4], the ages of employees of a commercial firm and the number of petals on a buttercup[29] and the weights of female students[30]. The curves obtained in this way fitted the observations better than formulæ obtained by the methods described by Pearson.

Curves of this type can be fitted to measurements recorded by Nagelschmidt[31] of the diameters of particles of airborne dust in coal mines. In some cases the distributions appear lognormal (λ=0·2–0·4), but in others the curves obtained when probits were plotted as ordinates against log diameter were concave upwards. When the transformation $X = \log (x + x_0)$ was used, the calculation of χ^2 showed that the fit was good.

Williams[15] used this transformation with $x_0 = 1$ in order to avoid complications in calculating the geometric mean when $x = 0$. This only affects the shape of the curve for small values of x.

Conclusion

If it were the normal custom, when scientific observations show uncontrolled variations large compared with the observations themselves, to convert them to logarithms before estimating their mean or variance, the usual result would be an increase in the accuracy and scope of the conclusions drawn from them.

[1] Poincaré, H. (1892), quoted from Mellor, J. W., "Higher Mathematics for Students of Chemistry and Physics" (Longmans, Green and Co., 1922).
[2] Cramér, H., "Random Variables and Probability Distributions", Cambridge Tract. Math., 36 (1937).
[3] Bagnold, R. A., "The Physics of Blown Sand and Desert Dunes" (London: Methuen, 1941).
[4] Kapteyn, J. C., "Skew Frequency Curves in Biology and Statistics" (Groningen: Noordhoff, 1903).
[5] Kapteyn, J. C., *Rec. Trav. Bot. Neerland*, **13**, 105 (1916).
[6] Curtiss, J. H., *Ann. Math. Statist.*, **14**, 107 (1943).
[7] Fisher, R. A., and Yates, F., "Statistical Tables" (Edinburgh: Oliver and Boyd, 1938).
[8] Gaddum, J. H., Med. Res. Coun. Spec. Rep., 183 (1933).
[9] Irwin, J. O., *J. Roy. Stat. Soc.*, Suppl. **4**, 1 (1937).
[10] Bliss, C. I., *Quart. J. Pharm.*, **11**, 192 (1938).
[11] Ferguson, G. A., *Psychometrika*, **7**, 19 (1942).
[12] Finney, D. J., *Psychometrika*, **9**, 31 (1944).
[13] Galton, F., *Proc. Roy. Soc.*, **29**, 365 (1879).
[14] Williams, C. B., *Ann. Appl. Biol.*, **24**, 404 (1937).
[15] Williams, C. B., *Trans. Roy. Entom. Soc. Lond.*, **90**, 227 (1940).
[16] Finney, D. J., *J. Roy. Stat. Soc.*, Suppl. **7**, 155 (1941).
[17] Wightman, E. P., Trivelli, E. P. H., and Sheppard, S. E., *J. Phys. Chem.*, **28**, 529 (1924).
[18] Bliss, C. I., and Cattell, M., *Ann. Rev. Physiol.*, **5**, 479 (1943).
[19] Withell, E. R., *J. Hyg.*, **42**, 124 (1942).
[20] Hemmingsen, A. M., *Vidensk Medd. fra Dansk naturh. Foren.*, **98**, 125 (1933).
[21] Snedecor, G. W., "Statistical Methods" (Iowa State College Press, 1940).
[22] Croxton, F. E., and Cowden, D. T., "Applied General Statistics" (New York: Prentice-Hall, 1939).
[23] Brew, J. D., *J. Dairy Sci.*, **12**, 304 (1929).
[24] Wechsler, D., "The Range of Human Capacities" (Baillière, Tindall and Cox, 1935).
[25] Cooper, F. A., *J. Soc. Chem. Ind.*, **56**, 447 T (1937).
[26] Cochran, W. G., *Empire J. Exp. Agric.*, **6**, 157 (1938).
[27] Williams, C. B., *Biometrika*, **31**, 356 (1940).
[28] Gaddum, J. H., *Proc. Roy. Soc.*, B, **121**, 598 (1937).
[29] Fisher, Arne, "The Mathematical Theory of Probabilities" (The Macmillan Company, 1922).
[30] Yuan, P. T., *Ann. Math. Statist.*, **4**, 30 (1933).
[31] Nagelschmidt, G., Med. Res. Coun. Spec. Rep. 244 (1943).

NEW VIEWS OF THE ORIGIN OF THE SOLAR SYSTEM

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THE field is still open for the formulation *de novo* of theories of the origin of the solar system. No observational test has ever been discovered which would impose a definitive restriction upon the basic possibilities, as, for example, to show whether or not we must look to some catastrophic event to produce the necessary initial conditions.

Interest in the problem has recently been revived by attempts to approach it afresh along three totally independent lines. Von Weizsäcker[1] proposes what amounts to a re-instatement of the nebular hypothesis, with the incorporation of several novel features; Alfvén[2] makes the radical suggestion that it was the magnetic field of the sun which governed the manner in which it acquired the material of the planets from interstellar space; Hoyle invokes a nova outburst as a catastrophic origin of this material. None of these theories can as yet claim completely to demonstrate that a planetary system must inevitably have resulted from its postulated initial conditions. But they all offer apparent explanations of some or other of the general characteristics of the actual planetary system. In spite of their diverse approaches, it is not impossible that further progress may be made by combining ideas drawn from more than one of them*.

At the same time, thanks to suggestions by Jeffreys and others, the idea is gaining ground that the basic agency in the formation of the solid substance of planets may be no more than the most common form of condensation from a vapour to a solid. This may prove to be a simplifying factor in the whole problem.

Weizsäcker's Theory

Weizsäcker's theory belongs to the class of those which seek the origin of a planetary system in a rotating nebulous envelope around an already existing sun. His fundamental hypothesis is that the chemical composition of the envelope was initially the same as that of the sun itself. Since the chemical composition of the present planets is very different (comprising a bigger proportion of the heavier elements) they can then represent only a fraction of the original mass of the envelope. Weizsäcker takes this fraction to be as low as one per cent. For he accepts a recent estimate by Biermann[3] for the composition of the sun, which gives it a much higher content of the lighter elements than is currently assumed. In this manner he proposes to overcome the difficulty, encountered by older theories of this class, that the initial density of the envelope would have been too small to lead by the ordinarily recognized gravitational processes to condensation into planetary bodies. At the same time, through the dissipation of the surplus 99 per cent composed of light elements, he proposes to account for the disappearance of an embarrassing amount of angular momentum.

Weizsäcker envisages several stages in the evolution of his system, each of which he investigates in detail. But it has to be said that the way in which it

* The meeting of the Royal Astronomical Society on July 13, 1945, was devoted to a discussion of these theories, which were outlined respectively by the present writer, Dr. A. Hunter, and Mr. F. Hoyle. Subsequent speakers were Prof. H. H. Plaskett, Prof. S. Chapman, Dr. H. Jeffreys, Dr. G. P. Kuiper and others. This article is a digest of what was said, with some slight additional commentary; it does not treat other recently proposed theories not included in the discussion, such as that of J. B. S. Haldane, *Nature*, **155**, 133 (1945).

is conceived to pass from one stage to the next involves a number of obscurities.

The envelope is considered to have been acquired in some relatively dense part of the general interstellar cloud. Since the latter was presumably in a state of turbulence, the first picture of the envelope is of an aggregate of portions of gas and dust particles moving in more or less independent orbits in the sun's gravitational field, the planes of the orbits being orientated in a haphazard fashion. Assuming a non-zero resultant angular momentum, the first effect of viscous interactions between the parts of the system is to bring them into nearly circular orbits in or near the plane through the sun normal to the axis of this momentum. This produces a flattening of the envelope; Weizsäcker estimates its resulting second stage to be approximately a disk of diameter about equal to that of the present solar system and thickness rather less than one-hundredth of this, the temperature of the material at any point being about the same as a planet there would possess at the present time.

By virtue of the orbital motions, the angular velocity of the material about the sun decreases outwards. The next effect of viscosity is to tend to equalize the angular velocity throughout. Now there is a familiar argument which appears to show that this results in a dissipation of the material, and such, fundamentally, is the process by which Weizsäcker disposes of his excess material. The argument, however, is one which Jeffreys has shown to be unsound, the actual effect of viscosity in such a system being mainly to cause the material gradually to ooze into the central body. Nevertheless, this in itself does not necessarily vitiate Weizsäcker's further inference that viscosity must produce turbulent convection currents in the material.

Weizsäcker argues that if the viscous forces are sufficiently small we should expect these currents to build up into some regular pattern. The endeavour to discover such a pattern is the central part of his whole work. He eventually proposes one consisting of a series of rings of large-scale 'vortices' moving with retrograde circulation between concentric circles along which there are trains of small turbulent eddies possessing direct rotation. In the 'vortices' themselves, turbulence is almost negligible and the eddies serve somewhat as 'ball-bearings' between them. A 'quantum condition' that an integral number of vortices should just fill each ring, coupled with certain conditions concerning the stability of individual vortices, requires the radius of the nth circle of the set to be proportional to 2^n.

Finally, Weizsäcker believes that the eddies must come together, and that this behaviour leads ultimately to the formation of planets by a mechanism of accretion. This way of locating the formation of planets gives satisfactory agreement with Bode's law concerning their distances from the sun. The fact that it does so is claimed by Weizsäcker as evidence for the occurrence of the whole process. He then finds scope in the theory for the production of satellites.

The pattern of 'vortices' may in itself possess all the properties that Weizsäcker ascribes to it. But it is founded upon a set of gravitational orbits which constitutes an extraordinarily special selection from among those of any random aggregate of such orbits. In fact the selected set possesses certain characteristics the reverse of the statistical ones of a random set. So it is exceedingly hard to conceive how it could naturally have arisen from any earlier state of the system. It is therefore scarcely to be expected that the theory will survive in anything like its present form. Its value will probably lie rather in stimulating a re-examination of many aspects of non-catastrophic processes which could have had some part in the formation of planets.

Alfvén's Theory

This theory, like the preceding one, supposes that the raw material of the planetary system was collected by the sun from interstellar space, but it makes everything depend upon the mechanism by which this was achieved. Alfvén's suggestion is briefly this: The sun was rotating and possessed a dipole magnetic moment; neutral atoms fell towards it under gravitational attraction until their motion became thermal owing to collisions and produced ionization; electromagnetic forces on the ions in the magnetic field overwhelmed gravity and prevented their falling further; the trajectories in the magnetic field led to an accumulation of ions in a thin layer near the sun's equatorial plane; there they once again became neutral and so acquired gravitational orbits; the planets then emerged as a result of a mode of coalescence described by Lindblad[4]. More precisely, this process is thought to have produced the major planets, while a similar one applied to dust-particles instead of gaseous atoms gives the others. The process necessarily involves a transfer of angular momentum from the sun to the captured material.

The fundamental difficulty of this approach is the question as to whether the sun can in fact possess the requisite unshielded magnetic field. A possible view is that its general field is inappreciable outside its own atmosphere, though it has been suggested that there may be slight evidence to the contrary in some observed features of comets' tails. Further, many questions concerning the production of the ions and concerning their mean free paths demand closer investigation than Alfvén has yet given.

So the situation is that, while electromagnetic effects would be of over-riding importance in the early stages under the conditions imagined by Alfvén, the realization of those conditions is still far from being an established fact. But his work does at least demand that, in the sort of re-examination contemplated at the end of the preceding section, the possibility of electromagnetic effects must be thoroughly investigated.

There are also points regarding the later stages which are not elucidated by Alfvén's work. For example, though it yields a density distribution which would give fairly correct relative masses of the planets were the material divided up at appropriate distances from the sun, it provides no clue as to why this particular division should in fact occur.

Hoyle's Theory

Hoyle believes that the difficulty of accounting for the mere quantity of material in the planets, if it is supposed to have been gathered from interstellar space, is more serious than the preceding theories allow. He therefore reverts to the hypothesis of a stellar, rather than interstellar, source of material. But instead of the more customary assumption that it was pulled out by a collision, he suggests that it was pushed out during a nova outburst. He cites the case of the Crab Nebula as showing that such a process can certainly involve a plentiful supply of potential raw material: since it started as a super-

nova in A.D. 1054, an estimated quantity amounting to about fifteen times the mass of the sun has been ejected. In such a case the material comes away with very high velocities. But Hoyle asks what would have happened had the original star been a binary.

Suppose the sun had at one time possessed a companion at about the distance of Jupiter, and suppose this companion became a nova. The ejected matter might not then come off with complete isotropy, so that the nucleus of the nova might have been knocked out of the system. When the outburst was dying down, some of the ejected matter may have had insufficient energy to escape from the gravitational field of the sun. This is Hoyle's suggested source of material for the formation of planets; the captured material need represent only a modest fraction, perhaps of the order of 10^{-4}, of the total ejected matter. The resultant angular momentum is regarded as traceable to the original orbital motion of the binary. However, the idea is so far only in tentative form; its author will no doubt shortly provide a fuller discussion.

Condensation Processes

Hitherto, gravitation has usually been thought of as the fundamental agency responsible for the condensation of nebulous matter into planetary bodies, either by causing a cloud of such matter to collapse upon itself under its own gravitation, or else by aiding accretion by causing particles of a cloud to fall towards an incipient planet passing through it. Jeffreys[5] has, however, recently posed the crucial question as to whether gravitation is the only important agency in producing condensation. The commonest process of condensation with which we are familiar is that represented by a raindrop. Is it possible that this process plays a part in the formation of a planet? The actual form of the process would be more like that which occurs in the production of a snowflake, condensation being directly into the solid state. The only criterion as to whether it will take place is that the partial pressure in the surrounding gas should exceed the vapour pressure of the solid. The necessary figures for the vapour pressures of planetary matter in the solid state are difficult to come by; but Parson[6] has given estimates according to which the criterion is likely to be satisfied at the kind of temperature to be encountered at, say, the distance of Jupiter even for existing pressures there.

The merit of such condensation as the key to the production of planetary material is that it can proceed in much less specialized conditions than the elaborations of the various theories are designed to provide. It is, in fact, fundamentally equivalent to an earlier suggestion by Lindblad[4].

Some indication of the validity of these ideas may be found in the fact that there are in the solar system small bodies, the density of which is less than that of any known solid. Jeffreys's suggestion is that such a body may be a loose agglomeration of crystals which have grown by this process of condensation—that the body possesses, in fact, the structure of a large snowball.

[1] Von Weizsäcker, C. F., *Z. Astrophys.*, 22, 319 (1944).
[2] Alfvén, H., *Stockholms Obs. Ann.*, 14, No. 2 (1942); No. 5 (1943); *Nature*, 152, 721 (1943). An account of the theory and of the difficulties in previous theories which it is designed to overcome is given by A. Hunter, *Nature*, 156, 378 (1945).
[3] Biermann, L., *Z. Astrophys.*, 22, 4 (1943).
[4] Lindblad, B., *Nature*, 135, 133 (1935).
[5] Jeffreys, H., *Nature*, 153, 140 (1944).
[6] Parson, A. L., *Nature*, 154, 707 (1944).

REACTIONS AT INTERFACES AND THEIR SIGNIFICANCE IN BIOLOGY

By Dr. J. F. DANIELLI
Department of Zoology, University of Cambridge

In his Liversidge Lecture before the Chemical Society, on "Reactions in Monolayers", Prof. E. K. Rideal made the most comprehensive survey yet available of studies of chemical reactions in monolayers. This is a field of chemistry which has recently become of exceptional interest to the biologist, so much so that the cell physiologist cannot afford to be ignorant of the progress which has been achieved in the last fifteen years; this is all the more remarkable in that thirty years ago this aspect of chemistry, practically speaking, did not exist.

It has, of course, for long been realized that reactions at interfaces present peculiar features, and that some of these may be of great importance in biology. F. G. Donnan laid emphasis on the importance of surfaces in biology when giving the first Liversidge Lecture. But before biologists could begin to consider these theoretical possibilities in relation to their special field it was requisite: first, that techniques should be devised capable of dealing with the surface properties of molecules of types of biological interest; and secondly, that an exploration should be made of the types of reaction and behaviour particularly characteristic of molecules at interfaces. The first of these steps was to a large degree accomplished by the early nineteen thirties, but the second phase was barely commenced. N. K. Adam had made some studies of hydrolysis of lactones in monolayers, and of the oxidation of cholesterol monolayers, which were highly suggestive. To-day a substantial part of the field has received a preliminary survey, largely embodied in reports from Prof. Rideal's own laboratory, and, though only parts of the field have been touched, it is already apparent that it will yield results of the greatest value to biologists.

From a theoretical point of view, the importance of this field is sufficiently emphasized if we consider some of the reactions involving the common major components of living tissues—fats, proteins, nucleotides and carbohydrates. The great majority of the natural fats are so insoluble in water that their reactivity as individual molecules in aqueous solution can be neglected. The final steps in their synthesis, and the initial steps in their utilization, must occur either in the interior of a lipoid phase or at a lipoid-water interface. The enzymes catalysing these reactions are insoluble in lipoids, so that the reaction site is limited to interfacial regions. The same is true of the steroids. The proteins are thought by some to be synthesized as polypeptide chains adsorbed at oil-water interfaces, and to acquire specific characteristics as globular proteins by processes occurring on desorption. Whether this be so or not, it is certain that a protein molecule, in the later stages of its synthesis, itself constitutes a moderately well-defined interface, in the vicinity of which any further synthetic or degradative reactions must occur. Finally, the enzymes catalysing the reactions affecting fats, steroids, proteins, nucleotides and carbohydrates are themselves such large molecules that the reactions they catalyse are in fact occurring at the surface of the enzymes, that is, at an enzyme-water interface, and in no sense in a homogeneous solution. In brief, it is fair to say that the present state of knowledge

indicates that the vast majority of the chemical reactions occurring *in vivo* are reactions occurring at interfaces, and moreover at interfaces resembling in type those which can be explored by present-day surface techniques.

That chemical equilibria at interfaces would be different from those in homogeneous solution was suggested by J. J. Thomson (1888), in his work "Application of Dynamics to Physics and Chemistry". Much attention has from time to time been devoted to the study of this principle, and H. Freundlich (1930), when giving the second Liversidge Lecture, brought together many striking examples of this phenomenon. We now know that interfacial regions differ from the homogeneous phases with which they are in contact in many particulars: the *p*H, ionic strength, oxidation-reduction potential and the ratio of univalent to polyvalent ions at an interface may all differ substantially from their values in the surrounding bulk phases. In addition to these differences, molecules diffusing into the interface will often be subject to special forces produced by the orientation of molecules at the interface, as a result of which unusual concentrations and juxtapositions of particular chemical groupings may arise, and to a sharp electrical potential gradient in the interfacial region produced by the oriented polar groups of the interfacial molecules. Some of the effects of these peculiarities of interfaces may be demonstrated by very simple experiments. Deutsch (1929) showed that if an aqueous solution of a *p*H indicator is shaken with a little liquid hydrocarbon, a marked colour change will occur if the *p*H of the aqueous solution is in the region in which the indicator is sensitive. The colour change produced by shaking is caused by adsorption of indicator on to the surface of the emulsified hydrocarbon, and is quite reversible, the original colour returning as the emulsion breaks. The change in colour on adsorption is produced by a shift in chemical equilibrium subsequent to adsorption. Later studies have shown that the shift is mainly caused by the fact that the *p*H in an interfacial region differs from that in the surrounding bulk phases. The colour shift shown by this experiment of Deutsch is in some ways allied to what is commonly known as the 'protein error' with *p*H indicators. When *p*H indicators are added to aqueous solutions of proteins, the colour produced may indicate a *p*H differing by more than a *p*H unit from the true value, given by a glass electrode. This 'error' has been shown to be produced, in part at least, by the fact that the *p*H at the surface of a protein molecule is substantially different from that of the bulk aqueous phase in which the protein is dissolved. When the indicator is adsorbed, it of course tends to react to the interfacial *p*H, not to the bulk *p*H.

A similar displacement of equilibrium is observed if a monolayer of palmitic acid is spread upon a solution of sodium and calcium acetate. If the sodium : calcium ratio in the acetate solution is 100 : 1, we might perhaps expect to find a similar ratio in the monolayer. But when the monolayer is swept off the solution and analysed, it is found that there is rather more calcium than sodium in the monolayer! This phenomenon lies behind the efficiency of calcium as an antagonist of the detergent action of soaps, and is likely to be concerned in determining the so-called 'physiological ratio' of sodium to calcium. For normal physiological behaviour of a tissue it is usually necessary that the fluid bathing it should have a sodium : calcium ratio of the order of 100 : 1. That one calcium ion should be competent to balance the action of a hundred sodium ions is inconceivable; but if, as we now believe, the site of action of the ions is a surface, and at this surface rough equality of concentration and balance of action of sodium and calcium is produced by a bulk ratio of 100 : 1, then we have a reasonable explanation of the importance of the physiological ratio of this order.

Experiments such as those just mentioned are not those with which Prof. Rideal was particularly concerned, but formed part of the background of less specific factors against which the review of more specific factors given in his lecture must be viewed. By using the special techniques of surface chemistry, he and his colleagues have been able to study many details of behaviour of the molecules which are more permanently fixed at an interface. For example, it has been shown that the velocity with which a molecule in a monolayer will react with a constituent of the bulk solution is a function of the closeness of packing of the molecules; the closer the molecules are together, the more slowly they react with the bulk phase component. This is true of the hydrolysis of lactones and esters by hydroxyl ions, and of the oxidation of unsaturated fatty acids by acid permanganate solution. Compression of a monolayer of such substances affects the rate of reaction by changing both the energy of activation and the steric factor, as may be shown by the case of the hydrolysis of trilaurin by hydroxyl ions: when the surface pressure, that is, the force compressing the monolayer in the two dimensions of the surface, is raised from 5·4 to 16·2 dynes/cm., the activation energy is raised from 10,100 to 15,100 calories, while the steric factor increases from $1{\cdot}1 \times 10^{-6}$ to $4{\cdot}1 \times 10^{-2}$. The velocity of hydrolysis of esters in monolayers is also affected by the orientation of the different parts of a molecule with respect to one another. Cetyl palmitate takes up one type of configuration giving a velocity constant of 0·18 min.$^{-1}$ under a given set of conditions, whereas ethyl palmitate, taking up a quite different configuration at an interface, has a velocity constant under the same conditions of 0·005 min.$^{-1}$. Prof. Rideal points out that there is some degree of parallelism between the phenomena observed when esters in monolayers are hydrolysed by hydroxyl ions, and those observed when the enzyme lipase is the catalytic agent. It would be of great interest to see such studies extended, though a pre-condition for analysis of the enzyme studies may perhaps be the isolation of pure lipase, which has not yet been achieved. But even the present state of investigation is of interest and assistance to the biologist in the formulation of working hypotheses concerning the control of enzymic reactions. One of the central problems of the cell physiologist is to discover the mechanisms whereby the rates of enzymic reactions are adjusted to suit the needs of the organism. It is common for enzyme and substrate to exist in the same cell, apparently in close proximity, and yet no net reaction will proceed until a particular phase of physiological activity is embarked upon. The influence of surface pressure on reaction velocity indicates one means whereby a reaction may be held in abeyance until required.

Another phenomenon of great interest to biologists is the formation of molecular complexes between molecular types such as fats, steroids, phospho-lipins, proteins and lytic molecules. Monolayer techniques

form an unusually elegant means of studying these complexes. When a second substance is injected into the aqueous solution underlying a monolayer of a pure substance, a large increase in surface pressure is found if complex formation occurs accompanied by penetration of the second molecular species into the monolayer. If the reaction is between polar groups only of the two molecular species, there may be no change of surface pressure, but there will be a change in the electrical potential across the film. If there is no complex formation of any type, no change in either surface pressure or potential occurs. Complex formation of the type revealed by these surface techniques has been shown to be of importance in the mechanism of red cell lysis, and in the permeation of some membranes by such substances as phenols. For example, the penetration of hexyl resorcinol into *Ascaris lumbricoides*, according to Trim and Alexander, may be accelerated by a factor of about fourfold by adding low concentrations of detergents, with which the resorcinol forms complexes. The mechanism of this acceleration is not yet understood, and may well repay detailed study.

Interesting complexes are formed between some carotenoids and certain proteins. Astaxanthin exists in the eggs and integument of lobsters, crabs, etc., as a blue-green pigment. The carotenoid is readily oxidized to astacene in the dead animals. When the association between carotenoid and specific protein breaks down, a colour-change ensues. The association may be destroyed by boiling, which denatures the specific protein, or by addition of sodium soaps. In the latter case, the change is reversible, restoration of the original complex being achieved by addition of calcium (Peters and Wakelin). Visual purple also appears to be a complex of this type, namely, protein-carotenoid. One theory of the action of light upon visual purple is that it oxidizes a terminal CHOH group of a polyene chain to the corresponding aldehyde. Monolayer studies show that on conversion of a CHOH group to a CO group, a large change of surface potential occurs. It is therefore possible that, if the carotenoid of visual purple also forms part of the lipoid layer of the cell membrane, the photo-oxidation will produce a change in surface potential sufficient to cause electrical excitation of the cell. These relationships are at present all highly speculative, but it is in harmony with recent developments in cell physiology to adopt the working hypothesis that the stimulation of retinal cells by light is produced by a surface photo-oxidation of the visual pigment incorporated in the cell membrane, and that the change in surface potential produced by this reaction temporarily discharges the resting potential of the cell, causing an electrical response.

These reflexions on the topics of Prof. Rideal's lecture show that a pathway for investigation of many biological problems has already been secured by the study of reactions at interfaces. So numerous are these possibilities that the rate of investigation of these fields is likely in the immediate future to be determined almost entirely by the number of investigators available; all such investigators will find a source of inspiration in Prof. Rideal's lecture.

OBITUARIES

Prof. Ernest Shearer

A NATIVE of the island of Stromness in Orkney, Ernest Shearer was brought up to farming; but he could also sail a boat and follow the maritime pursuits of his Viking ancestry. A 'lad of parts', he was thoroughly schooled in mathematics and classics and went on to the University of Edinburgh where, between 1897 and 1904, he studied and graduated M.A. with honours in economics and B.Sc. in agriculture. His first appointment was to the Indian Agricultural Service, where in five years he reached the grade of assistant inspector-general. In 1911 he was appointed under the Egyptian Government as principal of the Giza Higher College of Agriculture and in 1919 he was made chief technical officer in the Egyptian Ministry of Agriculture.

In 1924 Shearer accepted the post of principal in the Edinburgh and East of Scotland Agricultural College; two years later he was made professor of agriculture in the University, thus becoming the first head of the Edinburgh School of Agriculture. During his tenure of office the proper utilization of land and the teaching of young farmers became more and more of national importance, and he rose to eminence as an authority on agricultural education. He reached this position by reason of his training and experience, but also because of inclination, for he had a great interest in, and sympathy for, young people. When he retired from his academic posts in the autumn of 1944 he became secretary to the Mid and East Lothian Agricultural Executive Committees, and thus continued to serve the farming community until the time of his death.

Shearer was a large and genial man, entirely free from affectation, with a strong sense of humour and great personal charm. Completely at ease in any situation, he would pass an hour as happily with his gardener as with his fellows on the Senate. He handled a brilliant pen and possessed great strength of character and determination. Not only was he thus well qualified for leadership but he could also be relied on to fight for any right cause and to stand like a bulwark in the interests of his people.

His hobby was the propagation of fine fruits and beautiful flowers. He had planned to retire to his beloved Orkney and to devote himself to the production of plants which would bring both amenities and profit to the island farmers. His untimely death is, therefore, as much a loss to his native land as it is a grievous blow to his friends and colleagues.

J. A. MORE.

Mr. L. E. Adams

LIONEL ERNEST ADAMS, who was well known to an earlier generation as an active and enthusiastic observer of the natural history of the British Isles, died at Ryde, Isle of Wight, on September 20, at the age of ninety.

Adams was the nephew of Henry and Arthur Adams, famous in their day for their researches on the molluscs, and joint authors of "The Genera of Recent Mollusca". Circumstances did not allow him to follow his uncles' wider sweep, and he had to confine himself to the British land and freshwater species, on which he became an authority of repute.

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

THE INSTITUTION OF CHEMICAL ENGINEERS

EXAMINATION, 1946

Application forms (returnable December 1, 1945) and particulars of the Associate-Membership Examination for 1946 may be obtained from the Hon. Registrar, Institution of Chemical Engineers, 56 Victoria Street, Westminster, London, S.W.1.

TOBACCO RESEARCH BOARD OF SOUTHERN RHODESIA

Applications are hereby invited for the posts of (a) ENTOMOLOGIST and (b) PLANT PATHOLOGIST at the Tobacco Research Station, Trelawney, Southern Rhodesia.

The appointments will be on a contract basis for a period of three years in the first instance at a salary of £600 per annum.

The successful applicants will be required to produce a satisfactory medical certificate on the prescribed form signed by a Medical Officer appointed by the High Commissioner for Southern Rhodesia.

Applicants should hold a good science degree from a recognized University of the British Empire, and in the case of (a) should have specialized in Entomology and in the case of (b) should have research experience in Plant Pathology.

Applications accompanied by particulars of age, qualifications and copies of testimonials should be addressed to the Chairman, Tobacco Research Board, P.O. Box 387, Salisbury, Southern Rhodesia, and will be received up to December 31, 1945.

The successful applicants will be required to assume duty as soon as a passage can be obtained for them. The cost of these passages will be met by the Board.

COUNTY BOROUGH OF DONCASTER EDUCATION COMMITTEE

TECHNICAL COLLEGE

Principal: G. Lawton, Ph.D.(Lond.), B.Sc. Hons. (Lond.), F.R.I.C., A.M.I.Chem.E.

Applications are invited for the post of full-time teacher of Physics and Mathematics in the Department of Chemistry, Physics and Biology. Honours Graduate with teaching experience desired; industrial experience desirable but not essential. Salary in accordance with the Burnham Technical Scale.

Further details and forms of application may be obtained by sending a stamped addressed envelope to the undersigned, to whom completed forms should be returned by October 27, 1945.

V. H. HOSKIN,
Education Offices, Chief Education Officer.
Doncaster.

THE UNIVERSITY OF LEEDS

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY

Applications are invited for the post of Lecturer in Physiology in the University of Leeds, the appointment to date from March 1, 1946, or as soon thereafter as can be arranged; applications from service candidates will receive consideration.

The Lecturer will be responsible to the Professor of Physiology and to the Council and will be required to give his whole time to the work of the Department; his duties will include teaching in the Faculties of both Science and Medicine and the prosecution of research. The Lecturer's salary will be on the scale £500 rising by annual increments to £800 and the person appointed will be required to join the F.S.S.U. A scheme of Family Allowances is at present in force.

Applications, stating age, qualifications and experience, and the names of three persons to whom reference may be made, should be sent, not later than February 16, 1946, to The Registrar, The University, Leeds, 2, from whom further particulars may be obtained.

UNIVERSITY OF MANCHESTER

AGRICULTURAL ADVISORY DEPARTMENT

The following post is vacant in the Agricultural Advisory Department, Manchester University: ASSISTANT to the ADVISORY ENTOMOLOGIST (Temp. S.S.A.).

The appointment is temporary and not superannuated. Salary £300–£375 p.a. according to qualifications, plus £60 p.a. bonus.

Applications, together with copies of two recent testimonials, should be sent to the undersigned not later than October 29, 1945.

ARTHUR JONES,
The University, Chief Advisory Officer.
Manchester, 13.

THE ROYAL CANCER HOSPITAL (FREE)

FULHAM ROAD, LONDON, S.W.3

Applications are invited for the post of PHOTOGRAPHER to take charge of the Photographic Department. Salary at the rate of £400–£500 per annum, according to experience. The Department is staffed by a photographer and two assistants and deals with clinical photography, reproduction work, photomicrography and cinephotography for clinical and research departments. Applications, stating age, nationality, qualifications with dates, experience and details of previous appointments, accompanied by copies of two recent testimonials, should be sent to the Secretary not later than October 31, 1945.

B.E.A.I.R.A.

The Council of the above Association seek applications for the position of DIRECTOR from those who have had experience in electrical research, preferably from those who in addition have had some contact with the electrical supply and manufacturing industries. Age preferably not exceeding 50 years. Commencing salary £2,500 per annum with Superannuation (F.S.S.U.). It is desirable that the successful candidate should be able to take over early in the new year or sooner if possible. Applications with supporting particulars, which should be received not later than Friday, November 16, 1945, should be sent under personal cover to the Chairman of the Council, The British Electrical and Allied Industries Research Association, 15 Savoy Street, London, W.C.2.

UNIVERSITY COLLEGE LEICESTER

ASSISTANT LECTURESHIPS in BOTANY, CHEMISTRY, GEOGRAPHY, MATHEMATICS, PHYSICS, ZOOLOGY.

Applications are invited for the posts of Assistant Lecturer in each of the above subjects. Salary £350 p.a. Duties to commence January 1, 1946, or as soon thereafter as possible. Further particulars may be obtained from the Registrar to whom applications should be submitted not later than November 10.

UNIVERSITY OF BOMBAY

DEPARTMENT OF CHEMICAL TECHNOLOGY

The last date for the receipt of applications for the posts of (1) Reader in Plastics, Paints and Varnishes and (2) Singhanee Lecturer in Chemical Engineering (*Nature*, July 28, 1945) has been extended to January 15, 1946.

S. R. DONGERKERY,
Bombay. University Registrar.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Professor of Physics. Salary £1,250 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 17, 1945.

IMPERIAL MYCOLOGICAL INSTITUTE

ASSISTANT MYCOLOGIST required for indexing and editorial work. Literary ability and language qualifications desirable. Salary according to experience. Apply Director, Imperial Mycological Institute, Ferry Lane, Kew, Surrey.

NORTHAMPTON GENERAL HOSPITAL

Laboratory Technician required for Histology Department.

Salary in accordance with the British Hospitals' Association scale. Federated Superannuation Scheme in force.

Applications to the Superintendent.

Technical and Scientific Register of the Ministry of Labour and National Service, Appointments Department require a Physicist, to assist in work of advisory and employment service for men and women in this profession. Appointment will be made within salary range of £550 to £700 p.a. plus war bonus of £60, according to qualifications and experience. Candidates must possess University Degree in Physics. Apply in writing with full particulars to the Register, Room 473, at York House, Kingsway, W.C.2, by October 31, 1945.

Graduate Physical Chemists required, with research or industrial experience, age about 25, for research on conducting and dielectric properties of materials. Applicants should give full details of qualifications, experience and salary required to: Metropolitan-Vickers Electrical Co., Ltd., Research Department, Trafford Park, Manchester, 17.

Wanted: Young Man with scientific qualifications to assist in the culture of Lobsters and Oysters. Must be fond of sea fishing and prepared to live in somewhat primitive conditions. Good vacations and opportunities to keep in touch with Marine Biological establishments. Starting salary £300 per annum plus travelling expenses and an interest in results. Write Haliotis, Lynford, Keppel Road, Dorking.

Research Laboratories, West London, require trained abstractor for scientific library (mainly bio-chemistry and nutrition). Typing essential, knowledge of library routine advantageous, German desirable. Applicant should hold a science degree or should have had considerable experience. Position permanent and pensionable. Salary £350, or more if experience warrants. Write Box 846, Spottiswoodes, Regent House, Kingsway, W.C.2.

B.Sc. (Chemist, some research), 35, adaptable, wide experience of photographic technique (theoretical and applied), and optical measuring instruments, also technical journalism and lecturing, seeks post to develop one or all of these interests. Box P.149, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Qualified Physicist required by large firm in S.W. London area, for position of responsibility on Discharge Lamp Development. Some similar experience essential. Apply with full details of qualifications, previous experience, and salary required, to Box No. 885, L. P. E., 110, St. Martin's Lane, W.C.2.

Physicist, aged 25 to 30 years, graduate with research experience in general physics and electronics, to take charge under Consultant of small research department in old-established instrument manufacturing firm in London. Apply Box 425, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Woman B.Sc. (Physics and Maths.) seeks change of post; experienced in secretarial work, abstracting, patents (radio and television), good French and German, rudiments of Russian. Box P.146, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Organic Research Chemist, Ph.D., aged 26, seeks post of suitable responsibility. Four years academic and industrial research; experienced in controlling laboratory staff. Interests and experience: medical aspects of chemistry. Box P.145, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Indexer-Abstractor required by industrial research association in London. Knowledge of Chemistry, technical French and German essential. Superannuation under F.S.S.U. Salary £300–£450, according to qualifications and experience. Write Box 424, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Experienced Librarian (female), knowledge of German and French, seeks responsible position. Box P.148, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

For Sale: Petrological Microscope, Bausch & Lomb, Model LCH; Oculars 7, 5, 10 and 12.5; objectives 32 mm., 16 mm. and 4 mm. Offers to Box P.147, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Small Beck Microscope for sale with necessary fitments. Price £25. Critchett, 10 Earle Road, Bournemouth, West.

Brownian Movement—For Viewing units, as supplied to Polish Board of Technical Studies at London University, etc. Write Dr. S. C. Blacktin, 20 Denton Avenue, Leeds, 8.

Mercury Interrupter for large induction coil urgently wanted. New or second-hand. Box P.150, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Modern Inclined Binocular Research Microscope (Swift) with full range of apochromatic objectives and large collection of accessories, for sale complete at pre-war catalogue price totalling £250. Dr. Amies, Lister Lodge, Elstree, Herts.

Wanted: Complete sets and runs of Scientific Periodicals, including Nature and Learned Society publications.—The Scientific Book Supply Service, 5 Fetter Lane, London, E.C.4.

Microscopes, of all descriptions, only a few available, second-hand, perfect condition. Send details of your requirements, enclosing 3d. stamp.—Telephone or correspondence only. Chards, Forest Hill, S.E.23 (Spring Park 1628).

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

In 1884 he published "The Collectors' Manual of British Land and Freshwater Shells" with coloured plates drawn by his brother Gerald, but the figures of *Pupa* and *Vertigo* (Pl. vii, Figs. 10–22) prove that the author himself was no mean artist; a second edition appeared in 1896. Apart from this one book, Adams published many notes and papers in various natural history journals, especially in the *Journal of Conchology*. Most of these dealt with the habits of the animals, and were precursors of the ecological studies so fashionable to-day.

The native mammals of Britain attracted him strongly, and on them he spent much of his energy. The most widely known of these researches is that on the 'fortress' of the mole. After digging out no fewer than three hundred of these structures, Adams was able to show that not one of them was like the familiar figure derived from Blasius and Geoffroy St. Hilaire, which had been copied by one or another writer of popular works for more than a hundred years.

Even this did not exhaust Adams's activities. There was scarcely a group of invertebrates from earthworms to woodlice which he did not collect at some time or other, either on his own behalf or because he knew that someone needed the material for study. In the field he was a lively companion, a noted teller of stories; as a correspondent he was prompt and accurate, ready to pass on all the information at his disposal. A. T. Hopwood.

We regret to announce the following deaths:

Prof. George R. Gage, professor of botany in Vanderbilt University, Nashville, Tennessee, on August 18, aged fifty-five.

Mr. C. F. Dendy Marshall, a founder member and past-president of the Newcomen Society and an authority on the early history of railways, on June 14, aged seventy-two.

NEWS and VIEWS

Biochemistry at University College, London: Prof. F. G. Young

Prof. F. G. Young is relinquishing his chair at St. Thomas's Hospital Medical School to succeed Sir Jack Drummond as professor of biochemistry at University College, London. In so doing, Prof. Young will be renewing a long association with University College, of which he was an undergraduate in the honours school of chemistry; for, in addition to receiving his early training there, he was successively (1929–32) Bayliss-Starling Scholar in biochemistry, Sharpey Scholar and Shafer Prizeman in physiology. After holding Beit Memorial fellowships for medical research, Prof. Young then gained further experience by serving as honorary research assistant in the Department of Physiology, Aberdeen, and research associate, Department of Physiology, Toronto, returning to University College in 1934 as honorary assistant in the Department of Biochemistry. Two years later he joined the scientific staff of the Medical Research Council, on which he stayed until his appointment to the chair at St. Thomas's Hospital Medical School in 1942.

Prof. Young has already established an international reputation for himself by his research work. Commencing with the intermediary metabolism of carbohydrates, he was led naturally to the study of the diabetogenic action of extracts of the anterior pituitary and later to other activities of this gland. With Folley he published an important contribution upon the lactogenic hormone which led to further studies with Folley and others on the galactopoietic action of pituitary extracts. It is, however, in the sphere of carbohydrate metabolism that Prof. Young's chief interest has resided and in which his most numerous contributions have been made. In addition to his great activity as a research worker, Prof. Young has also given generously of his time to the Biochemical Society, which he served as joint secretary during 1938–42. In this year he was elected chairman of the editorial board of the *Biochemical Journal*, and the high standard maintained by that journal is an eloquent tribute to the success of his vigorous leadership. Prof. Young will carry the good wishes of all his colleagues with him to University College.

Prof. John Yudkin

Dr. John Yudkin, whose appointment to the chair of physiology at King's College of Household and Social Science (University of London) has recently been announced, takes with him from Cambridge a high reputation as an experienced and successful teacher. Since 1934 he has been supervisor in biochemistry and physiology at Christ's and Emmanuel Colleges, and since 1940 director of medical studies at Christ's. He is also distinguished as an investigator with wide interests in several fields of biochemistry and nutrition. Possessing a particular regard for the social implications of nutritional knowledge and its application in public health, he has shown much organizing ability in the planning of various nutritional and dietary surveys. Dr. Yudkin entered Christ's College with an open scholarship in 1929 and graduated in 1931, after taking biochemistry in Part 2 of the Natural Sciences Tripos. He was awarded the Benn Levy Research Studentship in 1933, and for some years was engaged in research at the School of Biochemistry and the Department of Colloid Science, Cambridge, on problems relating to bacterial enzymes, with special reference to the mechanism of adaptation and variation. In 1936 he interrupted his research work temporarily in order to complete his medical qualification; he received the Letheby Prize in pathology at the London Hospital.

Since 1936 Dr. Yudkin has specialized in nutritional investigations, and has been attached to the Dunn Nutritional Laboratory, Cambridge, where he has held successively a Grocers' Scholarship and a Halley Stewart Fellowship. He is author, or part author, of some twenty publications on the subject: the topics in which he has been specially interested including, *inter alia*, vitamin B_1 metabolism; dark adaptation and slit-lamp microscopy; dietary and nutritional surveys on school children and factory workers; and feeding tests with vitamins and other supplements. He joined the R.A.M.C. in 1943, being first attached to the R.A.M.C. College in London, and later as pathologist to the West African Forces, Sierra Leone, and has published a number of papers from both these centres.

Naval Research and Development

Dr. C. F. Goodeve, the first holder of the post of deputy controller for research and development in the Admiralty, has left the department to take up the directorship of the British Iron and Steel Research Association. The post of assistant controller for research and development was instituted in 1942 and the status of the post has since been raised to that of deputy controller. The holder not only helps the controller of the Navy in supervising the application of science, technology and design engineering in the large range of departments which work under his superintendence, but is also adviser to the Board on research and development generally. Before Dr. Goodeve was appointed to this post he had been for some time previously associated with the Admiralty as an R.N.V.R. officer.

The new deputy controller for research and development is Mr. A. P. Rowe, who has during the War been head of the largest radar research establishment in Britain, the telecommunications research establishment at Malvern. This establishment, under the Minister of Aircraft Production, has been responsible for the research and design of the radar equipment both of the R.A.F. and the Fleet Air Arm. Mr. Rowe's connexions with defence research work go back to 1922, when he first joined the scientific staff of the Air Ministry.

Terrestrial Magnetism and Atmospheric Electricity

The present year, 1945, will mark the completion of the fiftieth year of the quarterly publication, *Terrestrial Magnetism and Atmospheric Electricity*, the foundation of which by L. A. Bauer in 1896 was a step of far-reaching importance for the progress of the sciences named in its title. It provides a most valuable focus and forum for them, and for border subjects related to them, such as sunspot and ionospheric studies. Though the editorial and financial responsibility for the periodical has always been American, in the hands of its two successive editors, L. A. Bauer (1896–1932) and J. A. Fleming (1928 to date), the periodical is international in the sense that foreign associates have been and are linked with the responsible editors, and can advise or make suggestions either when requested or on their own initiative; and also that suitable contributions from all countries have been welcomed and have provided a considerable share of the matter printed. Moreover, though most of the papers are printed in English, and always have been, papers are invited also in French, German and Italian. The pages of the fifty volumes well mirror the great progress that has been made in these branches of geophysics during the half-century, and the printing and production have been maintained at a high standard from the outset, and throughout the war years. The subscription-rate, 3.50 dollars per year, is less than double that of 1896, and is remarkably low for a periodical of its size and excellence. The best wishes of the Editors and of many of the readers of *Nature* will be with the direction of *Terrestrial Magnetism* as it begins its second half-century next year.

Science and Development in Australia

The John Murtagh Macrossan Memorial Lectures delivered to the University of Queensland by Sir David Rivett on June 13 and 15, 1944, on "The Application of Science to Industry in Australia", have now been published (Brisbane: University of Queensland. Pp. 48). Sir David, while emphasizing the importance of the international exchange of ideas and thought and of traffic in the products of the experimental laboratory and of the original mind, points out that some decrease in the international to-and-fro movements of products of soil and factory, and in particular a diminished demand overseas for Australian primary products, may be expected, and may even be desirable, to eliminate unnecessary transport. Distribution, he suggested, has become once more a main factor in Australian economy; if we look after consumption, both in quality and in quantity, production will look after itself. That involves basing industrial life on the best human knowledge that is available or ascertainable; and if industrial activity in Australia is to be much more diversified, some general ideas as to the main lines of development and the place of scientific effort in that development are essential. We must think in advance so far as possible in a democracy; but we should do so with the clear understanding that the divergent phenomena of which all plans concerned with human relations have to take account make most plans nothing more than intelligent guesses as to the best justifiable and possible courses. As such they should, like any other hypothesis of the scientific worker, be discarded or amended when the facts prove such treatment to be necessary.

With regard to primary resources, Sir David Rivett believes that Australia should find more consumers within her own borders, these consumers making other products required in return. The building up of secondary industries is imperative, and Sir David referred particularly to shipbuilding and the aircraft industry, light metals and alloy steels for these and other transport purposes, including the motor-car industry, the manufacture of goods for the electrical industry, building materials, household accessories, organic chemicals from alcohol, coal and carbide, engineering, the prepared food industry and mineral industries from the raw material to the finished product. Not more than 200,000 out of every million people would be required to supply that million with foodstuffs and clothing by Australian standards, and the remaining 800,000 should be absorbed in such secondary industries. Such development will only be possible if the universities of Australia are adequately developed and take their full place in fundamental research. National laboratories will be required for such work; but science must not be regarded as just the handmaid of industry. Industry should attend to its own scientific housekeeping, and the national laboratories and the universities should be given the utmost freedom to prosecute fundamental research. Urging the importance of education as a factor in industrial development, he referred finally to the problem of the impact of society upon science: the outstanding problem, he believes, is the handling of our present and coming powers so that their enormous possibilities for the good of humanity will be realized and applied to the total exclusion of any deliberate pursuit of evil aims.

Scientific Rehabilitation in Europe

Prof. G. I. Finch, professor of applied physical chemistry in the Imperial College of Science and Technology, is visiting Belgium and Holland to convey the greetings of the Royal Society on behalf of the men of science of Great Britain to their colleagues in those countries. The purpose of his visit is to renew and re-establish scientific contacts and to see what help can be given by British science towards the

rehabilitation of science and scientific education in these two countries. In Belgium, Prof. Finch will be the guest of the Académie Royale des Sciences, des Lettres et des Beaux-Arts in Brussels, and in Holland he will be the guest of the Koninklijke Akademie van Wetenschappen.

Prof. I. M. Heilbron, professor of organic chemistry in the Imperial College of Science and Technology, and Dr. L. H. Lampitt, who are chairman and secretary of the British National Committee for Chemistry, have left on a visit to Paris to re-establish contact with French men of science. They hope to discuss informally the revival of international collaboration in science.

Nova Tamm

A TELEGRAM from Copenhagen announces the discovery by Dr. Tamm of a nova in the constellation of Aquila. It is thought that the nova will be named after its discoverer. On August 28, the date of its discovery, its visual magnitude was about 7 and its photographic magnitude 8·5. It was stated that there was a strong continuous spectrum with emission lines.

Dr. W. H. Steavenson observed the nova and gave more precise co-ordinates than those originally supplied. Its position, according to Dr. Steavenson, is R.A. 19h. 16m. 31s., Dec. + 0° 31·6′; equinox 1945·0; comparison stars + 0·4173° and + 0·4178°. Dr. Steavenson observed the nova on August 31 and found that it was pure white to the eye. Numerous bright lines in the spectrum, especially in the green and blue regions, were seen. He estimated the magnitude (visual) as 7·9. A later communication from Copenhagen states that the photographic magnitude originally given was very inaccurate. On August 30 it was 7·6. The position of the nova is now given as R.A. 19h. 16m. 30·64s., Dec. + 0° 31′ 45·4″.

Announcements

THE Lord President of the Council has appointed Prof. H. Munro Fox, professor of zoology in the University of London (Bedford College), Prof. I. M. Heilbron, professor of organic chemistry in the Imperial College of Science and Technology, London, and Dr. C. C. Paterson, director of the Research Laboratories of the General Electric Co., Ltd., to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research from October 1. Prof. A. V. Hill, Sir Felix Pole and Sir Robert Robinson retired from the Council on completion of their terms of office on September 30.

THE Council of the Institute of Welding has awarded the Sir William J. Larke Medal for 1945, together with a first prize of £50, to Mr. W. K. B. Marshall of the Aluminium Plant and Vessel Co., Ltd., for a paper entitled "The Fabrication of Aircraft Fuel Tanks in Aluminium Alloy containing 5% Magnesium". The second prize has been awarded to Mr. J. Corston MacKain, of Redpath Brown and Co., Ltd. A third prize was awarded to the late Mr. H. W. Clark, formerly assistant engineer (bridges and structures) to the London Passenger Transport Board; Mr. Clark was the winner of the Medal in 1944. The fourth prize goes to Mr. R. W. Arden, of Peterborough.

THE Theobald Smith Gold Medal of the American Academy of Tropical Medicine has been awarded to Dr. C. M. Wenyon, formerly director of the Wellcome Foundation Research Laboratories. The Medal will be presented to Dr. Wenyon in London through the United States Embassy.

THE Veterinary Educational Trust has made the following awards: *Boots Undergraduate Scholarships* (£150 per annum): M. H. Cross (University of Liverpool), G. Shattock (Royal Veterinary College), G. Sumner Smith (University of Liverpool), H. S. Taylor (University of Liverpool). *Halford Undergraduate Scholarships* (£100 per annum): Gordon Cox (Royal Veterinary College), D. C. Croft (University of Liverpool). All the scholarships are awarded for the full course of study for the diploma of M.R.C.V.S. These awards bring the total of undergraduate scholarships so far awarded by the Trust up to eighteen. In addition, eight research fellowships of an annual value of £450–£800 have been awarded for the investigation of veterinary problems of urgent importance.

THE following appointments have been made in the University of Sheffield: Mr. L. Mirsky to be assistant lecturer in mathematics; Dr. J. A. Pope to be lecturer in mechanical engineering.

The following resignations have taken place: Dr. E. T. Goodwin, lecturer in mathematics; Mr. J. H. Read, lecturer in chemistry; Dr. J. Shirley, lecturer in geology; Dr. W. Davies, temporary assistant lecturer in geology; Colonel R. G. Bellamy, lecturer in mechanical engineering; Miss M. C. Simpson, assistant bacteriologist.

THE Genetical Society is holding special meetings during October 31–November 2, at which several European geneticists will describe work and thought in that field in their own countries, and British geneticists will speak on progress in Britain. The meetings will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

THE Society of Czechoslovakian Mathematicians and Physicists is arranging a conference on the use of X-ray methods in the metal industry to be held in Prague during November 21–25. Some twenty-five Czech specialists and also invited guests from foreign countries will deliver lectures on the application of X-rays to the study of foundry sands, electrolytically deposited metals, deformation in polycrystalline materials, light alloys, fatigue in metals, welding, etc.; and on the use of gamma rays on material testing. The lectures will be published as a booklet. More detailed information about the conference can be obtained from Dr. V. Vand, 16 Woodburn Boulevard, Bebington, Cheshire, or directly from the Society of Czechoslovakian Mathematicians and Physicists, Prague II, Žitná 25, Czechoslovakia.

THE Council of the Polish Medical Association in the British Empire is appealing for books, text-books and periodicals which are urgently needed in Poland. During the German occupation, not only were no new books published but also the existing libraries were robbed and the most valuable books confiscated. The final stages of the War practically completed the destruction. Great efforts are now being made to train young people for the work of reconstruction. The greatest difficulty encountered in this task is the lack of books and text-books. The Association is particularly interested in books on medicine, and would be glad to receive such books, in English, German or French; volumes of the *Lancet*, *Medical Officer*, *Nature*, etc., would provide university libraries with material indispensable for the work both of students and staff. Correspondence should be sent to the president, Dr. Bąjedlewski, 43 Eaton Place, London, S.W.1.

LETTERS TO THE EDITORS

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

Can the Iron in Peroxidase be Replaced by Manganese?

In 1940[1] we demonstrated that pure horse radish peroxidase can be split reversibly into protohæmin and a colourless protein component. The original activity could be restored by mixing protohæmin and the protein. Later[2], we tested different iron-porphyrins for their ability to replace protohæmin. Only deuterohæmin and mesohæmin gave activity, both lower than protohæmin. Hæmatohæmin and many others were inactive. A graph, already published[2], shows that after one mol of hæmin per mol of protein is added, further addition of hæmin does not change the activity.

Gjessing and Sumner[3] cleaved impure peroxidase preparations according to our method, and investigated the activity resulting from addition to the protein part of (1) Cu-, Co-, Mn- and Ni-protoporphyrins; and (2) Fe-meso- and Fe-hematoporphyrin.

Copper, cobalt and nickel gave no activity. Some activity (28·4 per cent) was observed in one single test with the manganese protoporphyrin, whereas remarkably enough higher and lower additions gave practically no activity. Contrary to our experience, Gjessing and Sumner's protein preparations always gave strongly decreasing activity when the hæmins were added in increasing excess. We therefore considered it of interest to see if their positive result with Mn-protoporphyrin could be confirmed. The question is important, because iron is the only metal hitherto found in peroxidases, catalases and cytochromes.

We further know from our own experience that a positive peroxidase reaction in one single test is far from conclusive, since it may sometimes be caused by unknown impurities.

We prepared Mn-protoporphyrin by heating protoporphyrin in pyridine + acetic acid + chloroform with manganese acetate. It seems never to have been crystallized (we did not succeed in crystallizing it), so it was precipitated with water or ether, washed with water and dried. Mn found = 8·2 per cent, calc. 8·9 per cent. Absorption bands in pyridine: 593 and 572–542 mμ.

Pure horse radish peroxidase was split with acetone-hydrochloric acid in ice. The protein component contained 1·8 per cent of the original activity, that was restored to 80 per cent by the addition of 100 or 200 per cent of the quantity of iron-hæmin split off. Addition of 25, 50, 100, 200 or 400 per cent manganese hæmin gave no increase over the blank value tested both one and twenty-four hours after the addition. We thus feel justified in stating that manganese-hæmin is entirely incapable of giving any activity with peroxidase protein, though a spectroscopic change showed that a reaction, probably a coupling, occurred between Mn-protoporphyrin and protein. The light absorption, measured in a Zeiss photometer, increased during the reaction in the blue (*S* 47) and yellow (*S* 57) regions.

It should finally be pointed out that contrary to our experience Gjessing and Sumner found Fe-hæmatoporphyrin to be active (max. 76 per cent) and Fe-mesoporphyrin to be even more active than Fe-protoporphyrin. The discrepancy is probably due to the fact that Gjessing and Sumner worked with impure preparations.

Hugo Theorell.

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Department of Biochemistry,
Stockholm.
Sept. 4.

[1] Theorell, H., *Ark. Kemi, Min. och Geol.* (Stockholm), **14** B, No. 20 (1940).
[2] Theorell, H., Bergström, S., and Åkeson, Å., *ibid*, **16** A, No. 13 (1943).
[3] Gjessing, E. C., and Sumner, J. B., *Arch. Biochem.*, **1**, 1 (1942).

Vitamin C Peroxidasic Activity

Enzymatic oxidation of vitamin C, first recorded in 1921[1] and made more specific since 1928 by Szent-Györgyi, has given rise to the hypothesis that the vitamin acts as a constituent of dehydrogenating enzymes. However, so far as we know, direct evidence of the enzymatic activity of ascorbic acid has not been given. Our results show that vitamin C, acting as a peroxidase or as an antioxidant, can increase or reduce the already known peroxidasic action of ionized copper[2] and iron[3]. The experiments now reported consist in a comparison between the extinction coefficients of solutions, *A*, that contain an oxidizable substrate, ascorbic acid, hydrogen peroxide, copper sulphate and ferric chloride dissolved in 10 c.c. water, and solutions, *T*, devoided of vitamin, but similar to *A* in every other respect.

The freshly prepared ferric chloride solution contains 9 mgm. citric acid to each 10 mgm. iron. The measurements of the extinction coefficients were carried out in the Pulfrich Stuffenphotometer, 10 minutes after the starting of the reaction, and refer to a layer of 20 mm. The extinction coefficients in the spectral region of wave-length 470 mμ of the solutions *A* and *T* will be designed respectively by E_A^{470} and E_T^{470}, and the difference $\left(E_A^{470} - E_T^{470}\right)$ and the ratio E_A^{470}/E_T^{470} by E_{AA}^{470} and *V*. E_{AA}^{470} is positive or negative and *V* greater or less than 1 according as the vitamin promotes or checks the oxidation; the molar (atomic for Cu and Fe) concentrations are expressed in 10^{-4} gm. per litre.

Action of the vitamin on phenol. Standard solution: phenol 2 mgm. (21 m.); ascorbic acid, 1 mgm. (6 m.); hydrogen peroxide, 3·1 mgm. (91 m.); Cu, 0·48 mgm. (8 a.); Fe, 0·01 mgm. (0·2 a.). (See Table 1.)

Solutions *A* are brown-yellow, except for solutions 2 and 5 which take a pink tint turning to brown. Solutions *T* are colourless or yellow.

Cresol (1) *and tyrosin* (2). Standard solution: (1) phenol is substituted by 2·29 mgm. (21 m.) cresol; (2) tyrosin 2 mgm. (11 m.); ascorbic acid 2 mgm. (11 m.); hydrogen peroxide 6·2 mgm. (182 m.) Cu 0·48 mgm. (8 a.); Fe 0·02 mgm. (0·4 a.). (See Table 2.)

Solutions *A* of *ortho-*, *para-* and *meta*-cresol take respectively a brown-orange, brown-yellow and pink coloration. Solutions *T* are colourless or pale yellow.

Benzidin: Standard solution: benzidin 2 mgm. (11 m.); ascorbic acid 1 mgm. (6 m.); hydrogen peroxide 3·1 mgm. (91 m.); Cu 0·48 mgm. (8 a.); Fe 0·01 mgm. (0·2 a.); acetic acid 10 mgm. per 1 mgm. of benzidin. (See Table 3.)

Solutions *A* develop immediately a brown reddish coloration. Solutions *T* first give a faint blue tint turning to reddish-brown.

According to colorimetric measurements of the red tinted chloroform extracts of solutions A_1 and T_1,

TABLE 1.

	1	2	3	4	5	6	7	8	9
Modifications	Non-modified	Asc. ac. 4 mgm.	Phenol 1 mgm.	Phenol 5 mgm.	Cu 0·192 mgm.	Fe 0·04 mgm.	Cu 0	Fe 0	Asc. ac. 16 mgm. Fe 0·02 mgm.
E^{470}_{AA}	+0·23	+0·43	+0·18	+0·17	+0·23	+0·61	+0·06	+0·08	−0·09
V	9	15	7	7	7	2	3	–	0·2

TABLE 2.

	Cresol			Tyrosin					
Modifications	*ortho*-cresol	*para*-cresol	*meta*-cresol	non-modified	H_2O_2 9·3 mgm.	H_2O_2 12·4 mgm.	Fe 0	Cu 0	Asc. ac. 15 mgm. Fe 0·04 mgm.
E^{470}_{AA}	+0·28	+0·29	+0·23	+0·22	+0·27	+0·24	+0·05	−0·02	−0·31
V	10	8	6	3	6	9	4	0·9	0·2

TABLE 4.

	Dopa				Pyrogallol			
Modifications	Non-modified	Cu 0·48 mgm.	Fe 0·0025 mgm.	Asc. ac. 3 mgm. H_2O_2 3·1 mgm. Fe 0·02 mgm.	Non-modified	Asc. ac. 2 mgm.	Fe 0·01 mgm.	Fe 0·02 mgm.
E^{470}_{AA}	+0·058	+0·058	+0·034	−0·115	+0·058	−0·015	+0·051	−0·007
V	5	5	1	0·8	2	0·7	2	0·9

TABLE 3.

	1	2	3	4	5
Modifications	Non-modified	Asc. ac. 0·5 mgm.	Ascorbic acid 0·5 mgm. Cu=0	Fe=0	Cu, Fe=0
E^{470}_{AA}	+1·40	+1·20	+0·43	+0·24	0
V	4	3	4	4	1

with 2 mgm. of benzidin, 0·35 mgm. in the solution *A* and 0·09 mgm. in the solution *T* are converted at the tenth minute of the reaction into the benzidin bi-equivalent oxidized product, the diphenoquinone bis-acetate-imide, $C_{12}H_{10}N_2(COOH–CH_3)_2$.

3–4 *Dioxyphenylalanin, called 'Dopa'* (1), *and pyrogallol* (2). Standard solutions: Dopa 2 mgm. (10 m.); ascorbic acid 1 mgm. (6 m.); hydrogen peroxide 1·55 mgm. (46 m.); Cu 0·24 mgm. (4 a.); Fe = 0. (2) Pyrogallol 2 mgm. (16 m.); ascorbic acid 1 mgm. (6 m.); hydrogen peroxide 0·31 mgm. (9 m.); Cu 0·192 mgm. (3 a.); Fe = 0. (See Table 4.)

The Dopa *A* solutions take a brown coloration. Solutions *T* develop a faint blue tint turning to the brown. Solutions *A* and *T* of pyrogallol give a brown and pale yellow coloration.

The results of this investigation may be summarized as follows. Vitamin C and ionized copper and iron constitute a monophenol peroxidase, while the vitamin and copper give a polyphenol peroxidase. The observed activity of vitamin C seems, however, not to be exclusively limited to the transport of hydrogen, but may also involve a deep modification of the phenol molecule as suggested by the appearance of a pink coloration in phenol solutions.

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HELÈNE LEROUX.

Clinique Infantile
de l'Université de Strasbourg,
repliée à Clermont-Ferrand.
June 11.

[1] Bezssonoff, N., *C.R. Acad. Sci.*, **173**, 417 (1921) and *Bull. Soc. Hyg. Alim.*, **9**, 3 (1921).
[2] Thomas, P., and Charpentier, *Bull. Soc. Chim. Biol.*, **4**, 143 (1922).
[3] Wolf, *C.R. Acad. Sci.*, **146**, 784, 1217 (1908) and Wassermann, A., *J. Chem. Soc.*, Pt. 1, 826 (1935).

Hæmoglobin in Blood-sucking Parasites

THE hæmoglobins of different animals are not identical; the differences between them could be used as specific characters within a genus. In *Daphnia*, for example, the axes of the α-bands of oxyhæmoglobin, measured with the Hartridge reversion spectroscope, are at 5761, 5764 and 5766 A. in *D. obtusa* Kurz, *D. pulex* (De Geer) and *D. magna* Straus respectively, while for the larvæ of two species of the chironomid genus *Anatopynia*, the wave-lengths are 5769 for *A. varia* (Fabr.) and 5776 for *A. nebulosa* (Mg.). Moreover, hæmoglobins are not only specific: they also may be individual[1]. It is to be expected then that the hæmoglobins of a host and of its bloodsucking parasite will not be identical; yet this seems never to have been established. The only invertebrate parasites which suck the blood of vertebrate animals and have hæmoglobin in their own blood are certain leeches and copepods, and it has been supposed by some that the hæmoglobin of a parasitic copepod originates from that of its host, a fish, by passing through the gut wall of the parasite and accumulating in the blood of the latter[2].

There are two types of parasitic copepod with red blood, represented by *Lernanthropus* and *Lernæocera* (*Lernæa*). Van Beneden[3] in 1880 showed with the spectroscope that the blood pigment of the former is hæmoglobin; but the pigment of the latter has not hitherto been identified. Through the kindness of Miss N. Sproston and Mr. C. F. Hickling I have been able to examine the blood of *Lernæocera branchialis* (L.) from the gills of the greater forkbeard, *Urophycis blennoides* (Brünnich). The parasite's blood contains hæmoglobin, and the axis of the oxyhæmoglobin α-band is at 5790 A. (Hartridge spectroscope). That of the host's oxyhæmoglobin is at 5765 A. The two hæmoglobins are thus not only different, but also very different from one another. Among thirty-one species of animals examined, the wave-length of the oxyhæmoglobin α-band was found to be longest in *Lernæocera branchialis* and shortest in *Isidorella gibbosa* (Gould), a freshwater pulmonate snail from New South Wales. The α-band in this mollusc is at 5751 A., while in man it is at 5775 A.

It would be interesting to know the value, if any, of hæmoglobin to copepods, and whether there is a functional reason for its presence in some copepod parasites of fish and absence in others. Experimental work may solve the problem, but meanwhile it is not justifiable to assume[2] that in *Lernæocera* oxygen for respiration reaches the parasite through its mouth with the host's hæmoglobin, and that direct gas exchange between copepod and sea water is reduced to a minimum because the cuticle is relatively thick. Such a source of oxygen from the host is improbable, particularly when, as pointed out by the authors quoted, the parasite's meals are taken at rare intervals.

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July 19.

[1] Fox, H. M., *Nature*, **156**, 18 (1945).
[2] Sproston, N. G., and Hartley, P. H. T., *J. Mar. Biol. Assoc.*, **25**, 393 (1941).
[3] Van Beneden, E., *Zool. Anz.*, **3**, 35, 55 (1880).

Œdema in Hamsters Infected with *Leishmania*

In the course of work upon the chemotherapy of experimental kala-azar, I have observed that Syrian hamsters (*Cricetus auratus*) with long-standing infections of an Indian strain of *Leishmania donovani* sometimes develop severe œdema. Ascites and distension of the mesentery with fluid are the first signs of the condition. Later, gross œdema of the subcutaneous tissue develops and the skin is pulled down into a skirt around the flanks by the weight of the fluid it contains. The animal increases rapidly in weight through water retention and dies in a few days. An adult hamster weighing 80–100 gm. may gain 50 gm. in weight in the course of a week.

When this observation was first made in 1942, private correspondence with the late Dr. G. W. Dunkin of the Agricultural Research Council, who supplied the hamsters, confirmed the fact that the condition had not been recognized in stock animals.

The condition appears only after several months of infection with leishmania, and not every animal is affected. It does not depend upon the degree of infection as measured by parasite counts in spleen smears[1]. Œdematous animals are not suitable for use in tests for leishmanicidal substances, and the difficulty has been overcome by the use of recently isolated Mediterranean strains of leishmania, which produce heavy spleen infections in the course of a few weeks[2]. However, if animals infected with these strains are kept untreated for several months, some of them develop œdema. This shows that the condition is not associated with a single strain of leishmania.

Œdematous animals exhibit proteinuria; the kidneys are pale and enlarged, and histological examination shows degeneration of the glomeruli and obstruction of the tubules with protein casts. The serum protein in a few animals was determined by Walther's method[3]; the results for five œdematous animals were: 3·8, 5·4, 4·6, 3·5, 4·9 per cent of protein respectively, and for two normal animals of the same age, 7·1 and 7·6 per cent. It is evident that severe loss of protein through the kidney is the chief cause of the œdema.

All attempts to cultivate a secondary infective agent upon nutrient media or by inoculation of normal animals have so far failed. Intraperitoneal and intracerebral inoculations into mice and hamsters, and inoculation of chick tissue-cultures with a candled suspension of kidney, liver or spleen material from œdematous hamsters have also been without result. It seems probable that the nephritis is caused by a toxin liberated by the leishmania parasite under conditions of chronic infection.

The condition of the hamsters recalls that observed in mice infected with *Trypanosoma cruzi*, which has been investigated by Collier, Fulton and Innes[4]. The underlying cause of the œdema is not, however, the same, because these workers found the kidneys of œdematous mice to be normal.

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[1] Goodwin, L. G., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **38**, 151 (1944).
[2] Goodwin, L. G., *Trans. Roy. Soc. Trop. Med. and Hyg.*, in the press.
[3] Walther, W. W., *Lancet*, ii, 337 (1941).
[4] Collier, H. O. J., Fulton, J. D., and Innes, J. R. M., *Ann. Trop. Med. Parasitol.*, **36**, 137 (1942).

Production of *p*-Aminobenzoic Acid by the Tubercle Bacillus

Many workers have claimed that the common sulphanilamides in high concentrations may modify the course of experimental tuberculosis in animals. Much better results have been obtained, however, with the diaminodiphenyl-sulphone and some of its derivatives, for example, promin and diasone. The same applies to promizole, an analogous compound, which is a diaminophenyl-thiazole-sulphone. These sulphones have also shown a certain effect in a prolonged clinical trial, although it is necessary to seek for more effective, or at least less toxic, compounds.

The diaminodiphenyl-sulphone and similar compounds are said to act on sensitive bacteria in the same manner as the sulphanilamides. The fundamental condition for the effectiveness of these compounds against the tubercle bacillus would therefore appear to be that this bacterium also requires *p*-aminobenzoic acid as an essential metabolite. Indirect proof of this is furnished by the observation that the bacteriostatic action *in vitro* of sulphathiazole[1] and promin[2] on the tubercle bacillus is inhibited by *p*-aminobenzoic acid. We have, however, performed direct analyses[3], and succeeded in showing that both the tubercle bacillus and the culture medium in which it has been grown contain *p*-aminobenzoic acid. Assuming that *p*-aminobenzoic acid is of functional significance to the bacterium which forms it—and this is highly probable—the experiments with sulphones and related substances in experimental tuberculosis can therefore be considered as well founded.

The determinations were performed in the following manner. A number of flasks, each containing 200 ml. of Sauton's synthetic substrate, were inoculated with a virulent human strain (a platinum loop containing on the average 0·1 gm. of wet bacilli). The cultures were incubated at 37° C. for different times. The resultant cakes of bacteria were finely dispersed and washed and dried by suction. The filtrate was sterilized by heat (passage through a Seitz filter did not alter the values) and continuously extracted with ether at *p*H 3·8 for 30 hours. *p*-Aminobenzoic acid was determined colorimetrically in the ether solution

Time of cultivation (days)	Amount of *p*-aminobenzoic acid formed in substrate. (μgm. per flask of 200 ml.)			Amount of moist bacteria formed. (gm. per flask of 200 ml.)	Amount of *p*-aminobenzoic acid formed in bacteria. (μgm. per gm. moist bacteria)		
	Without hydrolysis	After alkaline hydrolysis†	Total		Without hydrolysis	After alkaline hydrolysis†	Total
5	2·0	0·5	2·5	0·3	—	—	—*
10	2·5	1·1	3·6	1·3	—	—	—*
30	6·5	2·0	8·5	3·9	0·3	0·6	0·9

* Quantity of bacteria too small for exact analysis.
† A more intense hydrolysis may perhaps give higher values.

with *p*-dimethylaminobenzaldehyde[4]. The residue from the ether-extraction was made normal with respect to sodium hydroxide and autoclaved for 30 minutes at 15 lb. pressure for the liberation of the bound form of *p*-aminobenzoic acid[5]. Alkaline hydrolysis is more effective here than acid hydrolysis. The hydrolysate was extracted with ether in the manner described above.

The washed bacteria were autoclaved with ten parts of water at the same pressure and for the same time as above. The free *p*-aminobenzoic acid was determined in the filtrate. The remaining bacteria were treated in the same way with ten parts of normal sodium hydroxide in order to liberate the conjugate form of *p*-aminobenzoic acid.

All reagents and the constituents of the culture medium were free from *p*-aminobenzoic acid. The method may be regarded as rather specific; of the substances which might be thought to give a disturbing effect, tryptophan produces another colour and kynurenin is not extractable at *p*H 3·8[6].

The values obtained are given in the table, from which it follows that *p*-aminobenzoic acid is formed and excreted by the tubercle bacillus. It is an interesting point that larger quantities are found in the substrate than in the bacteria themselves. It would also seem that the proportion of *p*-aminobenzoic acid in the free form is higher in the substrate than in the bacteria.

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[1] Vermehren and Vermehren, *Ugeskrift Laeger*, **104**, 1337 (1942).
[2] Steenken and Heise, *Proc. Soc. Exp. Biol. Med.*, **52**, 180 (1943).
[3] For some preliminary results, see Sjögren, "The Svedberg, 1884–1944", 554 (Uppsala, 1944).
[4] Tauber and Laufer, *J. Amer. Chem. Soc.*, **63**, 1488 (1941).
[5] Lampen and Peterson, *J. Biol. Chem.*, **153**, 193 (1944).
[6] Butenandt, Weidel, Weichert and von Derjugin, *Z. physiol. Chem.*, **279**, 27 (1943).

A Theory of the Formation of Hydrochloric Acid in the Gastric Mucosa

In a previous communication[1], the formation of a high degree of acidity (*p*H 1·7–1·8) during fermentation by ordinary bakers' yeast was described. Acid formed to this extent in the suspending fluid (0·6 part to 1·0 of yeast) when unbuffered and containing potassium chloride of about 0·1 *M* strength or more.

The mechanism of the formation consisted in an organic acid—such as pyruvic or phospho-pyruvic acid—exchanging its hydrogen ions for the external potassium ions. In this way an external hydrochloric acid content of about *N*/50 was developed. A similar mechanism for gastric hydrochloric acid was indicated, and throughout 1943–44 many experiments were carried out on human subjects after test meals, blood and gastric contents being analysed. Experiments were also carried out on rats and rabbits, the results being presented by one of us in a thesis on "Studies in the Relation of Keto-Acids to the Secretion of HCl by the Gastric Mucosa"[2].

Meanwhile, a more extended study of the occurrence in yeast appears to indicate that the acidic system involved is not mainly the pyruvic, but includes at least some other acid closely related thereto in the metabolic chain.

Owing to the publication this year of a paper by Bull and Gray[3] outlining a theory of hydrochloric acid excretion by the stomach, in some respects similar to that worked on since 1943 by us, attention is here directed to the latter and the work done in relation thereto. In our view the essential process consists in the secretion first of potassium chloride solution of about isotonic strength into a membrane lined tubule (which may be identified with the canaliculus in the parietal cells). As it passes along the tubule an exchange of hydrogen and potassium ions occurs, just as occurs in fermenting yeast with potassium chloride outside. The necessary organic acid is assumed to be formed in localized cell regions impinging on the canaliculus. No assumptions need be made throughout of a permeability other than that holding (say) for the muscle fibre membrane[4] or the yeast cell. With this view the movement of hydrogen ions across the membrane is apparently more effective than back into the cell; but again this also appears true for the yeast transfers, though another explanation may be more correct than a difference in velocity of passage. As the potassium ions pass back into the cell, the organic acid anions are continuously removed by oxidation, leaving bicarbonate ions in association with potassium ions and much free carbon dioxide. We may suppose K and HCO_3 ions passing across the boundary of the cell, because there the product of their concentrations is greater than outside; but as K and Cl are being extruded into the canaliculus, we may regard the events for the K ions as a circulation in the cell, with HCO_3 exchanging for Cl ions across the cell boundary.

A point of much importance arises in connexion with the formation of carbon dioxide by decarboxylation. It is generally taken for granted that the free gas is directly formed, but for yeast carboxylase at least, this can be shown to be incorrect[5], carbonic acid being first produced. As the process of decarboxylation is very likely similar for the animal cell, we may suppose carbonic acid also formed from keto-acids. Where there is an exceptional degree of activity associated with keto-acid breakdown, the presence of carbonic anhydrase would appear to be useful in hastening the change to carbon dioxide as the $KHCO_3$ diffuses back. This theory has the

advantage over others in that there is a readily producible biological model forming free hydrochloric acid in an essentially similar way, and no other permeabilities need be assumed than those observed for the muscle membrane[4].

Seeing that free carbonic acid is produced in decarboxylation, the idea may be entertained that, after all, it is this acid which provides the free hydrogen ions. Our present reasons for supposing that this is not the main source (and it may be certainly held to provide some fraction) is that the true first ionization constant of carbonic acid given as around $10^{-3.5}$ does not appear sufficiently high unless strong concentrations of the acid are localized. Secondly, even *in vacuo* the high formation of acid in the external fluid proceeds with fermenting yeast, and the total carbon dioxide is reduced to a low figure. More experimental work is, however, required in this connexion.

The theory will be discussed more fully elsewhere.

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July 4.

[1] Conway, E. J., and O'Malley, E., *Nature*, **153**, 555 (1944).
[2] Walls, D. P., thesis to the National University, Ireland (1944).
[3] Bull, H. B., and Gray, J. S., *Gastroenterology*, **4**, 175 (1945).
[4] Conway, E. J., and Cooke, R., *J. Physiol.*, **100**, 1 (1941).
[5] Conway, E. J., and MacDonnell, E., unpublished observations (1944).

A Neutral Solvent for Melanin

Melanin from the ink sac of *Sepia officinalis*, from a melanoma, and that prepared by the action of tyrosinase on tyrosine has been found to be soluble *in the cold* in ethylene chlorhydrin, $CH_2Cl.CH_2OH$.

Previously melanin had been thought to be soluble in diethylamine, but further investigation showed that in fact the solvent had combined with water vapour to form an alkyl hydroxide, and the resulting solution was strongly alkaline. It was also thought that 1 : 2-dihydroxypropane was a solvent, but on evaporation it was found that the resulting blackish-brown substance no longer had the properties of melanin. In the case of ethylene chlorhydrin the solution is neutral, and the substance remaining after evaporation is indistinguishable from the original melanin. The solubility increases with heat, and no change has been detected in the recovered melanin after treatment with the solvent in a Soxhlet extractor.

No guarantee of the purity of the melanin being possible, no attempt has been made to determine the precise degree of solubility, but it is very evident that both tumor and *Sepia* melanins are much more soluble than that obtained from tyrosine. No conclusions can be drawn from this fact, as it is not possible to state whether the tumor and *Sepia* melanins are or are not combined with a protein.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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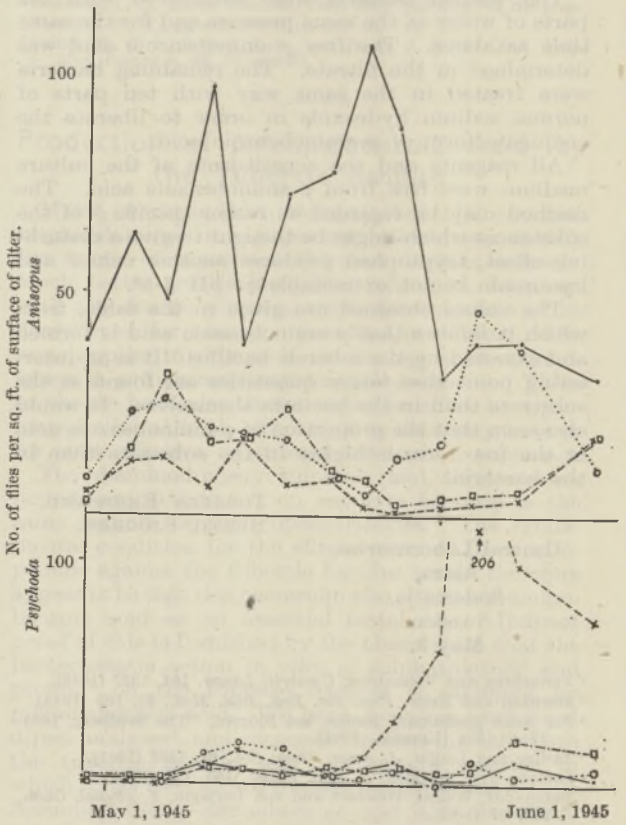
Control by D.D.T. of Flies Breeding in Percolating Sewage Filters

Nuisance often arises from the emergence of large numbers of flies from percolating filters treating sewage, situated near dwelling-houses or busy thoroughfares. Species which have caused most trouble are *Anisopus fenestralis*, *Psychoda alternata* and *Psychoda severini*. Various methods of control have been tried, including treating filters with creosote or bleaching powder, and flooding the filters with sewage; flooding can only be used, however, where the construction of the filter is suitable. The toxic substances so far used are non-selective in their action; the concentrations necessary to kill fly larvæ also kill other members of the valuable population of scouring organisms, such as Collembola and enchytræid worms, as well as bacteria and fungi, which form the active biological film on which the purifying efficiency of the filter depends.



Nos. of *Anisopus* and *Psychoda* trapped on percolating sewage filters treated with creosote, bleaching powder and D.D.T.

		Date of treatment
•———•	Control	
× - - - - ×	Creosote	April 24
o ..... o	Bleaching powder	April 16
□—·—·□	D.D.T.	April 26

Experiments on the treatment of small experimental filters with D.D.T. in the form of (*a*) a powder applied at a rate of 300 lb. of D.D.T. per acre, and (*b*) an emulsion of D.D.T. in naphtha or kerosene at a rate of application of 50–100 lb. of D.D.T. per acre, showed that more than 90 per cent of the larvæ of *Anisopus* and *Psychoda* were killed, but that the Collembola and enchytræid worms were unaffected. Preliminary tests show that D.D.T. in these concentrations is non-toxic to the bacteria and fungi in a filter, and thus

has no deleterious effect on its purifying capacity. The accompanying graph shows the results of an experiment on a large scale at the Minworth Works of the Birmingham Tame and Rea District Drainage Board. During the period April 16–26, 1945, filters were treated with the following substances: creosote (400 gallons per acre), bleaching powder (6½ tons per acre), and D.D.T. in the form of emulsion (75 lb. D.D.T. per acre); the numbers of emergent *Psychoda* and *Anisopus* flies caught in standard traps on the surface of the filters were then observed. Treatment with creosote gave the greatest reduction in numbers of *Anisopus*, but all the scouring organisms in the filter were killed and the biological film which later accumulated supported a secondary population of *Psychoda*. Bleaching powder caused the biological film to be discharged from the filter, and later there was a secondary peak in the emergence of *Anisopus*. With D.D.T. the numbers of both flies were greatly reduced and an active population of worms (*Pachydrilus lineatus*) and Collembola (*Achorutes viaticus*) remained and kept the growth of biological film in check.

Further experiments are being made, particularly to ascertain the minimum quantities of D.D.T. and the best method of application to control filter flies. At present D.D.T. is not available for civilian use; the possibility of applying it for control of flies at sewage works would, of course, depend on its price in comparison with the cost of alternative poisons.

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July 21.

Use of Hydrochloric Acid for Softening Algal Tissues for Microtome Sections

In view of the increasing interest in marine algæ it seems apposite to record a method of treatment which has been found useful in preparing microtome sections of some Florideæ with particularly firm thalli. Formalin-alcohol, although a good fixative for cytological purposes, tends to harden such thalli, making them difficult to cut by microtome. Moreover, in those species which have an abundance of mucilaginous substances between the cells, the sections, when floated on water, swell considerably, twist, and escape from their casing of paraffin-wax. These difficulties can be avoided by treatment with warm hydrochloric acid in the case of *Chondrus crispus*, *Gigartina mamillosa*, *Gracilaria confervoides* and *Rhodymenia palmata*.

The method of treatment has been to put a covered dish containing a mixture of 90 c.c. of 70 per cent alcohol and 10 c.c. of hydrochloric acid in the embedding oven. When the liquid has reached the temperature of the oven, the piece of thallus to be treated is transferred to it from 70 per cent alcohol. The duration of the treatment required by different materials can only be found by experiment as it varies not only from species to species, but from the younger portions of the thallus to the older. For example, young pieces of *Gigartina mamillosa*, after fixation in formalin-alcohol, require 15 minutes, whereas similar pieces of *Chondrus crispus* require only 5 minutes. The duration of treatment should be kept to the minimum as continued immersion interferes with the staining of the nuclei and ultimately causes disintegration of the thallus. After treatment the thallus is washed thoroughly in 70 per cent alcohol and embedded in the usual way.

Of the algæ mentioned above, *Gracilaria confervoides* cuts reasonably well untreated, but sections of treated material are definitely superior. *Gigartina mamillosa* is very difficult to cut untreated after fixation in formalin-alcohol, but the youngest portions of the frond can be cut without treatment after fixation in Karpechenko's fluid. Even so, better results can be obtained by the use of hydrochloric acid. This is indispensable for the older parts of the frond, fixed in Karpechenko's fluid, but the time required is shorter than after formalin-alcohol. The improvement in all cases is more marked with sections cut at 5 μ than at 10 μ.

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Activation Energy of Ionic Migration in Molten Salts

The conductivity of ionic melts, such as alkali and alkaline earth halides, can be represented fairly well by an equation $\varkappa = Ae^{-C/RT}$, where C may be regarded as the energy necessary to effect the configurational change occurring in ionic migration. Deviations from this equation, C varying with temperature, are found with some salts of a partially covalent character, for example, zinc chloride and lead chloride; with these salts, constitutional changes, such as dissociation, are likely to occur on rise of temperature.

The viscosity of ionic melts can be represented approximately by a similar equation: $\eta = A'e^{B/RT}$, where B is the energy necessary to produce the configurational change in viscous flow. Here also deviations have been recorded with some compounds of a partially covalent character[1]. Tabulated values for B [2] and C [3] are shown below.

	Equiv. conduct. (temp. 10 per cent above melting point [abs.])	C in cal./mole	B in cal./mole	r_A/r_C
LiCl	181	1150	8800	3·01
NaCl	149	1540	9400	1·91
KCl	120	2300	7800	1·36
RbCl	95	2830	—	1·22
CsCl	82	3330	—	1·07
NaBr	145	1840	10600	2·05
KBr	105	2550	7960	1·47
NaI	150	1250	7400	2·27
KI	106	2750	9200	1·62
$CaCl_2$	65	4100	9500	—
$BaCl_2$	78	4150	—	—

The activation energy of viscous flow (B) is always greater than that of ionic migration (C). This must be due to a difference in mechanism between the two processes. Viscous flow is determined to a greater extent by the large anions than by the small cations. On the other hand, the electric conductance of the alkali halides is mainly due to the small cations, while the contribution of the large anions is very much smaller[4]. This is shown by the fact that the equivalent conductivity changes strongly with change of cation but very little with change of anion. These salts are predominantly cation-conductors in the solid state also[5].

Thus, viscous flow involves a more far-reaching configurational change and higher energy barriers

than ionic migration. It is therefore not surprising that there is no simple relation between conductivity and viscosity of molten salts. For example, the temperature coefficients of the two properties are not equal.

With the alkali chlorides there is a distinct increase of the activation energy (C) from lithium to cæsium, together with a decrease of the ratio of anion to cation radius (r_A/r_C). The small values for lithium chloride and sodium iodide are probably due to comparatively small energy barriers in systems in which r_A/r_C is great; in the case of lithium chloride, the small cations must have considerable freedom of movement between the large anions in contact.

The C-values of the alkaline earth chlorides are greater than those of the alkali chlorides because of the stronger electric field in an assembly containing bivalent ions, and also because these molten electrolytes—by analogy with the solids[5]—may be expected to be anion conductors.

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[1] Ward, A. G., *Trans. Farad. Soc.*, **33**, 88 (1937).
[2] Most values taken from Barrer, R. M., *Trans. Farad. Soc.*, **39**, 48 (1943); others calculated from data by Karpachev, S., and Stromberg, A., *J. Phys. Chem. (U.S.S.R.)*, 11, 852 (1938).
[3] Calculated from conductivity data by Biltz, W., and Klemm, W., *Z. anorg. Chem.*, **152**, 267 (1926).
[4] Frenkel, J., *Acta Physicochimica U.R.S.S.*, **6**, 341 (1927).
[5] Cf. Mott, N. F., and Gurney, R. W., "Electronic Processes in Ionic Crystals" (Oxford, 1940).

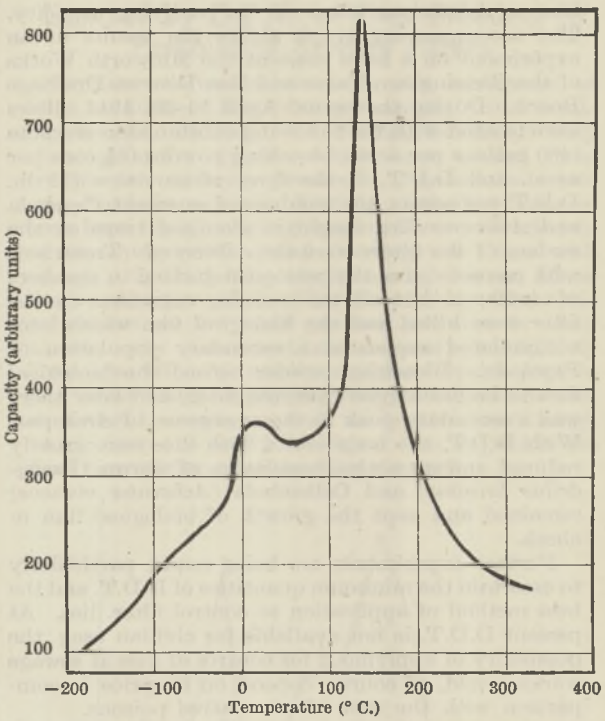
Dielectric Constants of Some Titanates

The oxides and carbonates of beryllium, magnesium, cerium, zinc, strontium, cadmium and barium were heated with titanium oxide to a temperature of about 1,500° C. The dielectric constants of the titanates thus obtained were, for beryllium titanate 70, for magnesium 17, for calcium 115, for zinc 30, for strontium 155, for cadmium 62, exceeding 1,000 for barium. The measurements were carried out at room temperature at a frequency of 1 M Hz.

The titanates may be divided into two groups according to their place in the periodic system and the values of their dielectric constants. The titanates of beryllium, calcium, strontium and barium belong to the first group, and those of magnesium, zinc and cadmium to the second one. Such a division in general coincides with the division of the titanates according to the type of their crystal lattice. The crystal lattices of the titanates of calcium, strontium and barium are of the perovskite type, whereas those of magnesium and cadmium are of the ilmenite type. The atomic or ionic polarizability depends upon the structure of the crystal, and for this reason the magnitude of the dielectric constant depends upon the type of the lattice.

The dielectric constants of the perovskites investigated were found to grow with the increase of the size of the alkaline-earth ion. The electron polarizability of the ion increases with the radius. A more important factor, however, is that with the increase of the radius of the alkaline-earth ion located in the centre of the elementary cell, the distance between the titanium and oxygen ions increases as well.

Barium titanate having a very large dielectric constant, the distance between the titanium and the oxygen ions exceeds the sum of their radii. Such a 'loose' structure of the crystal lattice leads to considerable atomic polarizability.



The dielectric constant of barium titanate varies considerably with the temperature. The variation of the capacity of a barium titanate condenser with the temperature is shown in the accompanying graph.

The present investigation was carried out with J. M. Golgman. A more detailed article will be published in the *C.R. Acad. Sci. URSS.*

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A Photographic Method of Deriving Isoclinics in Photo-elastic Methods

It is well known that the chief cause of inaccuracy in the photo-elastic method of stress analysis lies in deriving the isoclinics. We have used a photographic method which has greatly improved the accuracy with which the isoclinics can be drawn. It consists of varying the load on the model so as to blur out the isochromatic pattern (mercury green), leaving the isoclinics superimposed on a uniform grey background. The intensity of the light source is so adjusted as to enable a 30-sec. exposure of the photographic plate to be given, and the load is varied between a quarter and three-quarters of the full load used to take the isochromatic pattern. The reduction to three-quarters of full load is advisable to prevent fatigue failure. The model is carried through three complete cycles during the exposure.

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SOCIETY FOR APPLIED BACTERIOLOGY

AT the annual summer conference of the Society of Agricultural Bacteriologists, which was held at the Midland Agricultural College during July 23–25, plans were approved for a change in the title and range of interests of the Society. It has now been renamed the Society for Applied Bacteriology.

For some years the Society has, in fact, ceased to confine its interests entirely to the agricultural field and has attracted to its membership bacteriologists working in such fields as water supplies, sewage disposal, fisheries, food manufacture and various industries, as well as those in academic institutions whose work brings them into contact with the applied aspects of the subject. The inauguration recently of the Society for General Microbiology has fortunately provided a common meeting-ground for the discussion, by microbiologists working in all fields, of the more fundamental aspects of the science. There is, however, a large number of bacteriologists for whom hitherto no adequate society has existed, and whose needs are only partially satisfied by discussions at the 'fundamental' level. At a time when scientific men are being called upon more than ever to contribute to improvements and new processes in various industries, it is essential that those working in applied bacteriology should have facilities for meeting and discussing matters of mutual interest.

Membership of the Society for Applied Bacteriology is open to all who are interested in bacteriological problems. It is intended to hold an annual conference in the summer at different centres in the British Isles, and a shorter meeting in London in the winter. For the time being, papers, or abstracts of papers, will be published in the *Proceedings* of the Society. It is hoped that eventually the Society's publication will increase to the size of a journal. The officers of the Society are: *President:* Dr. L. A. Allen, Water Pollution Research Laboratory, Watford; *Secretary:* Mr. D. A. McKenzie, Provincial Laboratory, 36 Otley Road, Leeds; *Treasurer:* Mr. L. J. Meanwell, United Dairies (Wholesale), Ltd., Ellesmere; *Editor:* Mr. A. Rowlands, National Institute for Research in Dairying, Shinfield, Reading. The annual subscription is at present one guinea.

A survey of the papers at the summer conference follows.

A paper dealing with the teaching of bacteriology emphasized its unassailable claim to be taught as a science; its students are trained as bacteriologists in the widest sense, able to apply their knowledge and experience to any and every problem of a bacteriological nature, and not restricted to the relatively narrow field of its applications to some other science. With this ideal in view, a plea was made for the establishment at universities of independent departments of bacteriology, with the provision of a science degree, or at least a diploma, in bacteriology. A suitable curriculum was outlined together with observations on the teaching methods that should be applied, a distinction being drawn between the requirements of those intending to follow a career in bacteriology, and others for whom a knowledge of its applications in their own particular sphere was the only essential.

The origin and development of the National Collection of Type Cultures was described, together with an account of its organization and work. In view of the facilities now provided for the microbiologist by the type culture collections, their future is of considerable importance, and the problem was thoroughly discussed.

A contribution dealing with bacterial growth in aerated and quiescent flax infusion described the chemical changes produced. With quiescent cultures, the liquor obtained is acidic in nature, frequently containing appreciable amounts of volatile acids. Industrially, such a liquor tends to be evil-smelling, difficult to treat for purposes of disposal, and unsuitable for re-use in an industrial process. With aerated cultures, on the other hand, the reaction tends to become alkaline, with a much smaller and sometimes negligible content of volatile acids. Reduction of the organic carbon content, which as shown by the carbon balance sheet can be accounted for by the carbon dioxide produced by bacterial action, is reflected in a reduction of the polluting strength as shown by the usual methods of measurement.

A study of the microflora of immersion brines emphasized the many problems that require elucidating, not only as regards the curing process itself, but also as regards the bacteriological technique to be applied in studying the bacteria involved.

Water supplies used for dairy purposes at many Welsh farms and dairies were shown to be heavily polluted, and their purification by chlorination has been investigated. The residual bacterial flora of tap, well and clear river water was in all cases negligible following treatment for ½ hr. with 10 p.p.m. chlorine. A 2 hr.-contact period using 50 p.p.m. chlorine was necessary to attain similar results with turbid river water. False-positive presumptive coliform results obtained with chlorinated stream water were caused by an organism resembling *Bacillus polymyxa*.

Further evidence of the value of a modified Hotis test (plating Hotis-positive samples on crystal violet blood agar), not only in reducing the work involved, but also in increasing the number of positive samples, was adduced from the results of the examination of 639 quarter samples known to be, or suspected of being, infected with *Streptococcus agalactiæ*.

Methods for the bacteriological examination of milk continue to receive much attention. In a discussion of the choice of a suitable yardstick for evaluating tests, it was pointed out that no single test at present available is adequate to cover the whole range of producer, distributor and consumer requirements. A further paper dealt with the effect of temperature variations in the region of 37·5° C. on the reduction of methylene blue and resazurin in milk. Results show that at temperatures between 31° C. and 43° C., the acceleration of reducing action and the gradual inhibition of bacterial growth in milk by increasing temperatures more or less cancel out, mean differences in reduction times being well inside the experimental error of about ½ hr.

With the introduction of the National Milk Testing and Advisory Scheme, bacteriological tests and standards for the examination of washed churns were prescribed. Towards the end of 1944, 5,400 churns at 1,110 milk depots in England and Wales were being tested monthly by these methods. Results obtained in Wales showed that mechanically washed churns were, in general, bacteriologically more satisfactory than those washed by hand and then steamed over a jet, although at dairies dealing with a small number of churns daily (less than fifty), which allows of adequate time for steaming both lids and churns, equally satisfactory results were obtained.

The effect of contamination from churns on the bacteriological and keeping quality of both raw and pasteurized milk was the subject of another paper. There is in general no measurable effect, unless the number of bacteria added by the churns is at least equal to that initially present in the milk. Churns which have been mechanically washed efficiently are without effect on the keeping quality of the milk, and no advantage accrues from further steam sterilization of such churns.

The *Proceedings* of the Society, containing full abstracts of the papers read at the conference, may be purchased from the honorary treasurer.

BRITISH ELECTRICAL ENGINEERS AND THE WAR

AT the opening meeting on October 4 of the current session of the Institution of Electrical Engineers, Dr. P. Dunsheath delivered his presidential address, in the course of which he gave a broad survey of some of the contributions made by British electrical engineers to the successful outcome of the greatest war in history. The scope of the address was very wide and covered such subjects as the maintenance of the electric power supply of Great Britain, the considerable increase in communications both at home and overseas, the use of broadcasting and radar as defensive and offensive weapons, the defeat of the magnetic mine, radio aids to navigation and gun-laying, the improvement of searchlights and the development of electrical equipment for research on atomic energy. The success attained in all this work was in no small measure due to the extensive and ready co-operation which was built up between the Services and the electrical industry for the purpose of solving the many problems of design and production which continually arose. In giving some general facts about the above contributions, Dr. Dunsheath disclosed some striking figures concerning the various phases of electrical engineering as adapted to war-time requirements.

The problem of the maintenance of an adequate electric power supply had to be tackled in the face of such difficulties as the destruction of, or severe damage to, certain generating stations by enemy bombing, and the interruption of service due to the breakdown of the overhead wires of the Grid system. The large majority (about 73 per cent) of the faults on this overhead distribution system were caused by trailing cables of barrage balloons which had broken loose; and only some 14 per cent were directly attributable to enemy action. For strategic reasons it became necessary early in the War to effect a major transfer of munition works to South Wales and the south-west of England; and the resulting change in load distribution imposed a very onerous task on the national control organization of the Central Electricity Board. Having in mind the additional difficulties of obtaining materials, suitable coal and adequate labour, there can be no question that the successful operation of a system of public supply stations with an output in 1944 of more than 38,000 million kWh., which was an increase of nearly one half on the 1939 output, is an outstanding performance.

As the supply of electric power for industrial purposes was a prime war-time necessity, so was the maintenance and extension of communications between different parts of the country and overseas. In this field the British Post Office provided a vast private-circuit network for the operational, meteorological and administrative traffic of the Fighting and allied Services, and enlarged its peace-time trunk system to reduce delays in priority traffic concerned mainly with the supply of munitions. Much progress was made during the War in the equipment used on audio carrier current and coaxial cable systems with the object of making each circuit carry as many communication channels as possible. Where it was necessary or expedient, radio links operating on ultra-short wave-lengths were installed and used as an integral part of the land-line network. In spite of various precautions taken before and during the War, many disasters due to enemy action overtook the Post Office. For example, a single high-explosive bomb on the Old Bailey on May 10, 1941, severed 28 cables of different types and interrupted 5,200 working circuits, mainly long-distance.

Overseas communications for the Services, necessarily of a secret nature, were carried out mainly by the submarine cable system, a network of 155,000 nautical miles which suffered many vicissitudes during the War due to enemy action and other causes. The enormous quantities of Press traffic, etc., were mainly cleared on wireless circuits; and on the long-distance service an outstanding war-time technical development was the extension of relay working to avoid interruption of the service by unsuitable ionospheric conditions. Another remarkable development in British electrical engineering enterprise during the War was in connexion with the wireless transmission of photographs, drawings, etc. Although the whole of the London photo-telegraph apparatus was lost during the raids of May 1941, the number of circuits on which photographs can be transmitted has been increased from three to eleven, and some two thousand facsimiles are now being exchanged monthly over direct circuits between London and the principal cities of the world.

The British broadcasting service was outstanding during the whole of the War in providing entertainment, news and stimulating programme items so necessary in keeping public morale at a high level. In addition, an important job, not perhaps adequately appreciated by British listeners, was carried out in providing listeners in the occupied countries of Europe with their only access to truth in news and their only means of contact with the world outside Nazi domination. As a result of the war-time efforts of our electrical engineers, Great Britain now possesses the world's largest long-wave broadcasting station, capable of delivering to the aerials a power of 800 kW., as well as the world's largest short-wave broadcasting station, at which there are twelve transmitters, each capable of delivering 100 kW. to one or other of the fifty-one directional beam aerials. In order to improve home reception and to provide for local broadcasting in the event of the interruption of communications due to invasion, the B.B.C. built sixty-four small broadcasting stations, which were synchronized and operated on one wave-length—an outstanding technical achievement. These were finally closed on July 28, 1945, when the Corporation changed over to the first instalment of peace-time broadcasting.

During his address, Dr. Dunsheath referred at some length to the development and applications of radar, both as a defensive and as an offensive instrument of war. This technique, developed first as a means of detecting attacking enemy aircraft, and later used

as an entirely novel form of navigation and for the precision bombing of enemy targets on and, sea or in the air, is now well known as one of the outstanding achievements of the War, in which scientific workers, engineers, industry and the Services have co-operated with complete success. This work brought in its train remarkable developments in the technique and output of valves, cables with novel dielectrics, cathode ray tubes and many other components. The facts that a modern battleship carries about fifty transmitting sets of various kinds, and many more receiving sets, and that a Lancaster bomber fully equipped may require about four hundred valves, accounts for the statement that during the last year of the War thirty-eight million thermionic valves were produced for the Services as compared with a peace-time demand of a quarter of a million.

There are many other electrical engineering applications which have been exploited to the full during the War, such as the clearing of fields of magnetic mines and the fitting of ten thousand warships and merchant vessels with degaussing equipment, the improvement of searchlights and their automatic direction by radar control, and the lighting of ports, shipyards and other important open areas under conditions of severe restrictions.

Dr. Dunsheath was only able to make a passing reference to the importance of the corporate work of the Institution of Electrical Engineers, and to the teaching profession, in providing an adequate supply of trained and experienced personnel of all grades. Without the assistance of large numbers of trained personnel, many of the engineering and scientific achievements of the electrical engineer during the War would never have come to fruition.

SCIENTIFIC STUDY OF FELLMONGERING

THE wool trade and, later, the cloth trade are the two industries on which the wealth of medieval England was founded, and wool production is still one of the leading industries of the British Empire. Though large quantities of wool are taken from the living sheep at the annual shearing, a good deal comes from slaughtered sheep. The handling of the sheepskin after flaying, and the separation of the wool from the pelt, are the tasks of the fellmonger, who in many cases is carrying out his work to-day by the same methods as those employed by his ancestors hundreds of years ago. Fellmongering, however, like a number of other ancient crafts, has now become the subject of scientific research. Bulletin No. 184, recently issued by the Council for Scientific and Industrial Research of Australia (Melbourne: Gov. Printer, 1945), describes a series of important fundamental investigations on the fellmongering process carried out by F. G. Lennox, Margaret Maxwell and W. J. Ellis.

There are, speaking very roughly, two types of sheep farmed in Australia: the Merino sheep, with long fine wool and, even at best, a poor pelt, and the crossbred sheep with shorter, coarser wool and a better pelt. There are also two general methods of de-wooling. The older process, with origins lost in antiquity, is known as 'sweating'—the sheepskins are hung in a warm moist atmosphere until the wool loosens and can be pushed off the pelt by the hand, the wool fibre coming away complete with root. The more recent process is 'painting'; the skins are covered on the flesh side with a thick cream of lime and a reducing agent, generally sodium sulphide, and the alkali plus reducing agent travel through the skin and cause the wool fibre to break off just above the root. The painting process therefore leads to a slight shortening of the fibre, and the total loss of weight from this cause is sufficient to keep the older sweating process in being for Merino sheepskins, in spite of the considerable damage frequently done to the pelt, and the foul odour of the sweating chambers.

The present pamphlet contains twelve papers describing studies on wool-loosening by the sweating process, the effect on the pelt not being included. It is interesting that the foundation of the work is the development of a quantitative method for measuring the force required to detach a standard staple from the pelt. With this tool in the hands of the investigator, it becomes possible to study, with some accuracy, the effect of varying conditions on the rate at which the wool root is loosened from its base.

The active agents in the sweating process are bacteria; an ærobe, an atypical strain of *Proteus vulgaris* designated No. 7, being the dominant wool-loosening organism, though three or four other species also have the same effect. No. 7 exists sparsely at the wool roots at the start of the sweating process, and freely when the wool is ready to pull. The agents of putrefaction which damage the pelt are anærobes. Many skins from up-country kills are dried for transport and have to be soaked back by the fellmonger before they can be sweated. Studies of this soaking operation show that the soak-water is completely de-oxygenated, a condition which encourages the growth of putrefactive anærobes. This, however, does not appear to inhibit the growth of No. 7 in the sweating chambers, and oxygenating the soak-water does not accelerate wool-loosening.

During sweating a large amount of ammonia is produced. Ammonia itself has a wool-loosening action, but the accumulation of ammonia tends to inhibit bacterial wool-loosening. The action of ammonia is due to the NH_3 molecule. Aliphatic amines have a similar effect, though this diminishes with increasing size of the molecule, quaternary ammonium compounds having little activity. Lipid solvents similarly have a wool-loosening action, while reagents causing dehydration, such as acetone and solutions of sodium chloride, and even drying, have a wool-tightening action. Conditions which cause tissue-swelling also cause tightening, probably because the hair-bulb cannot pass up the follicle.

The impression left on the reader of the twelve papers is of work well planned, well executed and well reported. An interesting development of the research is a new method of de-woolling the numerous small scraps from the edges of skins treated by the painting process, as well as shanks and head pieces. In these the scraps of pelt have no commercial value, and it has been shown that by subjecting them to heat treatment at 65° C. the skin tissues can be completely hydrolysed by proteases prepared from a bran culture of *Aspergillus flavus-oryzæ* or by papain, leaving the wool undamaged.

The volume well illustrates how even the oldest craft can be improved by an understanding of its scientific basis, and further developments will be awaited with great interest.

D. Jordan Lloyd.

FORTHCOMING EVENTS

Saturday, October 20

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES BRANCH (at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1), at 2.30 p.m.—Discussion on "The Publicity of Science, with particular reference to Chemistry" (Dr. O. J. R. Howarth, O.B.E., Mr. O. F. Brown, Mr. G. A. Jones and others).

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. R. Gore: "A System of Production Control".

Tuesday, October 23

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. V. Gordon Childe: "The Science of Man in the U.S.S.R."

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "Recent Work on the Theory of the Latent Image".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. J. F. Dunn and Mr. G. S. Plant: "A New Photometric Exposure Meter for Camera and Enlarger".

Wednesday, October 24

MANCHESTER METALLURGICAL SOCIETY (joint meeting with the INSTITUTE OF METALS and the IRON AND STEEL INSTITUTE) (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. R. Jackson: "The Application of Radiography to the Improvement of Foundry Technique".

INSTITUTE OF WELDING, WOLVERHAMPTON BRANCH (at the Victoria Hotel, Wolverhampton), at 7 p.m.—Mr. H. Thompson: Chairman's Address.

Thursday, October 25

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. Hartridge, F.R.S.: "The Direction of Flight of Bats by means of Sound Waves"; Mr. James Hornell: "How did the Sweet Potato reach Oceania?"

Friday, October 26

CHEMICAL SOCIETY (joint meeting with the GLASGOW UNIVERSITY ALCHEMISTS CLUB and the ANDERSONIAN CHEMICAL SOCIETY) (in the Large Lecture Theatre of the Chemistry Department, The University, Glasgow), at 3.30 p.m.—Sir Robert H. Pickard, F.R.S.: "Long Chain Molecules".

BEDSON CLUB (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. N. K. Adam, F.R.S.: "Surface Films" (Sixtieth Bedson Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. S. H. Richards: Inaugural Address as Chairman.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. R. N. Arnold: "The Mechanism of Tool Vibration in the Cutting of Steel".

CHEMICAL SOCIETY (joint meeting with the SOUTH YORKSHIRE SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY) (in the Chemistry Lecture Theatre, The University, Sheffield), at 6 p.m.—Prof. D. T. A. Townend: "Flame".

BRITISH ASSOCIATION OF CHEMISTS, ST. HELENS SECTION (at the Y.M.C.A. Buildings, St. Helens), at 7.30 p.m.—Mr. A. Rees-Jones: "From Lab. to Full Scale Production".

INSTITUTE OF WELDING, EAST SCOTLAND BRANCH (at the Heriot-Watt College, Chambers Street, Edinburgh), at 7.30 p.m.—Mr. D. M. Kerr: "Recent Advances in Welding in the Shipbuilding Industry".

APPOINTMENTS VACANT

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

ASSISTANT VETERINARY INVESTIGATION OFFICER—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon (October 26).

HEAD OF THE BUILDING DEPARTMENT of the St. Helens Municipal Technical College—The Director of Education, Education Office, Cotham Street, St. Helens (October 27).

CHEMIST—The Secretary and General Manager, Newcastle and Gateshead Water Co., Pilgrim Street, Newcastle-upon-Tyne, 1 (October 27).

TEACHER (full-time) OF PHYSICS AND MATHEMATICS in the Department of Chemistry, Physics and Biology of the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (October 27).

LECTURER IN MECHANICAL ENGINEERING SUBJECTS (Graduate in Engineering or with equivalent qualifications and capable of teaching to Higher National Certificate standard), a LECTURER IN CHEMISTRY (well qualified academically to undertake work to Degree standard), and a LECTURER IN BUILDING SUBJECTS (qualified to undertake work to Higher National Certificate standard), in the St. Helens Municipal Technical College—The Director of Education, Education Office, Cotham Street, St. Helens (October 27).

CIVIL ENGINEERS by Singapore Municipality: Civil Engineer to become Assistant Municipal Engineer (Roads and Bridges) (Ref. No. E.1978.XA), Civil Engineer to become Assistant Municipal Engineer (Sewerage) (Ref. No. E.1979.XA), and a Civil Engineer to become Assistant Water Engineer (Ref. No. E.1980.XA)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 29).

GRADUATE LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING of the Coventry Technical College—The Director of Education, Education Department, Council House, Coventry (October 29).

SENIOR TEMPORARY ASSISTANT (man or woman) under the Psychological Adviser—The Secretary, Civil Service Commission (Dept. O), 6 Burlington Gardens, London, W.1 (October 30).

LECTURER (full-time) OF SCIENCE AND MATHEMATICS in the Department of Building and Architecture of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (October 31).

INSTRUCTOR (full-time) IN PRODUCTION ENGINEERING SUBJECTS at the Leeds College of Technology—The Director of Education, Education Office, Leeds, 1 (November 3).

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Borough Electrical Engineer, Shannon Street, Blackpool (November 5).

CITY ELECTRICAL ENGINEER, Salisbury, Southern Rhodesia—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting D.1485.XA (November 6).

FELLOWSHIP IN ELECTROTECHNOLOGY, Council for Scientific and Industrial Research, Melbourne—The Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (November 9).

ASSISTANT LECTURERS IN BOTANY, CHEMISTRY, MATHEMATICS, PHYSICS, ZOOLOGY and GEOGRAPHY—The Registrar, University College, Leicester (November 10).

TECHNICAL TRANSLATOR into English from Swedish by first-class electrical engineering company in Sweden, primarily for the English edition of their technical house journal—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting D.1498.XA (November 12).

DIRECTOR—The Chairman of the Council, British Electrical and Allied Industries Research Association, 15 Savoy Street, London, W.C.2 (November 16).

LECTURER IN INDUSTRIAL CHEMISTRY, a LECTURER IN MECHANICAL ENGINEERING, and an ASSISTANT LECTURER IN CHEMISTRY, at the University of Queensland—The Agent-General for Queensland, 409 Strand, London, W.C.2, and the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (November 30 in Brisbane).

DEPUTY ENGINEER AND MANAGER of the Warrington Corporation Water Works—The Town Clerk, Town Hall, Warrington, endorsed 'Deputy Water Engineer and Manager' (November 30).

DIRECTOR OF MUSEUMS, Liverpool—The Town Clerk, Municipal Buildings, Dale Street, Liverpool, 2, endorsed 'Director of Museums' (November 30).

SORBY RESEARCH FELLOWSHIP—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (December 1).

TUCKER-PRICE SCIENTIFIC RESEARCH FELLOWSHIP for research on Mathematics, Natural Sciences and allied subjects—The Secretary, Girton College, Cambridge (January 15).

INSTRUMENT MAKERS (20) for the Telecommunications Research Establishment, Malvern—The Exchange Manager, Ministry of Labour and National Service, Malvern.

PATHOLOGIST (whole-time)—The Superintendent, Northampton General Hospital, Northampton.

DEMONSTRATOR IN THE DEPARTMENT OF PHYSICS, and a JUNIOR DEMONSTRATOR IN THE DEPARTMENT OF BIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

LABORATORY STEWARD for cancer research laboratory, to take charge of animal house—The Director of Research, Glasgow Royal Cancer Hospital, 132 Hill Street, Glasgow, C.3.

TECHNICAL LIBRARIAN—The Secretary, Copper Development Association, Grand Buildings, Trafalgar Square, London, W.C.2.

LECTURER IN NEUROPATHOLOGY in the University of Sydney and NEUROPATHOLOGIST to the Mental Hospitals of New South Wales—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

CROP RECORDER at the Institute's Sub-station in Hampshire (applicants should have had a sound training in agriculture and/or botany)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

TEACHER (part-time) OF GEOGRAPHY—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15.

ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Aberdeen.

LECTURER (full-time) IN ELECTRICAL ENGINEERING (capable of teaching Design of Electrical Machinery up to the Higher National and London University Final B.Sc. Degree standard, together with at least one other advanced electrical subject)—The Principal, Royal Technical College, Salford, 5.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

H. M. Treasury. Statements relating to the Atomic Bomb. Pp. 24. (London: H.M. Stationery Office, 1945.) 4*d*. net. [288

Ministry of Education. Pamphlet No. 2: A Guide to the Educational System of England and Wales. Pp. 64. (London: H.M. Stationery Office, 1945.) 1*s*. net. [288

Post-War European Broadcasting. A Report prepared by the British Radio Equipment Manufacturers' Association. Pp. 20. (London: Radio Industry Council, 1945.) [298

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St Martin's Street, London, W.C.2, and The Macmillan Co., 60 Fifth Avenue New York 11, N.Y., U.S.A.—Saturday, October 20, 1945.