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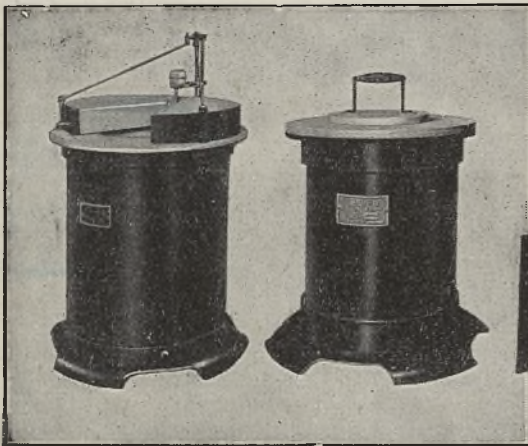
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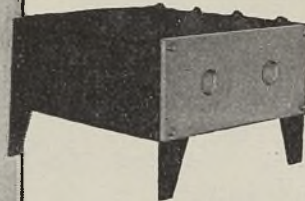
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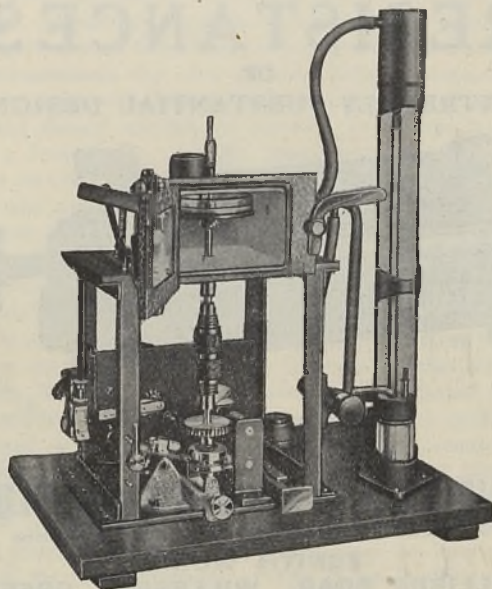
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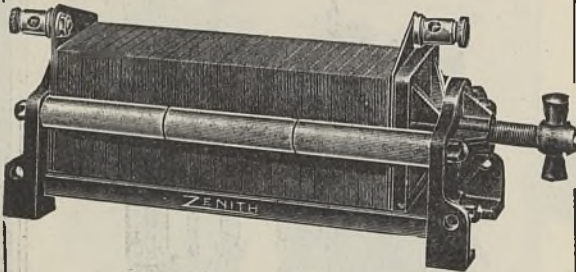
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NATURE

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CONDITIONS OF SURVIVAL: THE MORAL BASIS OF CIVILIZATION

THE debate on the Atomic Energy Commission which was initiated by Mr. Blackburn on the adjournment of the House of Commons on August 2 put into a more hopeful perspective the clash between the Russian and the American proposals, if not entirely dispelling the pessimism engendered by the forthright rejection by the Russians of the Baruch plan for the control of atomic energy. With some reason the insistence by the U.S.S.R. on the unlimited rights of national sovereignty has been regarded as the first step towards the dissolution of the United Nations, and if in fact the Russian attitude is as uncompromising as it first appeared to be, that grim possibility must be faced. No scientific worker doubts that the relinquishing of some degree of national sovereignty is the price that must be paid as an alternative to a scientific armaments race embracing not merely atomic energy but also the equally grim potentialities of biological warfare.

While it is necessary to insist that some abrogation of national sovereignty is essential if atomic energy is not to remain a great menace to our age, it does not seem that the disagreement on the panel of men of science attempting to formulate the question of control in terms of scientific possibilities is as wide as would appear from Mr. Gromyko's words. The Soviet delegate, Prof. Skobetsyn, has not made the same difficulties, and although the report which the chairman of the panel, Prof. Kramers, is drafting may prove extremely cautious, it is likely that the possibility of control—in the sense of assurance against secret misuse of atomic energy—at several stages in the development of atomic energy will be clearly indicated. The report will probably leave it to the politicians to resolve the problems involved in the adoption and administration of specific controls.

Mr. Blackburn's speech in the House of Commons suggested that the Russians had not rejected in any circumstances the idea of any form of inspection. Their point was that at the outset the nations of the world should abolish all recourse to atomic bombs by a formal act, and Mr. Blackburn urged that it was inconceivable that the working of any system for the control of atomic energy, once agreed upon by the Security Council, could remain dependent on any act of the Security Council itself. If we established a system of control which gave warning months in advance of the fact that a country which purports to be accepting the rules laid down is violating those rules, we could eliminate the political problem of the veto. Mr. Blackburn indicated his own belief that a careful study of the technical side of the problem showed that possible measures for the control of atomic energy were possible because they turned largely upon scientific considerations, and in spite of asserting that the wider political issues had been considered first, he appears to lean very much to the proposals of the Acheson-Lilienthal report itself.

There was little support for Mr. Blackburn's suggestions in the debate, although the point he made

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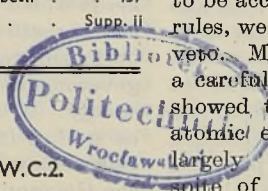
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about the effect of the proposals on the U.S.S.R. and the necessity for removing Russian suspicion if possible was appreciated. The importance of the distinction between disclosing full information regarding the technical aspects of the production of the atomic bomb itself to a super-national authority such as the Lilienthal Commission proposed, and imparting it to such a body as the United Nations Organisation was apparently appreciated, but the note of urgency which has been so firmly emphasized in almost every communication from the scientific side was lacking even in Mr. P. Noel-Baker's statement. Mr. Noel-Baker did not think that a solution would be quickly reached, but made the rather surprising statement that the Government believed that the American and the Russian plans required to be fused. The two proposals, he suggested, really dealt with different parts of the subject, and he did not think they were in conflict. The Russians proposed that the manufacture and use of atomic energy for war-like purposes should be outlawed and that every State should undertake neither to manufacture nor to use the atomic bomb. Mr. Noel-Baker said further that the American representative on the Commission had agreed with the Russian representative that there was no fundamental clash of principle between this and the American proposal.

Mr. Noel-Baker's chief observations, however, were on the question of control and inspection. The Government fully accepted the principle of control and believed that a practicable scheme could be devised which would give reasonable security. Agreeing that the start should be made from the technical side, Mr. Baker said that, in the Government's view, we should first aim at drawing up a practical plan in the form of a convention for the creation of an international authority, and that, having done this, we would come to the necessity for political decisions. Before the major decision was taken the governments should have time for reflexion, the benefit of a prolonged international debate and a concrete picture of the safeguards offered in return for the surrender of sovereignty which the plan would involve.

In reply to a question as to whether the technical commission which is to work out this scheme would also deal with scientific subjects and the interchange of information, Mr. Noel-Baker said that members of the Atomic Energy Commission were not primarily men of science, but on the scientific and technical committee there were some of the most eminent men of science in the world. Besides this there was a sub-committee, mainly political, dealing with the system of control. He thought it possible that there might be agreement on exchange of scientific information before any final convention was made, but he emphasized that while men of science as such had rendered great assistance for pooling and publishing information, directing attention to the main problems to be solved and suggesting lines on which a solution might be found, they could not assume the political responsibility which must remain with the Government. Finally, Mr. Noel-Baker agreed that the atomic bomb might be neither the last nor the worst weapon which science might produce. We had to deal with

armaments of all kinds and should make it our object of policy to stop all wars, as well as to remove the causes of war.

Much of Mr. Noel-Baker's statement is most reasonable and in accord with scientific opinion. His recognition that the surrender of national sovereignty is involved is clear enough, though it might well have been emphasized more strongly that without such surrender there can be no control and no alternative to atomic warfare. The fate of the Kellogg Pact alone indicates the futility of relying simply on the renunciation of a particular type of warfare. But while it is reasonable and important that the governments should have ample time for reflexion before they make their decision, it should also be recognized that time is an essential element in reaching a real solution. The problem may well become more intractable, if not insoluble, by delay, as the Lilienthal Board have urged. There is grave danger that dilatoriness may allow an international atomic armament race to attain such momentum that it cannot be stopped.

Mr. Noel-Baker's statement did nothing, therefore, really to dispel the fear that the question of atomic energy and its control is not regarded by the Powers with the sense of overriding urgency that is imperative, and this fear will not be diminished by a like failure of the Powers to face the issues involved by the termination of the United Nations Relief and Rehabilitation Administration on December 31. Despite the proved and known need, despite the fact that the World Health Organisation will not meet until January and that the transfer to the Food and Agricultural Organisation of the functions of relief and agricultural rehabilitation, as recommended by the Director-General of U.N.R.R.A., will take a long time, liquidation of the headquarters staff of U.N.R.R.A. has already begun. The World Health Organisation will meet to find that the body of experts uniquely qualified to serve its high purposes of mitigating disease has just been finally dissolved, and the Committee to which the Food and Agricultural Organisation has referred the practical difficulties of finance and organisation and of principle involved in the transfer, is apparently not to report until the existing organisation has been wound up, and no plans can be approved to operate in time to meet European needs in the closing months of the present harvest year.

This melancholy picture of failure to face facts and to make adequate transitional arrangements to meet needs which are ultimately to be provided by organisations still in their birth throes encourages no easy optimism regarding the willingness or ability of governments to deal with the problem of atomic energy. It is indeed a picture of moral dereliction as well as ineptitude, and however right Mr. Noel-Baker may be in emphasizing the responsibility of the Government for the political and administrative action required, it is equally right that men of science, having discharged the technical responsibilities that lie on their own shoulders, should leave their fellow citizens in no doubt as to the dereliction of duty for which the Powers can justly be arraigned.

That dereliction of duty is not one in which the British Government stands alone. We may gladly recognize that in regard to atomic energy the Government of Great Britain has taken a lead, and especially in insisting on the limitations of national sovereignty that are involved in any effective plan for control. But it is not sufficient merely to indicate acceptance of those implied limits on national sovereignty. That of itself will not place the responsibility for failure solely on the shoulders of those who primarily reject any such limits, unless every step has been taken to engender the confidence which would encourage the surrender by other nations of the necessary degree of national sovereignty.

Mr. Blackburn was right to indicate the responsibility which in this matter lies especially on the United States if Russian co-operation and confidence are to be secured, but nothing in the debate touched on a more fundamental responsibility of both Great Britain and the United States which is brought out even more clearly in relation to the dissolution of U.N.R.R.A. and the work of the Control Commission in Germany. The dominant factor in the present unsatisfactory position is the absence of a firm long-term policy for the whole of Germany. The most emphatic and important conclusion which the Select Committee on Estimates reached in its report on the Control Office for Germany was the need for the economic re-integration of the zones of occupation and the formulation of such a firm long-term policy; if not, in default of re-integration of the zones, for the whole of Germany then for the British zone and for such other zones as may be brought within the framework of a single economy. Fairly and squarely there was thus placed on the shoulders of the British Government the responsibility for formulating such a policy for the zone which it controls, and no refusal by the American Government or by the U.S.S.R. to face those facts and accept those responsibilities can excuse British refusal to honour the moral obligations implicit in the Atlantic Charter.

What has to be faced is that in deference to the U.S.S.R., Great Britain and America have abandoned the principles involved in the Atlantic Charter and have left themselves without any consistent peace aims. Abandoning the ideals and values of Western civilization, they have failed to practise them; and each successive challenge in Europe, whether of famine, of health, of economic reconstruction, no less than of the control of atomic energy, has found them with nothing positive to oppose to the aims and values of Soviet Russia. The first need for Britain and for the Western democracies is a positive policy based on those principles and ideals which are the highest expression of our Western civilization and which we professed only five years ago. If those values and principles are practised we may recapture the moral purpose and formulate the policies which can give them adequate expression.

Nothing is gained by concealing the fact that the aims and values of Soviet Russia are not those of Western Europe, or that what is needed to restore unity is a revival or a re-assertion of the religious standards and way of living from which

Western civilization has derived much of its greatness. Respect for human personality, freedom of thought and utterance, freedom of worship, freedom of investigation—these freedoms from want and from fear in the spiritual realm are exactly what are denied by communism and cherished by the Christian ethic. They are also the conditions of scientific investigation and are implicitly asserted in the resolutions recently adopted unanimously by the General Assembly of the International Council of Scientific Unions.

These resolutions point to the supreme opportunity and occasion for a new international unity, to develop the benefit latent in nuclear energy and to avoid its misuse and no less to avert the potential menace of biological and biochemical warfare and to bring to mankind the full benefits of the discoveries on which such warfare depends. The resolutions recognize clearly that attainment of an agreement on the application of nuclear energy would represent an example of the international co-operation in economic and political matters which is essential to promote the welfare of mankind, the judicious use of natural resources, the removal of causes of dispute and the settling of difficulties arising from the continuous change of world conditions in consequence of scientific and technical advances. They recognize also that military secrecy cannot be allowed to dominate scientific discovery in any country or to prevent frank discussion and open publication of scientific results: international control and co-operation presuppose an international community of knowledge.

EARLY MAN AND APES IN THE FAR EAST

Apes, Giants and Man

By Franz Weidenreich. Pp. vii+122. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.)

MORE than fifty years ago there were discovered in Pleistocene deposits in central Java the fragmentary remains of a large primate which in several respects appeared to be intermediate between man and ape. It was therefore named *Pithecanthropus*. But, because the remains were so fragmentary, they led to a considerable amount of controversy which, on the whole, was rather inconclusive. Then, in 1929, the skull cap of a Pleistocene primate similar to *Pithecanthropus* was found in China near Peking. It was described by the late Dr. Davidson Black and named by him *Sinanthropus*. Finally, during the few years preceding the Second World War, many more skeletal remains of these fossil forms came to light both in China and Java. Indeed, at present there are records of five skulls of *Pithecanthropus* (including that of an infant) from Java and no less than fifteen skulls of the Peking fossil, as well as jaws and teeth and some limb bones. Thus we are now in a position to speak with some confidence on the morphological characters of these ancient forms.

One of the anatomists who have been most active in the accumulation of this new evidence is Dr. F. Weidenreich, who succeeded Davidson Black in 1934 as professor of anatomy in the Peking Union Medical

College, and who during recent years has been responsible for the publication of a series of exceptionally fine monographs on *Sinanthropus*. Before the War, Dr. Weidenreich also maintained a close contact with Dr. v. Koenigswald, of the Geological Survey in Java, to whose energy and initiative the new discoveries of *Pithecanthropus* in Java were mainly due, and he was thus able to make a personal study of some of this valuable material. Specialists will already be well acquainted with Weidenreich's monographs published in scientific journals on these Chinese and Javanese fossils. Some of the results of his important studies have now become available in more popular form in a short book of essays published by the University of Chicago.

The first important point which has accrued from these studies is that the resemblance between the Chinese and Javanese fossils is very close, so close, indeed, that they are reckoned both by Weidenreich and v. Koenigswald to differ no more than two races of modern mankind. It is generally agreed by systematists now that this conclusion is certainly correct, and that *Sinanthropus* should really be allocated to the genus *Pithecanthropus* (though possibly with specific distinction). Weidenreich himself is reluctant to do this, since he thinks that such a change would be confusing. But it may be argued with reason that the retention of an implied generic distinction now recognized to be unwarranted would be even more confusing, for whereas in one case the confusion would be at the most a temporary inconvenience, in the other case it would be a permanent source of misapprehension.

The outstanding features of *Pithecanthropus* in Java and China can be stated quite briefly. Many of the skull characters are remarkably simian, including heavy projecting supra-orbital ridges, retreating forehead, marked platycephaly and massive jaws. At the same time, the teeth, though showing several primitive features, are human in their individual morphology and their general arrangement, and the temporo-mandibular joint is also constructed on the human plan. The cranial capacity is astonishingly variable, ranging from 750 c.c. to 1,200 c.c., and at its upper limits, therefore, comes well within the range of *Homo sapiens*. Lastly, the few available limb bones appear to be identical with those of modern man. It thus appears that *Pithecanthropus* was definitely a human being, though in some respects exceedingly primitive.

Among the Javanese fossil remains was found a fragment of a lower jaw containing the two premolar teeth and the first molar. The discovery was announced by v. Koenigswald early in 1941, and a cast of it was sent to Weidenreich (then in the United States). It was derived from the Trinil beds, and, because of its massive proportions, was named by v. Koenigswald *Meganthropus*. In its general features this jaw fragment appears to conform with a *Pithecanthropus* mandible discovered some years previously, though definitely larger. Whether its size really does put it beyond the range of variation of *Pithecanthropus*, and therefore justifies a generic distinction, can scarcely be affirmed with confidence until more fossil material becomes available. In any case, however, it may be somewhat misleading to refer to the owner of the *Meganthropus* jaw as a 'giant', since the latter term is commonly taken to indicate an unusual stature. All the known jaws of *Pithecanthropus* are massive as compared with those of a modern European, yet, so far as stature is concerned,

it is to the latter rather than the former that the term 'giant' might be more appropriately applied. Dr. Weidenreich includes among his 'giants' three molar teeth which were acquired by Dr. v. Koenigswald in Chinese chemists' shops in Hong-Kong. (It should be explained that fossil teeth are not infrequently to be found on sale in China under the name of 'dragons' teeth', and they are assumed to be of therapeutic value.) v. Koenigswald expressed the opinion that these were the teeth of an extinct ape of exceptionally large size, probably nearly related to the orang-utan, and he called it *Gigantopithecus*. Weidenreich, although he has only had access to casts for the study of these specimens, believes they are the teeth of a gigantic hominid. Here, however, we are quite unable to follow him. It appears to us that none of the morphological criteria on which he relies for his diagnosis are completely valid, and that the simian appearance and proportions of the teeth far outweigh in significance any suggestion of hominid traits which the teeth may seem at first sight to show. We would therefore agree with v. Koenigswald's point of view, particularly since Weidenreich has already stated specifically elsewhere that the *Gigantopithecus* molar closely resembles a fossil orang's molar from Kwangsi in south China in the form, number, arrangement and height of the cusps, as well as in their tightly set condition (*Anthrop. Papers Amer. Mus. Nat. Hist.*, 40, Pt. 1; 1945).

The accumulation of fossil primate material bearing on human origins is now proceeding rapidly, and it is becoming apparent that the number of forms of ape and man which existed in late Tertiary times reached a diversity hitherto quite unsuspected. One of the remarkable features which has been made evident by all these fossil remains is that they frequently present unconformities which would certainly not have been anticipated. Among such unconformities is the association of the peculiarly primitive skull and jaws of *Pithecanthropus* with delicately modelled limb bones of modern human type, and the association of a simian skull with teeth of human proportions in the Australopithecinae. Incidentally, such odd associations greatly weaken the arguments of those who still refuse to accept the possibility that the Piltdown jaw and skull may belong to the same individual.

Another point of interest which is now beginning to emerge very strongly is that, so far as the actual origin of man is concerned, Africa is likely in the future to be the main focus of attention for palaeontologists, and not Asia. For, as already mentioned, *Pithecanthropus* is definitely human, and in some respects is rather far removed from the ape. On the other hand, the fossil primate material reported from Africa by Dart, Broom, Leakey and MacInnes seems to bear witness to actual transitional forms between ape and man.

W. E. LE GROS CLARK

A BUDGET OF ERUDITION

Essays and Studies

By W. A. Osborne. Pp. vii+188. (Melbourne, Sydney and Adelaide: Lothian Publishing Co. Pty., Ltd., 1946.) 10s. 6d.

ABOUT a century ago, De Morgan, the mathematician, was contributing articles to the *Athenæum*, describing the various attempts which had been made to invent perpetual motion, to square

the circle, or to trisect the angle. These articles, along with many items gathered from his varied and extensive reading, were included in his "Budget of Paradoxes", a book which, as reprinted by his widow in 1872, is one of those books still beloved by readers who are interested not only in the highways but also in the by-ways of literature. The book is a marvellous combination of versatility and accuracy.

These thoughts about De Morgan, the mathematician of a century ago, came unbidden to the mind of the reviewer as he slowly turned the pages of Osborne, the physiologist of the present day. Parenthetically, it may be remarked that Dr. Osborne was born in Ireland and received his early education there, and later at University College, London, and at Tübingen. For some time he taught physiology in London, but he became professor of physiology at the University of Melbourne in 1902, and dean of the Faculty of Medicine during 1929-38, and is now emeritus. Just to call him a physiologist, however, is as inadequate as it would have been to call De Morgan a mathematician. Osborne's interests are astoundingly wide and varied, including highly original and often amusing comments on Shakespeare's language, a detailed description of the price-fixing and wage-fixing edict of Diocletian in A.D. 301 (conveying a lesson to us from the past), and the true place of science in education. The publishers of the book are justified in saying that the outstanding qualities of these essays is originality based on accurate scholarship, and the reviewer feels justified in calling the book "A Budget of Erudition".

Some of the most entertaining instances of Osborne's erudition occur in the essay on "Scientific Errors in Literature and Art". Here he shows himself no hair-splitting pedant. He disapproves of the mathematician who rebuked Tennyson for stating "Every moment dies a man, every moment one is born", and who suggested the correction "one and a sixteenth is born". He pounces only upon real 'howlers'. Rider Haggard in "King Solomon's Mines" has an eclipse of the sun lasting over an hour, whereas the maximum time is seven minutes. Wordsworth in his poem on the green linnet makes that bird "pour forth his song in gushes", but, alas! the green linnet is a songless bird. In Lever's "Charles O'Malley" a horse crashes badly and breaks a collar-bone, but a horse has not got a collar-bone; and when Browning in "How We Brought the Good News" makes a rider in full gallop shake off his jack-boots to lighten the load, one wonders, says Osborne, if Browning ever wore jack-boots or ever rode a horse.

The reviewer is compelled to pick and choose from the contents of this book. Time and space would fail him to enlarge on such attractive themes as "The Magic of Monosyllables", the sort of dial that Shakespeare had in his mind's eye when he wrote that Touchstone "drew a dial from his poke", the Voices of the Great—with its stories of Dickens and Gladstone and Spurgeon, whose Tabernacle was attended by an educated visitor to London because of "the incomparable melody" of the speaker's voice. The short essay on "Old Age Then and Now" is a sharp reminder of demographic facts and their economic significance. "Old John of Gaunt, time-honoured Lancaster" died at fifty-nine. Columbus, according to Walt Whitman, "a battered wrecked old man", died at fifty-six. Thackeray, who described himself in one of his poems as a "grizzled grim old foggy", died at fifty-two. History does, of course, adds

Osborne, give us examples of illustrious men dying at great ages, but they are regarded as prodigies surpassing Nature's law. Now they are no longer so, the span of life in all classes of the community has increased, and at the other end infant mortality is no longer regarded as philosophically as it was a generation ago. The essay on "Science in Education", being an address delivered at an All-Australian Education Conference, is a most careful and illuminating piece of work. The essayist is equally clear and plain-spoken as to what science can do, and what it cannot do, for the young learner; and, as may be abundantly gathered from his other essays, he is far too good a humanist to be a one-sided advocate of science in education. He denounces bad teaching, whether of science or of literature, with equal clearness and emphasis wherever he sees it. He impeaches the grammarians of destroying the appreciation of literature. A play of Shakespeare is prescribed and an examination is held, and most of the children "thus affected and afflicted acquire an abiding aversion to this drama and sometimes to its great author just because a work of art has been put to a use to which no work of art should ever be applied". Thus does Dr. Osborne again prove himself to be much more than an eminent physiologist.

T. RAYMONT

ATOMIC PHYSICS

Introduction to Atomic Physics

By Dr. Henry Semat. Revised and enlarged edition. Pp. xi+412. (New York: Rinehart and Co., Inc., 1946.) 4.50 dollars.

THESE is a real need for text-books covering a self-contained lecture course on atomic physics. By departing drastically from the historical order of development, a very wide ground may be covered even with students at a comparatively early stage. It is possible to make such a course relatively simple to follow and yet to include most of the important features of modern atomic, including nuclear, physics. The developments associated with atomic energy have raised the educational requirements for this branch of physics, so the demand for appropriate text-books should be considerable.

Dr. Semat's book is of this type and includes a well-balanced choice of subject-matter. The mathematics introduced is never difficult, requiring little more than a knowledge of elementary calculus. Part 1 deals with the foundations, Part 2 with the extra-nuclear structure of the atom and Part 3 with the nucleus. It is written in an easy, but not hearty, style, is well illustrated and is quite up to date. Thus it includes a discussion of the betatron and of nuclear fission. In fact, discussion of the nucleus is very thorough and would provide an excellent introduction to the subject.

At the end of each chapter useful references to other texts are given, together with another valuable feature—the provision of problems on the subject-matter of the chapter. These are well chosen and likely to assist the student to clarify his mind.

Tables of atomic weights, isotopic masses and stable isotopes are included among other appendixes.

The form and style of the book are pleasing, and it should be of much value to teachers of atomic physics in Britain.

H. S. W. MASSEY

The Countryman's Week-End Book

By Eric Parker. (Week-End Library.) Pp. 416. (London: Seeley, Service and Co., Ltd., 1946.) 12s. 6d. net.

ERIC PARKER is well known as a writer on a natural history for his ability to interpret natural lore in language which makes it freely available to all. Here he has attempted to produce a book especially for leisure hours, and has been very successful. It is meant to be a book for any odd ten minutes and for reading both forwards and backwards. Its merit is that no matter where one dips there is something of interest to while away the awkward moment before one's next engagement.

There are sections on building a house and the best wood for wood fires, and the best creepers and climbers. Parker will advise on the choice and care of a dog, while on the recognition of birds and the way to entice them to the garden he overleaps himself to be helpful. British mammals, reptiles, insects and wild flowers form other parts of this conversation in words, while, to take a different tack, he provides some useful and revealing information about country crafts and industries. Nor is he afraid to offer advice on forecasting the weather, or what books could be read with advantage on country matters. Even his facts about the record weights of fish and birds and the sports records of athletes do not exhaust this compendium for the aspiring countryman, for his final section includes a valuable account of the legal snares which await the innocent townsman taking up country pursuits. In simple terms Parker explains the Game Act of 1931, how and when and what to shoot, the laws that must be observed when engaging fish or domestic servants, as well as the law of trespass. And, lest the man of science thinks that this is a scrappy collection of superficial miscellanies, let him be reminded that Parker's information has been collected in a life-time of acute observation in the country. During that period he has used a discerning eye to note the kind of information which interests most men and women, and "The Countryman's Week-End Book" is an interesting record of his discrimination.

T. H. HAWKINS

Electric Discharge Lighting

By F. G. Spreadbury. Pp. viii+136. (London: Sir Isaac Pitman and Sons, Ltd., 1946.) 15s. net.

THE title of this little book is misleading. It deals not at all with the principles or practice of lighting, but is merely an account of some of the properties of modern electric discharge lamps. In the last fifteen years, the search for high luminous efficiencies and coloured light sources has led to rapid development of these lamps, and there are now about a dozen principal types available commercially in Great Britain. The author, therefore, in the small amount of space at his disposal, has clearly attempted to give only a very superficial treatment of what is now an extensive subject.

Judged in this light the book has merit. Chapter I, on fundamentals, is clear and concise; although there are some mistakes, it will serve as the sort of introduction to the subject required by a layman. There follow three chapters in which low-pressure lamps (both cold-cathode and hot-cathode types), high-pressure mercury vapour lamps, sodium vapour lamps and fluorescent lamps are dealt with. While the next two chapters, concerned with circuits and the design of circuit components, are not free from fault, they provide in a clear manner information that many readers will find useful and interesting.

The last chapter is called "Technical Applications of Discharge Lamps"; the reviewer can only wonder why this was written and how it found its way into a book on lamps.

Those who have no special knowledge of the subject, but have a general interest in knowing something about the discharge lamps which are being increasingly used for lighting, will probably find the book suitable for their purpose. It is not recommended for those who require anything more than a very general introduction to the subject. The production is good and the figures and diagrams (122 in all) are excellent, but the almost complete omission of references detracts from the value of the book even for the general reader. V. J. FRANCIS

Heaviside's Electric Circuit Theory

By H. J. Josephs. (Methuen's Monographs on Physical Subjects.) Pp. viii + 116. (London: Methuen and Co., Ltd., 1946.) 4s. 6d. net.

IN following the standard set in this series of monographs, the author gives us a tidy, critical, and slightly historical account of the basis of operational calculus as devised by Oliver Heaviside. It should be a great help to students, because it is in the initial stages that the difficulties are most severe. There is a slight parallel between Heaviside and the author, for the latter, without paper qualifications, has risen to be an effective exponent of his master's subject, a corner of the field of mathematics which is not densely populated by authors.

Indeed, Mr. Josephs seems to have read more deeply into the works of his master than others, for he has found a new theorem, "Heaviside's Last Theorem", which he shows to be a unifying theorem for much other work, including Carson's integral equation and the rigorous derivation of the remaining Heaviside operational processes of use in electric circuit theory. L. E. C. HUGHES

The Warlis

By K. J. Save. Pp. x+280+15 plates. (Bombay: Padma Publications, Ltd., 1945.) 10 rupees.

THE Warliribe is a branch of the better known Bhil tribe, and this account of it by the Special Officer for the Protection of Aboriginal and Hill Tribes in the Thana district of Bombay is for practical purposes an excellent factual account of a primitive tribe slowly being absorbed into Hinduism. Though the Brahman is beginning to take the place of the tribal priestess, the power of the tribal shaman is still very great, and in the opinion of the author is no less a stumbling block to progress than the Warli love of drink and their economic depression to the position of landless labourers living from hand to mouth. The author deals in detail with the daily life, society, organisation, mythology, religion and language of the tribe and incidentally with their material culture. In so far as it is documentary, as distinct from interpretative, the account given is commendable and thorough. There are forty-three photographs, but unfortunately reproduced on too small a scale to be really satisfactory, an index and a glossary; there are also a few text cuts, but no detailed drawing of the rather remarkable horn-pipe, the favourite musical instrument of the tribe. Except for rather too numerous misprints and misspellings, the printing is good. The author is to be congratulated on a painstaking piece of very useful ethnographical work.

On the Choice of a Common Language

Edited by H. Jacob. Pp. xiv+130. (London: Sir Isaac Pitman and Sons, Ltd., 1946.) 7s. 6d. net.

ANYONE who has listened patiently to radio accounts of proceedings at the Peace Conference must have fresh in his mind the prodigious expenditure of time, and sometimes the shocking confusions and misunderstandings, caused by what one of the contributors to this book calls "these linguistic difficulties which have cursed mankind since Babel". Here is sufficient proof that something needs to be done about it.

The aim of this book is to show that a common language is not only an urgent need, but also a practical possibility. It is produced under the auspices of the New Education Fellowship, an organisation which is too well known to call for description or commendation in any educational journal. In the first part the writer gives a short history of the constructed languages, such as Volapuk and Esperanto. The second part is devoted to an exposition of Basic English, its meaning, its principles, and its educational value. The book as a whole comes down definitely on the side of Basic English as the simplest and most promising way of meeting the need of the peoples of the world for international communication, now that the nations are inevitably drawn closer together. The book is packed with reliable information, and is a credit to its writers.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1946. Edited by Dr. M. Epstein. Eighty-third annual publication, revised after Official Returns. Pp. xli+1,461. (London: Macmillan and Co., Ltd., 1946.) 30s. net.

THIS valuable year-book again provides the official statistics for every country of the world. For some of the belligerent States of Europe revised figures are at last available. For the main enemy countries, however, that is not yet possible. The frontier changes in eastern Europe contemplated at the Berlin Conference of July 1945 are shown in a coloured map—the allocation of the Polish corridor, East Prussia, Bessarabia and Bukovina, with the western spread of the U.S.S.R. A second map shows the changes indicated by the Potsdam proclamation to Japan, including the return of Manchuria and Formosa to China, of Karafuto and the Kurile Islands to the U.S.S.R. and the independence of Korea. The section on the League of Nations is replaced by one on the United Nations with the complete text of the Charter. The British Council is also noticed. The volume retains unchanged its compact shape and size and high standard of production.

Self

A Study in Ethics and Endocrinology. By Michael Dillon. Pp. vi+128. (London: William Heinemann (Medical Books), Ltd., 1946.) 6s. net.

THE ancient precept, inscribed in gold letters over the portico of the Temple at Delphi, is rendered into English as "Know Thyself". This precept is adopted as a motto by the author of "Self: a Study in Ethics and Endocrinology". Mr. M. Dillon is the author of the book, and Dr. Gilbert Russell writes a commendatory but cautious foreword. The author sets himself the question: Why is a man what he is? The beliefs, tastes, hobbies, eccentricities, which build up the normal man or

woman, are the origin of the disorders which develop if any trait gets out of perspective. This book is an attempt to discover how far the character of the individual depends (the words are important) upon physical structure and the chemistry of the body. The author examines the difference of outlook between the two sexes, how this difference arises and what it implies. In discussing, in the second part of the book, the mind, he necessarily deals with the problem of free-will, and this brings him to a synthesis of science and philosophy as a guide to man's understanding of himself.

All things considered, the book is simply written, but for the less initiated the author thoughtfully adds an explanatory vocabulary. He concludes with a bibliography and a reference to papers on the subject.

The Photography of Scenery

By Dr. Vaughan Cornish. Pp. 129. (London: Sifton Praed and Co., Ltd., 1946.) 12s. 6d. net.

DR. VAUGHAN CORNISH has not infrequently charmed us with his studies of beautiful things, sometimes natural and sometimes man-made. Now he provides another collection, from his camera this time, with a promise of some sketches to follow.

Apart from the technically high level which is achieved, the appeal of these photographs resides to a considerable extent in the sense of tranquillity which many of them produce. That is very valuable in these days of riotous movement. For example, No. 22 (banyan tree) is almost a Blake drawing in essence, rhythmic yet reposeful. The architectural studies, Wells for example, are very successful in their own way and manage to convey characteristic local atmosphere. When all this is presented in an attractive little book, one goes on one's way rejoicing that there is still somebody who values scenery intensely and wants other people to do so too.

F. IAN G. RAWLINS

Karlova Universita

(The Charles University). By Prof. V. Vojtíšek. Pp. xii+130. (Brno: A. Piša, 1946.) 84 crowns.

PROF. VOJTÍŠEK is archivist to the city of Prague, and his object is to emphasize the Czech origin of the city's University. This he does by reproducing and explaining the early documents relating to its foundation. These are Pope Clement's Bull of 1347, Charles IV's "Golden Bull" of 1348 and his endowment charter of 1349. The 1401 and 1402 reports of the then dean (Magister John Hus) are given together with the legal observations of 1414 on Wenceslas IV's 'Kutná Hora' decree reiterating the precedence of the Bohemian 'nation' in all university affairs. The need to establish the facts relating to the origin of the University has arisen as a consequence of the German action during the occupation of transferring the privileges and possessions of the University to the German University of Prague.

Rostlina pod Drobnohledem

(The Plant Under the Microscope). By Prof. S. Prát. Pp. 206. (Prague: Česká Grafická Unie, 1945.) 99 crowns.

THIS is a new text-book of structural botany for Czechoslovak university students. It is noteworthy for the excellence of the author's photographs of microscope preparations.

BIOCHEMICAL RESEARCH ON CHEMICAL WARFARE AGENTS

By DR. M. DIXON, F.R.S., and DR. D. M. NEEDHAM

Department of Biochemistry, Cambridge

THE fundamental mechanisms by which poison gases produce their effects, involving as they do the action of chemical substances on living tissues, are primarily a matter for investigation by the biochemist. For some time past the belief has been growing that many, if not most, poisons act by attacking one or more of the essential intracellular enzymes, thus producing what Peters has termed a 'biochemical lesion'; the actual damage observed is a consequence of the resulting metabolic disturbances.

At the time of the Munich crisis in 1938, when war seemed imminent, we put forward suggestions for work on these lines, involving a study of the action of war gases on enzymes. These suggestions were not then proceeded with, but on the outbreak of war a year later they were renewed, and early in 1940 a research team under the direction of Dr. M. Dixon was formed to work in this laboratory for the Chemical Defence Research Department of the Ministry of Supply. This article gives a brief account of this team's work, which extended from 1940 until 1945; it will be seen that although attention was especially focused on mustard gas, the work was not confined to the problem of vesication, but developed to include other problems, such as the mechanism of systemic mustard and lewisite poisoning, of lachrymation, of the action of myotics, etc. Some of the later work on mustard gas was done in collaboration with Prof. Wormall's team, which was evacuated to Cambridge from London during the War.

It was soon found that (a) the different classes of substances (lachrymators, vesicants, myotics, etc.) do, in fact, poison different groups of enzymes, and (b) different substances belonging to the same class in general poison the same enzymes, even though they may have very different chemical constitutions. This gave strong support to the view that these poisons act primarily by a specific attack on enzymes.

Lachrymators

These are of two types, containing respectively halogen atoms and $>C=C<$ groups. In the first group, it was already known that lachrymatory properties were associated with the presence of a 'positive halogen', for example, in a grouping such as

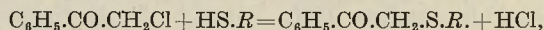


$-C-CH_2X$, and Ford Moore¹ had correlated activity with chemical structure on this basis with considerable success. It was not known, however, why the positive halogen should confer these properties, why such properties should also be shown by substances of the second group, or what kind of chemical reaction was responsible.

In 1941 a survey by Mackworth² showed that lachrymators irreversibly inhibited all those enzymes the activity of which had already been shown by independent evidence to depend on $-SH$ groups. Among these were succinic dehydrogenase, triose-phosphate dehydrogenase, yeast alcohol dehydro-

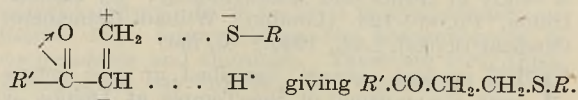
genase, hexokinase, the pyruvate oxidase system (of bacteria), papain and urease. Xanthine oxidase was also sensitive and hence probably should be classed as an $-SH$ enzyme. A large number of other enzymes tested were not affected. Mackworth therefore suggested that lachrymators act by a specific attack on essential $-SH$ groups.

There is other evidence supporting this. (a) Morgan and Dixon³ showed directly by means of the nitroprusside reaction that the lachrymators of both groups attack the $-SH$ groups of proteins very rapidly and completely. Mustard gas (*H.*) also reacts with protein $-SH$ groups very slowly⁴; but the rate is quite negligible in comparison³ and mustard reacts mainly with other groups in proteins. It does not affect most $-SH$ enzymes under similar conditions. (b) $-SH$ enzymes are inhibited by lachrymators only in the $-SH$ form; the oxidized ($-S-S-$) forms are not inactivated^{3,5}. (c) Peters and his colleagues⁷ had shown that arsenicals such as lewisite can combine reversibly with $-SH$ groups in enzymes, and van Heyningen⁵ found that if hexokinase is first inhibited by lewisite, then treated with a lachrymator, and finally treated with *B.A.L.* (British anti-lewisite) to remove the lewisite, no inactivation occurs. The $-SH$ groups are masked by the lewisite and so the enzyme is protected against attack by the lachrymator. (d) The use of a lachrymator of the halogen type (for example, *C.A.P.*) in the presence of bicarbonate gives a valuable method for estimating $-SH$ groups in proteins: each *C.A.P.* molecule reacting liberates 1 acid molecule, thus:



and the CO_2 liberated thereby can be measured manometrically⁸. The results agree with those given by other methods. Ovalbumin, with no $-SH$ groups, gives no immediate reaction; but after heat denaturation, which liberates $-SH$ groups, it reacts immediately and the results agree exactly with the accepted values. (b), (c) and (d) afford strong evidence that, at any rate in neutral aqueous solution, the lachrymators react only with $-SH$ groups in proteins. The lachrymators have in fact given us a means of identifying $-SH$ enzymes which is much more reliable than any test previously available.

Dixon⁹ considered the chemistry of the lachrymators and pointed out that the reaction with $-SH$ would explain the existence of lachrymatory properties not only in those containing a positive halogen, but also in those containing a $>C=C<$ link, such as acrolein. The same groups (ketone, ester, aldehyde, nitro, etc.) which give the neighbouring halogen its positive properties are known to polarize adjacent olefinic linkages in such a way that they can add nucleophilic reagents, and such substances would be expected to combine with $-SH$ groups thus



The carboxyl group, which does not undergo a similar electromeric displacement, is ineffective; though acrylic esters are lachrymators, acrylic acid is not; similarly, iodoacetic acid attacks only a few $-SH$ enzymes and leaves others practically unaffected, while its ester (the lachrymator *K.S.K.*) is a general poison for $-SH$ enzymes.

The site of action of lachrymators was shown to be the corneal nerve-endings¹⁰, and the molar concentration required for stimulation was found to be of the same order as that needed to poison enzymes¹¹. So far, however, the nature of the connexion between the —SH groups in the nerve-ending and the production of the nervous impulse is not known, though hypotheses apparently fitting the known facts could be suggested. The work was discontinued for more urgent problems, but further work on these lines may throw light on the mechanism of sensory nerve-endings.

The lachrymators, as was to be expected, were found to be strong inhibitors of cell respiration² and glycolysis¹⁷.

Alkyl Fluorophosphonates

These substances, which act as powerful pupil-constrictors or myotics, have recently been described by McCombie and Saunders¹² in *Nature*. It appeared that they might act by inhibiting choline esterase, like other myotics such as eserine, and Dr. Saunders supplied us in 1941 with a series of the compounds for testing. Mackworth¹³ and Webb¹⁴ found that they do indeed act as powerful inhibitors of choline esterase *in vitro*. They differ from eserine, however, in that while the inhibition by eserine is not progressive and is easily reversible by dialysis, that due to the fluorophosphonates is progressive and irreversible. The conditions for a standard quantitative manometric test of inhibitory power were worked out, the results of which agreed satisfactorily with the biological tests. The members of the series differ considerably in potency; the most active ones, which also have lethal properties, were found to produce an inhibition even in a concentration of 10^{-11} M. These compounds, in fact, are the most powerful and specific enzyme inhibitors known. Apart from the esterases, no enzyme was found to be inhibited at all, even by high concentrations. More recently Webb¹⁵ has found that, in addition to choline esterase, ordinary esterases are inhibited by the fluorophosphonates, although eserine has no action upon them.

Webb¹⁶ also examined the action of the fluoroacetates on enzymes *in vitro*. These compounds are also toxic, but their action seems to have little in common with that of the fluorophosphonates; they do not inhibit choline esterase, or indeed any of the enzymes tested by Webb.

Lewisite

As already mentioned, Peters and his colleagues¹⁸ showed at Oxford in 1940 that arsenicals of the lewisite group strongly inhibit certain —SH enzymes by combining with the —SH groups. They differ fundamentally from the lachrymators, however, in that the combination is reversible, and the degree of inhibition is determined by the affinity of the particular enzyme for the arsenical. There are considerable differences in this respect between the various —SH enzymes, and not all those enzymes which are poisoned by the lachrymators are significantly affected by lewisite¹⁹. Three enzymes are outstandingly sensitive: a component of the pyruvate oxidase system, which is inhibited 50 per cent by $M/65,000$ lewisite (Peters *et al.*⁷); hexokinase, which (in the absence of its substrate glucose, which has protective action) is inhibited 50 per cent by

$M/100,000$ lewisite (Mackworth¹⁹); succinic dehydrogenase from heart, which Mackworth finds inhibited 100 per cent by $M/24,000$ lewisite, though Peters finds the enzyme from brain comparatively insensitive. Mackworth finds the other —SH enzymes (including triosephosphate dehydrogenase) much less sensitive, requiring concentrations of the order of $M/1,000$, and this was also found by Morgan and Dixon³ for —SH groups in non-enzymic proteins. Mackworth has suggested that the exceptionally high affinities are due to the presence of the double bond in lewisite ($\text{ClCH}=\text{CH.AsCl}_2$), as they are not found with $\text{ClCH}_2\text{.CH}_2\text{.AsCl}_2$ ^{17,19}. The results depend on the nature of the arsenical; a number have lachrymatory properties, though this is not the case with lewisite, and more comparative studies may identify the enzymes connected with lachrymation more precisely.

The development of the dithiol lewisite antidote *B.A.L.* by Peters at Oxford has already been described in *Nature*⁷, where the reversal of pyruvate oxidase poisoning is described. We have found that *B.A.L.* also reverses the lewisite poisoning of hexokinase⁶ and succinic dehydrogenase¹⁹. It is of interest that the poisoning of hexokinase is also reversed (in presence of its substrate glucose) by monothiols such as cysteine⁶, which is not the case with the other systems.

B.A.L. has a certain toxicity, and in an attempt to find the cause Webb and van Heyningen²⁰ in this laboratory studied its action on a large number of enzymes. They found that it is a selective poison for metal enzymes, that is, enzymes the activity of which is due to atoms of copper, iron, zinc, etc., which form part of their structure. Other enzymes were not affected. Thus catechol oxidase (a copper-protein), carbonic anhydrase (a zinc-protein) and peroxidase (an iron-protein) were all inhibited by *B.A.L.* When copper was restored to the inhibited catechol oxidase the original activity was restored. It is clear, therefore, that the inactivation of enzymes by *B.A.L.* is due to its very high affinity for metals, and it may form a useful reagent in testing for metal enzymes. The only enzyme believed to be a metal protein which was not found to be inhibited was cytochrome oxidase, by which, however, the *B.A.L.* was rapidly oxidized.

The development of a non-toxic derivative of *B.A.L.* (*B.A.L.-intrav*) by Danielli and Mitchell in this laboratory in collaboration with Owen and Shaw in the Imperial College²¹ has recently been described in *Nature*²², as has also the preparation of proteins labelled with dye molecules, attached by azo-links, for the study of permeability changes in lewisite shock²³.

Mustard Gas and Related Compounds

A large amount of work was done on mustard gas (*H.*), partly because it was regarded as one of the greatest dangers and partly because the problem proved a particularly difficult one.

H. produces both local and general effects. When a small amount is applied to the skin there is first a delay of about two hours, after which cedema and erythema appear, followed later by vesication. If larger amounts are applied, instead of vesication, necrosis of the skin is produced. In general, vesication is not observed in animals, although their skin shows a well-marked cedema and sometimes erythema. The skin of the perfused frog, however, readily

blisters like human skin, as has been found in this laboratory²⁴. *H.* is readily absorbed through the skin into the circulation, and so produces more general systemic effects, especially a degenerative effect on the white cells of the bone marrow and consequent leucopenia, and damage to the gastro-intestinal tract. The effects are likely to prove fatal after a few days if appreciable amounts have been absorbed. There is reason for thinking that the local skin effects and the general systemic effects may be produced by different mechanisms, and they have therefore been considered separately.

(a) Local Effects: Biochemistry of Vesication

This problem was approached in 1940 from two different aspects: (a) a study of the changes in the metabolism of skin as a result of application of *H.* or similar vesicants; (b) a systematic study of the action of *H.* on isolated enzymes *in vitro*. It soon became clear that both lines of work led to the same conclusion, that is to say, the very specific enzyme poisoning by *H.* which was observed *in vitro* would, if it also occurred in the skin, produce exactly those changes in metabolism which were actually found and shown to be correlated with the skin damage resulting from *H.* application.

Metabolism of normal and vesicant-treated skin. Very little was known previously about the enzymes present in normal skin or about its metabolism, and Needham and Dixon²⁵ therefore first made a study of normal skin. The hairless abdominal skin of rats about four days old was found to be very suitable, being sufficiently thin for manometric experiments without slicing. It was found to have an active metabolism. In bicarbonate-Ringer solution the Q_{O_2} was -5 , either in the presence or absence of glucose or pyruvate, and the *R.Q.* was 0.9 with glucose and 0.77 without. The aerobic glycolysis was zero with or without glucose. In anaerobic experiments there was only a little glycolysis without added substrate, but with glucose the $Q_G^{N_2}$ was about 4.5 and with hexosediphosphate about 1.4.

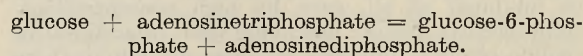
The effect of *H.* application was tested by rubbing it evenly over the under surface of the young rats with a glass rod and keeping them for varying times up to three hours before killing. Untreated rats from the same litter were always used as controls. No immediate metabolic effects were found, but after about two hours signs of skin damage began to appear, becoming marked after three hours, and these were accompanied by two well-marked changes in metabolism. (a) There was a sharp fall in the *R.Q.* with glucose from 0.9 to 0.56, although the rate of oxygen uptake remained only slightly below normal. This indicated that carbohydrate could no longer be utilized. (b) The anaerobic formation of lactic acid from glucose was strongly inhibited, the inhibition increasing with time, in a manner parallel to the onset of the symptoms, until the glycolysis had fallen to the value obtained without added glucose. (Berenblum²⁶ had previously reported an inhibition of glycolysis and respiration in tumour tissues.) There was no inhibition of lactic acid formation from hexosediphosphate or from the substrate originally present in the skin.

Much evidence was obtained that a direct connexion exists between this characteristic inhibition

of glycolysis and the production of skin damage. Not only *H.* but the other vesicants as well, no matter what their chemical nature, produce the inhibition¹⁷. Of some twenty-five different vesicants tested, all inhibited the skin glycolysis, except one or two volatile substances which are only vesicant to human skin when evaporation is prevented and which did not damage the rat skin. Some twenty non-vesicant substances, most of them very closely related chemically to the vesicants, did not inhibit and produced no signs of damage. There was a fairly good quantitative correlation between the degree of glycolysis inhibition and the severity of the skin damage, and we never observed damage without inhibition. Moreover, there was also a correspondence in time relations; the inhibition by *H.* only occurs after a delay period, and it is only then that visible damage develops, while with lewisite the inhibition appears almost at once, and so also does the damage.

Further evidence of a connexion with glycolysis is given by the action of prussic acid²⁴. Perfusion of the frog with *M*/1,000 prussic acid, which inhibits respiration but not glycolysis, produces no vesication. *M*/100 prussic acid, however, inhibits glycolysis, not by poisoning any of the enzymes concerned, but by combining with intermediary metabolites, for example, triosephosphate. Perfusion with this concentration of prussic acid produces copious vesication. It is also of interest in this connexion that Lutwak Mann²⁷ has found that tissue slices (gastric mucosa) *in vitro* undergo considerable disintegration anaerobically when deprived of glucose, though not in its presence.

The fact that *H.* does not inhibit the glycolysis of hexosediphosphate suggested that it might be the initial phosphorylation of glucose which was inhibited; in other words, that the inhibition of glycolysis was due to the poisoning of hexokinase, the enzyme which catalyses the reaction:



This could be verified directly²⁸. An aqueous extract of ordinary muscle acetone powder contains all the enzymes of the glycolysis system except hexokinase, while hexokinase can be prepared from yeast. A mixture of both preparations therefore gives a complete glycolysis system, converting glucose into lactic acid. This system, like that in skin, is inhibited by treatment with *H.* If the muscle extract is treated with *H.*, and the hexokinase added only after the *H.* has disappeared by hydrolysis, no inhibition is produced. If, however, the hexokinase is treated with *H.*, and the muscle extract added afterwards, a large inhibition results. The effect is therefore a specific one on the initial phosphorylation step.

Further work on skin²⁹ showed (a) that the glycolysis is of the phosphorylating type, as in muscle; (b) that hexokinase is in fact present in normal skin, as also in skin a short time after *H.* application; (c) that hexokinase is absent from *H.*-treated skin after the inhibition of glycolysis has developed. Several other enzymes were shown not to be inhibited.

Enzymes in vitro. While this work was in progress, a systematic survey of the effect of *H.* on isolated enzymes *in vitro* was undertaken by van Heyningen in this laboratory³⁰. Peters³¹ had previously shown that the pyruvate oxidase system of brain was inhibited *in vitro* by *H.* sulphone, and a partial

inhibition had also been obtained after stirring brain brei with liquid *H.*³²

As *H.* reacts with water, in which it is only slightly soluble, the testing of aqueous solutions of enzymes with *H.* presents special problems. The method adopted was to add to the enzyme solution a very small volume of a solution of *H.* in ethyl cellosolve or propyl alcohol and mix rapidly, the amount taken being such as to give $M/400$ *H.* This is sufficiently below the solubility limit at 38° to give instantaneously a clear solution. The solution was then kept at 38° for 20–30 min. before testing the enzyme. Controls were always done with the same amount of solvent (without *H.*), incubated similarly. During the incubation period the *H.* concentration rapidly falls from $M/400$ to practically zero in about 20 min., owing to reaction with water, with buffer salts, and possibly with the enzyme and other components of the system. The mathematical theory of the partition of *H.* by reaction with the various substances in a solution was worked out by Ogston *et al.*³³ at Oxford, and later by Cannan³⁴ in the United States. The amount of *H.* combining with the different components is determined by their concentrations and their 'competition factors'. The competition factor of a substance is the ratio of the velocity constant of its reaction with *H.* to that of the hydrolysis of *H.* Thus for an enzyme to be sensitive to *H.* under these conditions, the competition factor of its active centres must have a high value.

Van Heyningen³⁰ found that of about thirty-four enzymes tested, thirty were unaffected by this method of *H.* treatment, so that *H.* is certainly not a general enzyme poison. Later work, mostly in the United States, has added about eighteen further enzymes which are unaffected. Hexokinase, however, was found to be markedly inhibited by *H.* *in vitro*, in agreement with the results of the previous section, and so was the pyruvate oxidase system obtained from *B. coli*³⁵. Needham³⁶ has given reasons for believing that the component of the pyruvate oxidase system which is inhibited may be a phosphate-transferring enzyme belonging to the same group as hexokinase. We suggested the name 'phosphokinase' for this small but important group of enzymes, and both she and Cori³⁷ in the United States have shown that several (though not all) of the phosphokinases are sensitive to *H.* The evidence for the 'phosphokinase theory' of vesication, according to which vesication results from the poisoning of certain phosphokinases in the skin, was reviewed by Dixon³⁸ in 1943, and reasons were given for thinking that hexokinase inhibition played the most important part.

In addition to this group there is a second small group of *H.*-sensitive enzymes containing a few proteases, namely, pepsin (Northrop³⁹), a tissue peptidase (Bergmann⁴⁰), and a skin proteinase (Peters⁴¹). Most proteases, however, are insensitive to *H.*

According to Thompson⁴², there is a partial inhibition of the choline esterase in skin after *H.* application. As the fluorophosphonates, which are infinitely more powerful inhibitors of this enzyme than *H.*, are completely non-vesicant, it is clear that this inhibition cannot be the cause of vesication, although it may contribute to the other effects of *H.* Van Heyningen³⁰ found no inhibition of this enzyme by *H.* *in vitro*.

A different method of treating enzymes with *H.* has been used especially by Northrop³⁹ in America, namely, by stirring the aqueous enzyme solution with excess of liquid *H.* The solution is thus kept saturated

with *H.*, and as the stirring was often continued for several hours, it will be clear that even chemical groups with low competition factors will react with *H.* under such conditions. A fairly general attack on proteins then takes place, and it is not surprising that a fair number of enzymes are affected by this method. It is probable, however, that such conditions correspond rather to the skin necrosis observed with larger amounts of *H.* than to vesication. As vesication is produced by quite small amounts of *H.* we have preferred to keep to our original method.

Hexokinase. (a) Properties. As it was clear that this enzyme was likely to prove important, and as very little was previously known about it, van Heyningen in 1941 undertook a study of its properties. Working with the enzyme from yeast, she found⁵, as shown shortly before by Colowick and Kalekar⁶, that it transferred only one of the pyrophosphate groups of *A.T.P.* to glucose, in accordance with the equation given above. Magnesium was necessary for the reaction, but calcium and zinc were inactive. Half the maximum velocity was reached in a glucose concentration of about $M/1,000$. The enzyme acted on glucose, fructose or mannose, but little or no activity was found with any other sugar. With excess substrate, the rate with fructose was about twice that with glucose, but the affinity for fructose was only about half of that for glucose, so that in smaller concentrations the rates were approximately equal. Mannose was less active than either.

The enzyme has a broad optimum at pH 8–9, but at 38° it is very unstable above pH 7. It is stabilized, however, by the addition of its substrate glucose ($M/10$), though not by its other substrate *A.T.P.* or by any of the other sugars, with the exception of mannose. It is also stabilized by muscle powder extract, or by cysteine. It was shown to be an —SH enzyme, readily inactivated by oxidation and reactivated by cysteine, and sensitive (though only in the reduced form) to lachrymators and to the arsenical vesicants, which as already stated combine with the same groups. It seems that most, if not all, of the phosphokinases are —SH enzymes³⁶.

Hexokinase. (b) Action of vesicants. We have mentioned above some of the reasons which led us to the hypothesis that hexokinase is the most important point of attack in the skin in vesication by *H.* The strongest evidence, however, came from the action of a large number of vesicants and related non-vesicants on this enzyme *in vitro*. There are special circumstances which are particularly favourable for a definite test of this hypothesis. The vesicants form an extremely heterogeneous group of substances, including the most diverse chemical structures, ranging from *H.* to protoanemonin, from arsenicals to acrolein. Apart from the power of vesication, they seem to have little in common. Nevertheless, if our hypothesis is correct, they should share the property of inhibiting hexokinase. Furthermore, this property should be absent in non-vesicant substances (though an exception is conceivable in the case of a substance which is non-vesicant simply because it cannot penetrate into the skin). This test can be made very stringent, owing to the fact that many substances exist which are very close to *H.* in chemical structure and yet are completely devoid of vesicant properties. This was first pointed out to us by Prof. S. Sugden.

On putting this to the test it was found¹⁷ that there was indeed a most striking correspondence between the occurrence of vesicant properties and power of inhibiting yeast hexokinase *in vitro*. Some fifty substances, about half of them vesicant, were tested. All the vesicants inhibited the enzyme, no matter what their chemical nature; all the related non-vesicants failed to inhibit (with the exception of the sternutator *D.M.*, which cannot penetrate the skin, and one or two alkyl halides which, although strictly non-vesicant, produce oedema and gave a partial inhibition). Some of the results, mostly extracted from the extensive table of Dixon, Needham and van Heyningen¹⁷, are given in the accompanying table.

Substance.	Vesicancy.	% Inhibition of hexokinase <i>in vitro</i> .
S (CH ₃ CH ₂ Cl) ₂	++	80
OS (CH ₃ CH ₂ Cl) ₂	—	0
S (CHClCH ₂) ₂	—	0
S (CH ₂ Cl) ₂	—	0
S (CH ₃ CH ₂ CH ₂ Cl) ₂	—	0
O ₂ S (CH=CH ₂) ₂	+	60
OS (CH=CH ₂) ₂	—	0
S (CH ₂ CH ₂ OH) ₂	—	0
C ₂ H ₅ S, S, CH ₃ CH ₂ Cl	+	45
C ₆ H ₅ S, S, CH ₃ CH ₂ Cl	++*	40
CH ₃ N (CH ₂ CH ₂ Cl) ₂	+	65
N (CH ₂ CH ₂ Cl) ₃	+	70
ClCH=CHAsCl ₂	++	100
ClCH ₂ CH ₂ AsCl ₂	—	0
CH ₃ CH ₂ AsCl ₂	+	45
C ₂ H ₅ I	—	30
CH ₃ Br	++*	90
BAL	—	0
PCH ₂ COOCH ₃	—	0
(C ₂ H ₅) ₂ PFO ₂	—	0
CH ₂ =C(O)CO	—	0
CH=CH	++*	40

* When evaporation is prevented.

The results of these tests afford strong circumstantial evidence of the truth of our hypothesis. Up to the present, hexokinase remains the only cell-constituent which has been found to pass the test.

The enzyme tests *in vitro* actually led to the discovery of vesicant properties in several compounds which were not known previously to possess them. A few substances, submitted to us as non-vesicants, were found to inhibit the enzyme (for example, C₆H₅S.C₂H₅Cl). Further examination showed¹⁷ that the apparent lack of vesicancy was due to rapid evaporation from the skin; if this were prevented by covering with a glass cover-slip, good vesication was obtained. Furthermore, it was predicted from the fact that hexokinase was an —SH enzyme, inhibited by lachrymators, that lachrymators should also be vesicants. This was already known in certain cases, but we verified the prediction with all the available lachrymators, when evaporation from the skin was prevented.

The tests showed a further point of some interest. The presence of glucose protects the enzyme to some extent against poisons, presumably by covering the active centres—a fairly common effect with enzyme substrates. We found that with high concentrations of glucose a few vesicants failed to inhibit the enzyme. With no glucose at all, on the other hand, it became very sensitive to vesicants, but was also inhibited by many of the non-vesicants. A proper correlation was only obtained in the presence of the physiological glucose concentration, such as would actually be present in the tissues *in vivo*.

In contrast to the lachrymators, *H.* attacks both oxidized and reduced forms of the enzyme; moreover, while lewisite protects the enzyme against lachrymators by masking the —SH groups, it does

not protect against *H.*⁵. It is therefore improbable that the poisoning by *H.* is due to an attack on —SH groups. This is in agreement with observations by Peters and ourselves that the reaction of *H.* with —SH groups in proteins is very slow in comparison with the reaction of lachrymators with these groups.

Crystalline hexokinase. In order to study the chemical nature of the reaction of *H.* with the enzyme, it was necessary to have the latter in the pure state. A method of isolation from yeast was worked out in this laboratory by Bailey and Webb⁴³, the final crystallization step being the same as in the method of Northrop⁴⁴, which had been reported a short time before. The crystals were identical in every way with those of Northrop.

As the amount of recrystallized enzyme available was small, it was not practicable to estimate the amount of *H.* combining by S analyses as usual. In collaboration with members of Prof. Wormald's team, therefore, the enzyme was treated, under the same mild conditions as in our previous *in vitro* work, with *H.* containing radioactive sulphur (*H.**). The extent of the inhibition was determined, and the treated enzyme was precipitated with alcohol, exhaustively extracted with alcohol, acetone and ether, dried, and the N and S* determined by the usual methods. From the results it was calculated that when there was 100 per cent inactivation by *H.*, each molecule of hexokinase (mol. wt. 97,000) had combined with 6–7 *H.* molecules. This means that the combination of less than 1 in every 100 amino-acid residues in the enzyme with *H.* is needed to effect complete inactivation; this is consistent with the view that the attack is a specific one on the active centres, and it is certainly not a general one on the enzyme protein.

The nature of the groups attacked in the enzyme is not known. Their competition factor is high (about 8,000) in the absence of glucose; in *M*/150 glucose it is reduced to about 800. A number of attempts were made to reverse the combination with *H.* and so restore the enzyme activity, but without success.

For comparison with hexokinase, the combination of *H.* with ovalbumin, fibrinogen and serum proteins under the same mild conditions of treatment was determined, in order to see whether the *H.*-sensitive groups were peculiar to hexokinase. It was found⁴³ that the amount of *H.* combining was of the same order in all four cases. The conclusion drawn was that although hexokinase is exceptionally *H.*-sensitive as an enzyme, it is not so when considered as a protein; in other words, its sensitivity is not due to any special reactivity to *H.*, but to the fact that in this particular enzyme the activity depends on the groups which react with *H.*, which is evidently not the case with most other enzymes. Presumably it is only when the combination of an enzyme with *H.* affects its activity that metabolic disturbances and consequent tissue damage can result.

(b) General and Systemic Effects

When the importance of the systemic effects of *H.* became clear, we turned our attention to the biochemical mechanisms underlying them. It could not be assumed that they were the same as that underlying vesication. Special attention was given to the tissues most affected, namely, the bone marrow and the gastro-intestinal tract.

Bone marrow. Needham, Cohen and Barrett⁴⁵ studied the metabolism of marrow, both in its normal

state and after the injection of a lethal dose of *H.* They found a very marked fall in anaerobic glycolysis, which was just perceptible after four hours and complete after twenty-four hours, running parallel with or slightly preceding the cell damage observed histologically. It was not shown, however, that this was due to a poisoning of hexokinase. In marrow, unlike skin, the whole metabolism, including the respiration, falls after *H.*, and the effect is not a specific one on one reaction only.

H. was found to inhibit marrow glycolysis immediately *in vitro*, and it is possible that this was due to a poisoning of hexokinase. It seems from the work of Cori⁴⁸ that phosphokinases are inhibited in several different tissues after treatment *in vitro* with *H.* and similar compounds, but that they are not inhibited in the same tissues in systemic poisoning, although other enzymes (for example, pyrophosphatase, choline oxidase, choline esterase) may be.

Gastro-intestinal tract. Greville and Barrett⁴⁷ examined the metabolic changes in the intestinal mucosa side by side with the histological changes after *H.* injection and found a definite fall in glycolysis running fairly parallel with the damage. It seems, however, that this was due to the fact that the rats ceased to eat during systemic poisoning, and not to hexokinase inhibition. The glycolysis in this tissue depends very much on whether the animal has been recently fed, and equally large differences were found between normal fed and fasting rats. Cori has in fact shown that hexokinase is not inhibited in this tissue in systemic *H.* poisoning.

Lutwak Mann^{47a} at the same time examined the metabolism of gastric mucosa and found a similar fall in glycolysis in the badly affected rats, and a rise again in those which spontaneously recovered, though it is not yet certain how far these results were due to the fasting. *H.* strongly inhibited the glycolysis *in vitro*, as in other tissues.

Fate of injected H. in the body. In connexion with the systemic effects it is of interest to know the distribution of injected *H.* in the body, and in particular where most of the *H.* reacts. When *H.* combines with a cell-constituent, for example, a protein, it is no longer extractable with organic solvents, and is said to be fixed. This problem was studied in collaboration with members of Prof. Wormald's team⁴⁸, who had prepared *H.* containing radioactive sulphur for this purpose⁴⁸. This was injected intravenously into rabbits, and the amounts of fixed and total S* (radioactive sulphur) in the different tissues determined after varying times. S* appeared within a few minutes in the urine and bile, but although notable amounts were excreted in this way, the greater part was found in the tissues, and of this most was in the fixed form. There were large differences between the different tissues; very large amounts of *H.* were fixed in kidney (peak value at one hour) and lung (peak at four hours) compared with other tissues; bone marrow was at the other extreme with a content only about 1/20th of the maximum in kidney and lung. It is surprising that marrow, the tissue most damaged, had the lowest *H.* content, while the two tissues with by far the highest *H.* content are practically undamaged by *H.* poisoning. Another surprising feature was that almost all the fixed *H.* had disappeared from the tissues after twelve hours, which would not be anticipated if the *H.* were fixed to cell protein.

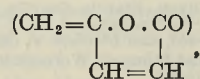
H. sulphoxide. In this substance (*HO*), unlike *H.*, the Cl atoms are unreactive, it does not hydrolyse in water, is non-vesicant, has no effect on the enzymes tested or on tissue metabolism *in vitro*^{47,47a}, and even in high concentration does not combine with proteins⁴⁸. Yet according to Marshall and Williams⁵⁰ it is as toxic as *H.* by injection. Radioactive *HO* was therefore prepared and injected, in the expectation that systemic effects similar to those of *H.* might be produced without fixation of S* in the tissues⁵¹. The surprising result was that not only was even more S* fixed in the tissues with *HO* than with the same dose of *H.*, but that the rabbits suffered absolutely no ill effects or histological damage^{47,47a}. With much larger doses of *HO*, systemic effects like those of *H.* were produced, with damage to the marrow and digestive tract. It is possible, of course, that *HO* may be converted in the body into some more reactive substance; the closely similar distribution to that of injected *H.* strongly suggests that the same kind of reaction, and perhaps the same substance, is responsible for the fixation of both. Nevertheless, with *HO* no damage is produced (for example, in the marrow) by an amount of fixation which, in the case of *H.*, wrecks the tissue. This leads to the conclusion that the chemical groups blocked are not essential to the cells; in other words, that the fixation is not in the main due to the reaction which causes the damage.

This leads to the following hypothesis, which accounts for many of the facts. Assume that the damage results from the poisoning of an essential tissue constituent *E.* (hexokinase or some other substance); the tissues also contain varying amounts of another substance *N.* (not necessarily a protein) which is non-essential, but which has a higher competition factor than *E.* Then in those tissues which contain much *N.* much *H.* will be fixed, but at the same time the *H.* will be diverted from *E.*, which will therefore be protected. A tissue which contains only a little *N.* (marrow) will fix little *H.*, but will be severely damaged because the *H.* can immediately attack the *E.* This may also explain the puzzling delay in the action of *H.* on skin, for the *H.* will react first with the *N.*, and it is only when all the *N.* is used up that it will attack the *E.* appreciably. In marrow *in vitro* there is practically no delay in the action of *H.*

The work on *H.* is still incomplete, but was terminated when it became clear that there was no likelihood of gas warfare.

Natural Vesicants of Plants

The juices of certain crushed plants have vesicant properties. At the suggestion of Porton these were investigated by Hill and van Heyningen⁵². In the case of the buttercup they isolated the naturally occurring substance in pure crystalline form and identified it as a glucoside, which forms a surprisingly large fraction of the total carbohydrate of the plant. The glucoside itself is harmless, but is hydrolysed by an enzyme which is liberated when the plant is crushed, and it then yields free proto-anemonin



which is the vesicant. It evaporates fairly readily from the skin, but when this is prevented it is a fairly powerful vesicant.

Acknowledgments

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LONDON TRAFFIC AND THE LONDON PLAN

THE problems of London traffic become more acute with every week that passes, and it is generally accepted that no schemes for reconstructing and replanning London will be satisfactory without drastic adjustments to existing facilities for transport. At a conference held at the Institution of Civil Engineers on September 12-13, on "London Traffic and the London Plan", the British Association provided a platform for the discussion of some of the problems involved in planning large-scale improvements which will not merely prevent London's traffic from seizing up in the near future but also will serve the requirements of future generations.

The conference, which was opened by Sir Richard Gregory, president of the Association, was held in three sessions. At the first, over which Lord Latham, leader of the London County Council, presided, there were general papers on traffic, town planning and architecture; at the second, more technical papers on roads, railways, underground railways, air transport and sub-surface works; and at the third, open discussion. Sir William Halcrow, president of the Engineering Section of the Association and president-elect of the Institution of Civil Engineers, took the chair at the second and third sessions.

The principal plans for reconstructing London are the L.C.C. (1943) Plan, the Greater London (1944) Plan, and the City of London (1946) Plan, and these, together with the Highway Development Survey (1937), the 1946 report to the Minister of War Transport by the Railway (London Plan) Committee, formed the background of the papers and discussion.

In opening the conference, Sir Richard Gregory referred to the magnitude of the task confronting those who were responsible for taking decisions on the replanning of London and of carrying them out. Many questions must be put and answered before the real work could begin in the right order and on the right scale. Men of science could contribute to this vast enterprise and should be consulted to the full; apart from the giving of technical advice there was, here, a great opportunity for the application of the scientific discipline of experiment and research, critical examination of evidence, and finally drawing up conclusions and objectives.

Lord Latham said that the L.C.C. had accepted the proposition that one of the major defects of London was an obsolete road system, and would do all within its power to effect improvements. London must be replanned while the life and activities of its millions went on, and these could neither be stopped nor even greatly slowed down, nor could any responsible authority contemplate, in the present shortage of housing, any substantial destruction of living or business accommodation to make way for new roads. This was, however, no apology for complacency. He announced that the L.C.C. had settled in principle a short-term programme of post-war work on roads in the County, and was at work on a second programme to be carried out over a longer period. The cost of all the schemes under consideration might be put tentatively at £100,000,000; the short-term programme was estimated at £20,000,000, and those parts of it which had been passed for execution in the initial period would cost £8,000,000. The L.C.C. would welcome any guidance or counsel which the Conference could give.

Sir William Halcrow said that, so far as road traffic was concerned, it seemed to him that more road space was essential, and this raised the question whether new roads or the crossings should be above, below or at the level of existing roads. The advantages and disadvantages of each needed discussion; but in view of the congestion of existing underground services of all kinds, the balance appeared to be in favour of overhead construction, which had been achieved with success in Sweden and had been recommended by road planners in Great Britain so long ago as 1904. As regards railways, most of the main-line London termini were about a hundred years old and needed rebuilding. Recent proposals that some should be put underground raised engineering problems which would need serious examination; other proposals envisaged a closer grouping of these termini, but it should be considered whether this would not add to congestion on roads in the immediate vicinity.

Sir Alker Tripp, assistant commissioner of Metropolitan Police, said that the change from horse-drawn to motor traffic had been revolutionary, and nothing short of a revolution in the design and use of roads would be sufficient to remedy the defects of the present system. Redesign of existing roads and the planning of new roads must serve two purposes, circulation and safety. As regards circulation, there were lessons to be learnt from the railways, which could not operate without sidings; and the first remedy was to provide adequate car parks, underground, at ground-level, and in multi-storied buildings. As regards safety, there was wide scope for improvements. There were two million casualties on the roads of Britain in 10 years before the War, and in London 60 per cent of the killed were pedestrians; the daily toll of life continued at a dreadful level, although there was less traffic on the roads. He was convinced that the main expedient for stopping wanton exposure of pedestrians to fast traffic was to divert the main stream of traffic flow from the daily haunts of the people. Planning should distinguish between roads built as traffic conduits and those intended for shopping and local services. Existing roads should be reclassified and the design of new roads should not be attempted before their purpose was clearly determined.

Prof. W. G. Holford, joint author of the City of London Plan, maintained that amenity, hygiene, scenic effect, traffic flow and safety should not be overstressed as the dominant considerations in planning traffic facilities: they all ultimately depended on the economic function of the area to be served. Compromise would no doubt be necessary; but clear objectives should first be decided. Dealing with private cars, he recalled that in 1938 they were increasing at the rate of a thousand a day. As the number on the roads at the present time was about the same as in 1939 (3,189,000), and as this number could be expected to increase, it was not impossible that there would be a doubling of the load within the next thirty years. Urban development and satellite towns would reduce the number of journeys to and from large cities; but the gain might be offset by increased travelling resulting from rising standards of life. Reviewing the probable cost of adequate improvements in all forms of transport, Prof. Holford submitted that, in many cases, such development was beyond the resources of local authorities and that the financial burden might have to be borne regionally, if not nationally. He saw the replanning of London as a vast combined operation, involving the

co-ordination of land use, architecture, administration, research and execution, and presented a number of broad conclusions coupled with suggestions for priority of work and for immediate research.

The concluding paper of the first session was read by Mr. W. H. Ansell, past-president of the Royal Institute of British Architects, who asked that roads should not be regarded, as was too often the case, as traffic conduits along which it was permitted to place buildings. Just as buildings were planned so that corridors did not occupy space at the expense of rooms, so towns should be planned so that roads did not unduly cramp the buildings between them. Furthermore, before existing roads were widened or new roads were built, there should be a scientific examination of the nature and volume of the traffic likely to use such roads, having regard, among other things, to the probable difference in traffic loads which would result from the removal of badly sited industry or railway termini or markets such as Billingsgate and Covent Garden. The average man was hoping that there would be substituted for ugliness, slums and smoke, the beauty of a spacious orderliness of which war has so often deprived him, and although there were dangers in planning for architectural effect, appearance should not be overlooked. In his view the scale and size of buildings could with advantage be increased; both traffic and architecture would benefit from a pooling of sites, and congestion on roads could be relieved by providing parking and loading facilities within the perimeter of buildings.

The first paper of the second session was read by Mr. A. J. Lyddon, lately chief engineer of the Roads Division, Ministry of War Transport, who dealt with roads. Using the example of Western Avenue which, though only ten miles long, took twenty years to complete, he enumerated some of the difficulties such as public inquiries, land acquisition, legal proceedings, and so on, which tended to delay physical construction and which must be taken into account in setting targets for the next few years. Referring to the L.C.C. (1943) Plan, which assumed that congestion in central London is largely due to through traffic, which ring roads would obviate, he advocated, as did a number of other speakers, a systematic census which would indicate the origin, destination and nature of London's traffic. Such a census would be costly and would take time, but it appeared to be a prerequisite of intelligent planning.

Mr. V. A. M. Robertson, chief civil engineer of the Southern Railway, spoke with special reference to railways. As an example of the difficulties which would face engineers if railway termini were to be put underground, he analysed the requirements at Charing Cross, and came to the conclusion that, assuming the diversion of all main-line traffic to other stations, suburban traffic alone would need an underground station costing perhaps £17,000,000 and involving the use of escalators deeper than any existing to-day. In general comment, Mr. Robertson made the following suggestions: bridges, viaducts and stations should not be moved, and no decision to move them should be taken until adequate underground substitutes were guaranteed; all railways within the Greater London area should be electrified, engines being changed if need be, as in the United States, outside the County boundary; suburban traffic should be separated from main-line traffic so far as possible; express underground lines should be provided wherever demand required; main-line

terminals should be connected by convenient underground lines; all goods depots should be removed to carefully selected centres served by roads restricted to commercial vehicles at certain times; horse-drawn traffic should be banned from heavily used roads; hours of work should be staggered; above all, a prompt start should be made on the vast amount of investigation and design which was needed.

Mr. E. Colston Shepherd, secretary-general of the Air League of the British Empire, presented a paper on air transport which, in his absence, was read by Wing-Commander T. R. Cave-Browne-Cave. He discussed the trend of the load passing through Heathrow and Northolt, and the expectation concerning European services alone was that there would be a traffic between them, taken together, and London of 6,000 persons per day in 1948 rising to 8,000 per day in 1951. Discounting helicopters as offering no immediate substantial relief, the choice of transport to and from the airports lay between roads and railways. As there was little evidence that the western approaches to London would be rapidly improved, the balance was in favour of railway transport, and, further, adjustment to underground facilities leading to Earl's Court appeared to be relatively more simple than adjustment of main-line tracks. This conclusion led Mr. Shepherd to advocate that the Government should reconsider a decision to reserve for trade exhibitions the buildings at Earl's Court, which were considered to be admirably suited for a central terminus for air traffic.

In a paper on sub-surface works, Mr. H. F. Cronin, chief engineer of the Metropolitan Water Board, described the congestion of existing underground services for supplying water, gas, electricity, telephones, and so on, all of which must be taken into account not only by those who would solve overhead congestion by going underground, but also by any who planned diversion of existing streets or the sinking or raising of their level. Removal of these services was both costly and slow, and he thought that the proposals in the various London Plans should be considered from this angle. He supported the proposal that a committee of engineers might well be appointed to examine and report on the engineering implications of the London Plan.

The second session concluded with a paper by Mr. J. C. Martin of the London Passenger Transport Board, who dealt with underground railways and who, in the light of very long experience in the construction of the present underground system, analysed the engineering implications of proposals that underground tunnels and stations should be constructed for main-line rolling stock and traffic. He was inclined to believe that much could be done without drastic modification of existing services to improve the present facilities, and strongly supported the proposal that a co-ordinating technical body should be appointed to work continuously on the problem.

The third session was devoted to free discussion, which was opened in a lively and provocative manner by Colonel Mervyn O'Gorman, and continued by many other speakers, including Dr. R. V. Southwell, Sir Frederick Cook, Prof. Cave-Browne-Cave and Mr. J. S. Wilson.

The full proceedings will be published in the *Advancement of Science*, and in the meantime the report of the Conference will be studied by officers of the Engineering Section with the view of deciding on what points further action should be recommended.

D. N. Lowe

ROYAL PHOTOGRAPHIC SOCIETY EXHIBITION

THE ninety-first Exhibition of the Royal Photographic Society was opened on September 14 by Sir Henry Dale. This exhibition, which is open to the public, can be regarded as the first fully post-war exhibition of the Society, and a great effort has been made to make it an outstanding occasion, to compensate for the previous six lean years during which time acute shortage of photographic materials and security measures had a marked effect on the quantity and quality of the exhibits. Contrary to the usual practice the exhibition is being held in a gallery of the Science Museum, Exhibition Road, London, S.W.7, where there is much more accommodation than is available at the Society's house in Prince's Gate. A special effort has been made to obtain more material, particularly in the Scientific and Technical Section, and some of the research carried out during the War and held up for security reasons has been released. This section is undoubtedly of a higher standard and contains more material than has ever before been shown in the Society's exhibition. The organisers as well as the exhibitors are to be congratulated on the result, which is well worth a visit. The exhibition is open on Monday to Friday 10 a.m.—8 p.m., Saturday 10 a.m.—6 p.m., Sunday 2.30 p.m.—6 p.m., until October 26.

In a short space it is not possible to mention all the exhibits of scientific interest, and it is difficult to make a selection because of the great variety of different subjects illustrated. There are, however, a number of exhibits which will attract special attention either because they illustrate relatively recent developments in which photography has played an important part, or because of the striking nature of the illustrations of quite well-known techniques. In the first category may be placed a number of electron micrographs. One from the Kodak Laboratories is of particular interest to photographers as it shows the filaments of silver produced by development of silver grains in photographic emulsions. A later technique is beautifully illustrated by the exhibit from the Department of Biomolecular Structure of the University of Leeds. The technique was developed by Williams and Wyckoff and consists in projecting a beam of atomic gold at a very small angle towards the plane of the thin collodion membrane supporting the specimen. The film and specimen become coated with a thin film of gold except for the 'shadow' portions protected by the raised parts of the specimen. Gold, being a dense metal, gives a contrasty record when examined in the electron microscope, and the resultant picture has more the appearance of a normal photograph showing modelling than a conventional electron micrograph. Bacilli and the tobacco mosaic virus are among the examples; the magnification in the electron microscope is in all cases 9,500 times, and the enlargements bring the overall magnification up to as much as 57,000 times.

An exhibit of topical as well as scientific interest is that shown by Dr. C. F. Powell and others from the H. H. Wills Physical Laboratory, University of Bristol. This illustrates, by means of many prints, the use of the photographic technique of recording the tracks of fast-moving charged atomic particles. When a charged atomic particle traverses a photographic emulsion, it renders at least some of the silver

halide grains through which it passes developable. The quality of the resulting track depends upon the nature of the particle and upon the characteristics of the particular photographic emulsion used. All the photographs in this exhibit were made from tracks obtained in Nuclear Research Plates specially made for use with this technique by Ilford, Ltd. The exhibit contains examples of records of alpha particles, protons, tritons, and the products of disintegration and fission. Neutrons cannot, of course, be recorded by this means because of the absence of charge, but protons ejected by neutron bombardment provide enlarged tracks some 3 ft. long (1.4 mm. actual). Alpha-particle tracks are produced both by bombarding the plate at grazing incidence with alpha-particles from polonium, and by bathing the plate in a solution of a thorium compound. Alpha-particle and triton tracks are produced by disintegration of lithium atoms incorporated in the emulsion during manufacture and bombarded with 9 MeV. neutrons. Uranium fission tracks are produced by bathing and bombarding with slow neutrons. The photographs are accompanied by adequate captions, and the whole exhibit is covered by an excellent descriptive folder attached to the case.

The exhibit of Mlle. Y. Cauchois from the Laboratoire de Chimie Physique, Paris, illustrates a new technique in the production of X-ray spectra. A crystal is bent into the arc of a cylinder and acts towards X-rays in the manner of a cylindrical lens. This provides the possibility of focusing a beam of X-rays, and the technique is illustrated with X-ray emission and absorption spectra and X-ray shadowgraphs of small objects irradiated by X-rays and 'imaged' on a photographic material by means of such a 'lens'.

The Kodak Laboratories show a picture of molecules of hexamethyl benzene and phthalocyanine by an X-ray diffraction method at a magnification of 250 million. The details of the method used are not specified; but the groups of which the molecules are composed are shown as diffuse dark areas in a clear ground.

In the X-ray field must be mentioned the exhibit by J. A. Fairfax Fozzard, which has been awarded the Rodman Medal. This illustrates, by means of a series of X-ray studies, the shell deposition in the egg of the domestic fowl. Radiographs have been made at intervals during the period of about twenty-six hours between the laying of one egg and the next. The shell of the egg has a greater opacity to X-rays than the surroundings, particularly around the circumference where the distance traversed through the shell material is greatest, so that the boundary of the egg is clearly seen.

High-speed photography is nearly always represented in the Exhibition, and this year there are several particularly interesting examples. The National Physical Laboratory shows a shadowgraph of a modern wing section in a 650 m.p.h. air stream at an exposure of one microsecond; also a series of shadowgraphs of a projectile in flight at different velocities. The latter shows the variation of wave pattern with velocity, from 0.86 to 2.51 times the velocity of sound, in five stages. There are two interesting high-speed radiographs shown by the Research Laboratories of the Westinghouse Electric Corporation. One shows a 20-mm. shell and the other a model bomb both just after bursting. The distribution pattern of the fragments is clearly shown.

Some of the research in air photography carried out during the War is illustrated by a number of exhibits from the Royal Aircraft Establishment, Farnborough. The value of movement compensation in night photography is illustrated. The film is moved in the focal plane at a rate based upon the speed and altitude of the aircraft, so that the image remains substantially stationary during exposure. This technique is particularly valuable for night photography since it permits longer exposures. The same principle is used in very low-altitude air photography in daylight, when the image movement is so great that exceedingly short exposures would be required to give sharp pictures. In the exhibits shown the image moves over a slit in the focal plane and the film is moved at the appropriate speed behind the slit. No camera shutter is required.

These are but few of the one hundred and sixty-four exhibits in the Scientific Section. The Natural History Section contains more than one hundred and fifty prints, and for relaxation there are some two hundred prints in the Pictorial Section, also lantern slides and stereoscopic photographs, etc. There is no doubt that this is the finest exhibition the Royal Photographic Society has organised, at least for many years. It is partly due to the increased space available, to the release of material after the War, and to the convenience of the lay-out which has been made possible by holding it in a gallery of the Science Museum.

During the period of the Exhibition there are six lectures and film shows open to the public. Admission to these is free but by ticket only. Particulars and tickets may be obtained from the secretary of the Royal Photographic Society, 16 Prince's Gate, London, S.W.7.

OBITUARIES

Dr. William Payman

WILLIAM PAYMAN, a principal scientific officer of the Safety in Mines Research Board and known at home and abroad for his researches on flame and explosives, died on August 10 at the age of fifty after a short illness. He leaves a widow and two sons.

After graduating at the Manchester College of Technology in 1915, Payman began a post-graduate study of the inflammation of gas mixtures under the guidance of Dr. H. F. Coward, with whom he was again to become associated in later years. He pursued this field when in 1917 he joined the staff of the Home Office Experimental Station at Eskmeals, Cumberland, an organisation devoted to an examination of the explosion hazards in coal mines and later expanding into the Safety in Mines Research Board, with stations at Buxton and Sheffield. During his early years at Eskmeals, Payman developed rapidly under the stimulating direction of the late Prof. R. V. Wheeler, and here was formed the nucleus of what was to become the Sheffield school of flame research when Wheeler became also professor of fuel technology at Sheffield. Payman's contributions are recorded in numerous papers in the *Journal of the Chemical Society*, notably in the years 1919-22, and he formulated his 'law of flame speeds in mixed gases', the cause of a sharp controversy with the school which had grown up under the late Prof. W. A. Bone at the Imperial College.

Although he always retained his active interest in flame, Payman transferred his attention in the early 'twenties to a more pressing problem, one aimed at ensuring the safe use of explosives in coal mines. Little was known regarding the intrinsic safety of the 'permitted' class of explosives when fired in contact with firedamp, nor of the means whereby gaseous mixtures were ignited by explosives, whether by contact with flame, hot gases or incandescent projected particles or by adiabatic compression in the shock wave. He set out with characteristic vigour and determination to study these possibilities, while at the same time approaching the problem more directly from its practical aspects. In this work he was aided by a team of research workers whom he imbued with his own enthusiasm and whose judgment and ideas he valued. These researches are described in the *Proceedings of the Royal Society*, in papers of the Safety in Mines Research Board, and in various mining journals. Payman's individual and original researches were recognized by the award of the D.Sc. degree by the University of Manchester in 1929.

Payman believed strongly in the value of fundamental research in the study of practical problems. His resuscitation and development of *Schlieren* photography due originally to Töpler were mainly responsible for its extensive modern usage, and many of the photographic techniques developed by Payman and his co-workers have been duplicated in other countries. Much of the mining research carried out by Payman and his co-workers was interrupted in 1939 and remains unpublished; even so, he contributed more than sixty papers to the scientific and technical press. He was also joint author with Prof. I. C. F. Statham of a monograph on "Mine Atmospheres". He achieved international recognition in 1938 when he was appointed president of the Explosives Section of the Congress of Applied Chemistry held at Nancy. He was also for some years secretary of the informal Explosives in Mines Research Committee of the Safety in Mines Research Board.

It seemed fitting that the main effort of the explosives section of the Board's staff should be diverted during 1939-45 to war-time problems, and it was here that Payman was at his best, directing with unflagging energy a variety of researches con-

nected with the Service use of explosives, and serving on committees of the Ministry of Home Security and of the Scientific Advisory Council of the Ministry of Supply. It is too soon to write in detail of this contribution to the national effort and much will inevitably remain unpublished; it is sufficient to say that Payman derived an intense personal satisfaction from his efforts and those of his staff, from whom he received loyal support. The end of the War found Payman replanning for the Safety in Mines Research Board the organisation of his section to cope with a full renewal of its peace-time function in addition to a continuation of some of the war-time researches; these plans were coming to fruition when illness intervened.

Despite his aptitude for experiment, Payman gained greater satisfaction from co-ordinating and guiding the researches under his control; he had the rare ability of controlling without interfering, and his quiet manner quickly won him the confidence of those with whom he dealt. This was evident both in technical committee and during talks with the many large parties of miners, sometimes sceptical of the experiments they were witnessing, who visited the research station at Buxton. It may truly be said of Payman that his work was his life. His confidence and his friendship, not lightly given, were valued highly by his friends and colleagues, many of whom were associated with him during more than twenty-five years of joint effort to achieve safety in mines.

F. V. TIDESWELL

WE regret to announce the following deaths:

Prof. M. Camis, formerly professor of physiology in the Universities of Parma and Bologna, on August 28, aged sixty-eight.

Mr. H. J. E. Peake, president during 1926-28 of the Royal Anthropological Institute, on September 22, aged seventy-eight.

Dr. Hassan Suhrawardy, during 1939-44 adviser to the Secretary of State for India, formerly vice-chancellor and dean of the Faculty of Medicine of the University of Calcutta, on September 18, aged sixty-one.

Mr. George Tickner, an authority on British birds, aged seventy-eight.

NEWS and VIEWS

Atomic Scientists' Association: International Contacts

THE desirability of setting up an international federation of atomic scientists was discussed at the conference held by the Atomic Scientists' Association at Oxford during July, at which foreign men of science were present. Because of the diverse forms in which atomic scientists were or might be organised in different countries, and of the difficulties of getting one central body to speak on behalf of scientific men scattered over the world, it was decided that it was not warranted at present. The need for international contacts, however, was stressed, and one man of science from each of the foreign countries represented (France, Holland, India, Norway, Sweden, Switzerland and the United States) volunteered in a personal capacity to be responsible for liaison and for the exchange of published literature between the Atomic Scientists' Association and any bodies already exist-

ing or which might be set up with similar aims in their own countries. To extend this, a letter setting out the aims of the Association—"To maintain in Great Britain an informed public opinion about atomic energy, in order that all possible steps shall be taken to secure, in the words of the Washington Declaration of November 1945, international control to the extent necessary to insure its use only for peaceful purposes"—was afterwards sent to the academies of science and various scientific men in countries not represented at the conference, with a request that it might be brought to the notice of the scientific workers of their country and, if possible, a correspondent be appointed with whom the Atomic Scientists' Association can keep touch. The countries circularized were the Argentine, Australia, Belgium, Brazil, Canada, China, Czechoslovakia, Denmark, Jugoslavia, New Zealand, Poland, South Africa and the U.S.S.R.



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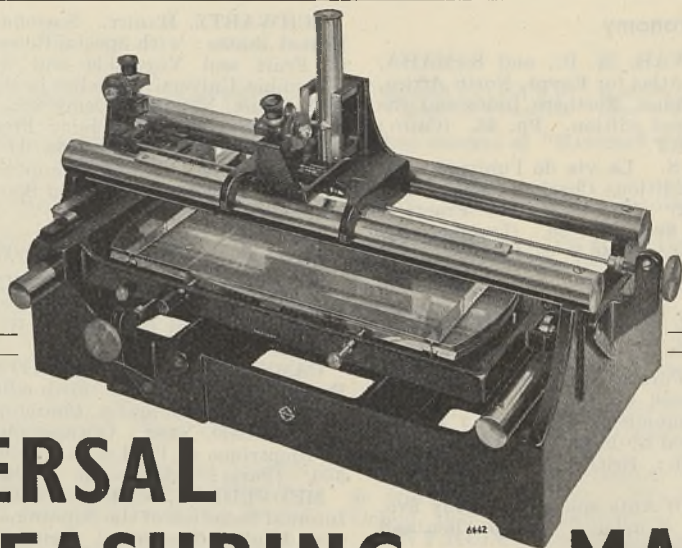
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Aircraft Exhibition at Radlett Aerodrome

THE Society of British Aircraft Constructors recently held a flying display and static exhibition of aircraft, aero-engines, equipment and materials at the Radlett Aerodrome of Handley Page, Ltd. It was intended to appeal primarily to foreign and overseas users, and included both fighting service and civil machines. It was the first opportunity that the aircraft industry has had of displaying the progress that has been made during the war years, and the way in which the knowledge gained is being applied to the problems of civil air transport. More than 6,000 guests representing aviation in forty different countries attended, and it is already announced that the Avro Company has secured foreign orders worth some £2 millions and Messrs. de Havilland some £3 millions. A target of £16 millions in the next three years is confidently expected to be reached.

Fifty-five different types of aircraft were exhibited, ranging from a small two-three seat run-about of 1,500 lb. gross weight to a four-engined trans-Atlantic air-liner of 80,000 lb. The jet-propelled machines included a new Vickers-Armstrong *E/10/44* Spiteful, with a speed of more than 600 m.p.h. with full military load. Equally fast was a new tailless jet-powered monoplane with swept-back wings, built by the de Havilland Aircraft Co. as an experimental model of the large aircraft of the future. One large four-engined experimental aircraft had a mixed power plant of two jet units and two piston engines driving airscrews. A helicopter demonstrated its ability to hover completely stationary over the aerodrome at the will of the pilot.

The most outstanding feature of the whole show was the way in which the lessons learnt during the War are being applied to air transport. For strategical reasons the British aircraft industry concentrated on the development of combat aircraft, while the production of transport aircraft was allotted to the United States. As a result Great Britain, although it lacks practice in heavy transport work, has accumulated experience in high-speed flight, including the use of the internal combustion turbine and jet propulsion, and also upon the principles of production. This is having a profound influence on both the design and competitive cost of the new civil aircraft coming forward.

Engineering at Dundee: Prof. W. T. Marshall

DR. W. T. MARSHALL has been appointed to the chair of engineering at University College, Dundee. Dr. Marshall, who was born in 1907, received his early education at Westminster City School and later at the City and Guilds College, Imperial College of Science and Technology, at South Kensington. While at South Kensington he obtained, in 1928 and 1929, his degree of B.Sc. (Eng.) with first-class honours, the A.C.G.I., D.I.C. and, in 1939, Ph.D. On leaving College he had some five years experience with the British Reinforced Concrete Engineering Co. as reinforced concrete designer and afterwards further experience as engineering assistant with Messrs. F. A. Macdonald and Partners, of Glasgow, where he was mainly engaged on the design and construction of road bridges.

Later he returned to the City and Guilds College for nine years as lecturer in civil engineering, and during that time he was engaged on a number of Government researches (including 'Fido'). Immedi-

ately before this present appointment, Dr. Marshall was for one year technical officer to the Institution of Structural Engineers. He is a member of that Institution and an associate member of the Institution of Civil Engineers. Numerous publications on various problems in the theory and design of structures stand to his credit. Dr. Marshall will therefore bring to the chair a wide knowledge of teaching, research and practical experience.

British Iron and Steel Research Association: Mr. W. C. Fahie

MR. W. C. FAHIE, who joined the British Iron and Steel Research Association on March 1, has recently been appointed head of the Instrument Section in the Physics Department. Mr. Fahie took a degree in experimental and mathematical physics at University College, Dublin, where he later carried out research on the electrical measurement of short time intervals, band spectrum analysis and various applications of thermionic devices. He was commissioned in the R.A.F. on the outbreak of war and served as a signals officer in the Middle East, Malta and France. He was seconded to the American Air Force as signals planner for the invasion of Europe and was later signals planner in Combined Airborne Force Headquarters, where he served until the termination of the War.

Royal Commission on Awards to Inventors

THE Royal Commission on Awards to Inventors, under the chairmanship of Lord Justice Cohen, has been set up as an independent tribunal to investigate the claims of inventors who allege that their inventions, drawings or processes have been used by Government Departments and Allied Governments during the War. The terms of reference, rules of procedure, and general instructions to claimants are contained in a pamphlet entitled "Royal Commission on Awards to Inventors 1946" (London: H.M. Stationery Office. 2d. net). This Commission follows the general lines of that set up in 1919 after the First World War, and a pamphlet entitled "Statement of the Principles Governing Assessment of Compensation Adopted by the 1919 Royal Commission on Awards to Inventors" has also been issued by the Stationery Office (6d. net).

The deputy chairman of the Commission is Mr. Kenneth Swan, K.C., and other members of the Commission are experts on different subjects. Thus Sir George Lee and Sir William Stanier are well-known engineers, Sir John Greenly is the chairman of Messrs. Babcock and Wilcox, Dr. G. M. Bennett was until recently professor of chemistry at King's College, London, and is now the Government Chemist, and Sir James Rae is the representative from the Treasury. Other eminent men of science and engineers will be co-opted to the Commission, depending upon the nature of the case to be heard. The secretary of the Commission is at present Mr. R. G. Lloyd, a member of the Patent Bar. Communications intended for the Commission should be addressed to the Secretary, Royal Commission on Awards to Inventors, Somerset House, Strand, W.C.2.

Revue d'Hématologie

A NEW journal devoted to blood, blood groups and blood transfusion is welcome. The *Revue d'Hématologie*, of which the first number has recently appeared, is the organ of the Research Laboratory

of the French National Blood Transfusion Centre in Paris. It is edited by Dr. Tzanck, director of the transfusion centre, and by Dr. Bessis, head of the research laboratory, with the help of a distinguished editorial committee. This journal will help to satisfy a need which has been felt for some time in Europe. The rapid advance made during the War in the field of blood groups—to mention only one aspect of the subject—has demanded much printing space. Indeed, the advance has been so rapid that by the time papers have been published in English quarterly journals of a general nature, with their long waiting lists, most of the original interest has been lost; for this reason, *Nature*, the *British Medical Journal* and the *Lancet* have borne the brunt of publishing blood-group work in Great Britain, of necessity in a concentrated form. Other rapid outlets are needed for more detailed and technical papers, and French workers in this subject are to be envied in the possession of their new journal. Perhaps the editors will consider publishing occasional papers in English. They have already shown an international spirit, for Sir Lionel Whitby launches the journal with an article on "Stockage et conservation du sang et de ses dérivés", and there is also an article by Race, Mourant and Macfarlane on "Travaux recents sur les antigènes et anticorps Rh avec une étude particulière de la théorie de Fisher". Papers by French authors are: "Les leucoses à plasmocytes" by Lamy and Willk, "Recherches sur la coagulation sanguine" by Tzanck and Burstein, "Contribution à l'étude de la cytologie sanguine" by Bessis, "Immunisation anti-Rh et pan-réactivation des anticorps anti-Rh. Description d'un nouveau test biologique" by Bessis, and also some useful notes on the technique of Rh testing. The *Revue d'Hématologie* is to appear quarterly and is published by Masson et Cie., Paris, and can be obtained in Great Britain through Messrs. H. K. Lewis and Co., Ltd., Gower Street, W.C.1; the annual subscription is 450 francs.

Indian-made Skis

At the request of the R.A.F. Rest and Leave Camp at Srinagar, Kashmir, an investigation into the possibility of making solid wood skis from Indian timber was carried out at the Forest Research Institute, Dehra Dun, India. The investigation and experimental work is described in two *Indian Forest Leaflets*, Nos. 78 and 79, 1945 (For. Res. Institute Publications, Civ. and Milit. Press, Pram Nagar, Dehra Dun). The common timbers in Europe for skis are ash and hickory, the latter being the better, whereas ash is the lighter. As might be expected, the requirements of timber for ski-making are very exacting. The wood must be tough, elastic, straight-grained, smooth and capable of taking a good polish with wax. It must not be too heavy, nor warp or twist, and should wear well. The three Indian timbers tried were *Terminalia tomentosa* (laurel wood of Great Britain), *Dalbergia sissoo* and *Artocarpus hirsuta*. None of these timbers appears to be ideal for the purpose. The *sissoo* and *laurel* are too heavy, and the *Artocarpus* does not appear to wear well. These experiments are described in Leaflet No. 78, entitled "Bending of Skis". Leaflet No. 79, entitled "Laminated Skis", carries the problem further. After discussing the advantages of laminated skis in a country in which temperatures and moisture are so varied as in India at different periods of the year, it is stated that a method of making laminated skis from Indian timbers using water-resistant phenolic resin

adhesives has been devised. Skis so made from *Terminalia tomentosa* and *Artocarpus hirsuta* have been found satisfactory. Lamination, it is said, facilitates seasoning, effects a better utilization of wood, as material too small for other purposes can be used; defects are reduced; it facilitates impregnation with resins in a more even manner and makes possible longer and stronger, especially curved, structures, than with solid wood. The investigations and methods are described in the two leaflets.

World Organisation of Museums

A PARAGRAPH in *The Times* of August 20 reported an American movement towards the establishment of an international organisation of museums. This envisages the promotion of: (1) international exchange exhibitions, (2) the exchange of museum specimens, (3) the exchange of staff, (4) the establishment of travelling scholarships, and (5) the establishment of an international school for training young men and women in museum work. Mr. Chauncey J. Hamlin, chairman of the Policy Committee of the American Association of Museums, and president of the Buffalo Museum of Science, has visited several European countries, and this has resulted in the formation of committees (which will work upon the proposals) in France, Switzerland, Holland and Belgium. It is to be noted that each of these committees is composed of leading museum officials. Mr. Hamlin has also been in touch with officials of the United Nations Educational, Scientific and Cultural Organisation, and before his return to America he was in London to discuss with the Museums Association and directors of leading British museums the possibility of the formation of a British committee to work along the same lines.

The Electron Microscope

THE separate revised publication of a lecture given to the Queckett Microscopical Club in February 1945 provides the general biologist with a very useful half-crown's worth of information ("Introduction to the Electron Microscope." By F. E. J. Oekenden. Monographs of the Queckett Microscopical Club. Pp. 24+8 plates. London: Williams and Norgate, 1946. 2s. 6d. net). It is in no sense a user's handbook complete with all the necessary technical details required by the user of the instrument, still less is it a summary of all the more important results obtained with it. Some recent technical developments of the first importance, notably the gold replica method of Williams and Wyckoff with which some startlingly beautiful stereoscopic pictures have been published in *Nature* (among other places) this year, have been omitted entirely. Nevertheless, as a sample of what this important new instrument is concerned with, the uninformed general reader could do much worse than read this pamphlet; and if it whets his appetite for closer acquaintance with the real thing no harm will have been done.

The British Institution of Radio Engineers

THE British Institution of Radio Engineers has recently issued its twentieth annual report, which covers the activities of the twelve months ended March 31, 1946. The main object of the Institution is the advancement of the practice of radio engineering, not only by the promotion of meetings and conferences by which the dissemination of technical knowledge is effected, but also by such other activities

as will improve the training of radio engineers and secure better recognition of the status of the profession as a whole. The Institution has attempted to improve the education of the young radio technician, not only by the conduct of its own graduateship examinations which continue to attract an increasing number of candidates each year, but also by co-operating with other interested bodies in an attempt to establish suitable national courses of training in the various branches of the telecommunications field. Accounts of the work of the various committees of the Institution during the past year are contained in the report referred to above; and at the twenty-first annual general meeting held on September 25 the Council unanimously recommended the election of Admiral Lord Louis Mountbatten as president of the Institution for the year 1946-47.

Copies of *Nature* for Service Men in Italy

LIEUT.-COLONEL J. C. CASTLE wrote a year ago from the Directorate of Disposals in Italy (see *Nature*, August 4, 1945, p. 140) asking for unwanted copies of *Nature* to be sent to him for the use of service men stationed in Italy. There was a good response to this appeal. Colonel Castle now writes that his unit is being disbanded, and no further copies should be forwarded to him; he asks us to thank, on his behalf and on behalf of the troops who also received these copies of *Nature*, those anonymous senders who have been forwarding copies of the journal to him.

Diffusion in Solution

The *Annals of the New York Academy of Sciences* (46, 209; 1945) contains six papers by I. G. Longsworth, C. O. Beckmann, M. M. Bender, E. M. Bevilacqua, E. B. Bevilacqua, D. M. French, A. R. Gordon, H. H. Harned, L. Onsager, J. L. Rosenberg, and J. W. Williams, dealing with various aspects of the diffusion of electrolytes and macromolecules in solution. The fundamental theory of diffusion and the mathematical treatment of the subject are adequately dealt with, and experimental methods described, references to the literature being given. Attention is directed to these papers, which are likely to interest workers in various fields.

The Night Sky in October

FULL moon occurs on Oct. 10d. 20h. 40m. U.T., and new moon on Oct. 24d. 23h. 32m. The following conjunctions with the moon take place: Oct. 18d. 13h., Saturn 4° S.; Oct. 26d. 16h., Mars 2° S.; Oct. 26d. 23h., Mercury 4° S.; Oct. 27d. 11h., Venus 7° S. In addition to these conjunctions with the moon, the following conjunctions occur: Oct. 10d. 12h., Mercury in conjunction with Jupiter, Mercury 2° S.; Oct. 21d. 01h., Mercury in conjunction with Mars, Mercury 2° S. The following occultations of stars brighter than magnitude 6 take place: Oct. 14d. 01h. 14·0m., 43 Taur. (*R*); Oct. 16d. 00h. 00·6m., 5 Gemi. (*R*); *R* refers to reappearance and the latitude of Greenwich is assumed. Mercury sets half an hour after the sun on Oct. 1 and is unfavourably placed for observation during the month. The planet attains its greatest eastern elongation on Oct. 31. Venus sets about 25 minutes after the sun on Oct. 1 and a few minutes after sunset on Oct. 31. The planet attains its greatest brilliancy on Oct. 13. Mars and Jupiter are unfavourably placed for observation in October. Saturn, in the constellation of Cancer, can be seen in the morning hours, rising at 0h. 17m.,

23h. 27m. and 22h. 28m. at the beginning, middle and end of the month respectively. The stellar magnitude of Saturn is 0·5 during October.

It is possible that there will be a short meteor shower on Oct. 10, most likely in the early morning hours, but it may occur before midnight on Oct. 9. These meteors are the debris of Comet Giacobini-Zinner, and the radiant will be in the head of the Dragon. Moonlight will seriously interfere with observations, and it is quite probable that few—and those only the very bright meteors—will be seen.

Announcements

PROF. M. L. E. OLIPHANT, Poynting professor of physics in the University of Birmingham, will deliver the third Rutherford Memorial Lecture of the Physical Society on October 7 at 5.15 p.m. in the Royal Institution; he will speak on "Rutherford and the Modern World".

MR. GEOFFREY HEYWORTH, chairman of Lever Bros. and Unilever, Ltd., and vice-chairman of its sister company, Lever Bros. and Unilever My., has been appointed chairman of the Advisory Council for Scientific and Industrial Research, in succession to Lord Riverdale, who is retiring after holding the appointment for nine years. Prof. H. W. Melville, professor of chemistry in the University of Aberdeen, has been appointed a member of the Council, in succession to Sir Franklin Sibly.

THE Medical Research Council has recently received from Sir Leonard Rogers a further generous addition to the endowment for research in tropical medicine with which he originally entrusted the Council in 1926. The capital value of the fund thus created is now approximately £15,000. The income is applicable to special purposes within the general field of tropical medical research.

PRIOR to 1939 the Departments of the History and Philosophy of Science and of the History of Medicine at University College, London, which were the only departments of their kind in Great Britain, provided either full-time or part-time postgraduate courses of one and two years. On an average they accommodated 30-35 students. With the return of University College to London last year, the study of these subjects has been revived. Prof. H. Dingle is now in charge, and under his supervision courses in the history of science are being provided.

A BRANCH meeting of the Association of Special Libraries and Information Bureaux will be held in the Hornby Library, William Brown Street, Liverpool 3, at 3 p.m. on October 18. Mr. A. B. Agard Evans, of the Ministry of Works, will speak on "Information Service and the Export Trade". Mr. R. Brightman will be in the chair. Particulars can be obtained from Miss L. Wolff (hon. secretary), I.C.I. Ltd., Dyestuffs Division, Hexagon House, Blackley, Manchester 9.

THE following appointments to the post of provincial director in the National Agricultural Advisory Service have been made: South-East Province, Mr. Eric Rea, at present agricultural adviser to Messrs. R. A. Lister and Co., Dursley; South-West Province, Mr. Colin D. Ross, at present executive officer to the Devon War Agricultural Executive Committee (in place of Mr. W. T. Price, who has resigned on appointment as principal of Harper Adams Agricultural College).

LETTERS TO THE EDITORS

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

Moulds Producing Penicillin-like Antibiotics

It has already been found that penicillin-like antibiotics are produced by a number of moulds besides *Penicillium notatum*, including species of both *Penicillium* and *Aspergillus*¹⁻¹⁵. Penicillin-like antibiotics have now been shown to be produced by a further five species of *Penicillium*:
P. steckii Zal. National Collection of Type Cultures No. 3950. The observation that this mould produced an inhibitor active against *Staph. aureus* but not against *Bact. coli* was reported by Wilkins and Harris¹⁴.

P. chloroleucon Biourge.

P. asperulum Bain.

P. crateriforme Gilman and Abbott (Daltico-Rubbo's strain).

P. griseo-fulvum Dierckx.

The last four strains were kindly supplied by Prof. J. Westerdijk, of the Centraalbureau voor Schimmelcultures, Baarn.

In each case the antibacterial activity developed on a number of media, of which the best was modified Czapek-Dox with lactose substituted for glucose, and with the addition of corn-steep liquor.

The antibiotics produced on this medium all had the following properties: active against *Staph. aureus*, not against *Bact. coli*; extracted into organic solvents at pH 2 and re-extracted into water at pH 7; inactivated by acid and alkali; slowly inactivated by heating at pH 7; completely inactivated by penicillinase and by copper ions. The combination of these properties is satisfactory evidence of the penicillin-like nature of the active substance. The antibiotic from *P. chloroleucon* was completely inactivated by methyl alcohol, but with the other four antibiotics the inactivation by methyl alcohol was only partial.

P. steckii, *P. chloroleucon* and *P. asperulum* bear some resemblance morphologically to the *P. chrysogenum-notatum* group: the other two species are widely separated both from this group and from each other.

Two of us (F. J. P. and A. V. P.) are indebted to the Agricultural Research Council and the Medical Research Council respectively for personal grants.

M. E. JOHNS
 FLORA J. PHILPOT
 A. V. POLLOCK

Sir William Dunn School of Pathology
 University of Oxford.
 Aug. 21.

¹ Fleming, A., *Brit. J. Exp. Path.*, 10, 226 (1929).

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Effect of Calcium on the Production of Botulinus D Toxin

SOME time ago, Dr. K. F. Meyer, director of the Williams Hooper Foundation, told us that he had obtained high yields of botulinus A and B toxins on media containing filtered alkalized corn steep liquor. Lamanna, McElroy and Eklund¹ have since reported similar results.

We were unable to obtain high yields of D toxin on corn steep media until we added back to the media the ashed precipitate from the alkalized corn steep filtrate. Eventually we found that the ash could be replaced by calcium, in the form of the chloride, lactate, phosphate, carbonate, etc. The optimum amount of soluble calcium was about 30 mgm. per cent. The media contained 0.5-1.5 mgm. per cent before the addition of calcium. The addition of lactate acid or calcium lactate to media containing excess calcium carbonate resulted in further improvement. The medium now used is prepared as follows. Unconcentrated corn steep liquor is precipitated at pH 8.5-9.0. The precipitate is removed and the liquor diluted with an equal amount of water. Thirty mgm. per cent calcium is added as lactate, together with 0.5 per cent calcium carbonate. The pH is adjusted to 7.2, and the medium sterilized at 15 lb. pressure.

An interesting point was the relatively large amount of iron required for adequate toxin production. The optimum was about 6 mgm.

per cent, but amounts as high as 60 mgm. per cent did not lower toxin yields. Iron, magnesium and phosphorus were, however, present in sufficient amounts in the steep, and the major deficiency was calcium. A typical result is shown in the accompanying table.

Corn steep medium precipitated at pH	Calcium added	Value of toxin	
		No. M.L.D. per c.c. for mice	* Prov. units antitoxin bound by 1 c.c.
7.5	Nil	No growth	No growth
8.5	Nil	No growth	No growth
9.0	Nil	No growth	No growth
9.0	CaCl ₂	> 10 ⁶	500
9.0	CaH ₂ PO ₄	> 10 ⁶	250
9.0	CaCO ₃	> 10 ⁶	500
9.0	Ca(C ₂ H ₃ O ₂) ₂	> 10 ⁶	1000

* Prov. = provisional laboratory units.

L. M. WENTZEL
 M. STERNE

Onderstepoort Laboratories,
 South Africa.
 Aug. 16.

¹ Lamanna, C., McElroy, O. E., and Eklund, H. W., *Science*, 103, 613 (1946).

Poly-agglutinable Red Cells

In a recent communication in *Nature*, Basil-Jones, Sanger and Walsh¹ described a case of puerperal pyemia the red cells of which (Group O) were agglutinated at 20° C. but not at 37° C. by 45 out of 45 normal sera of all groups. The peculiar behaviour of these red cells appeared to be similar to that described by Levine and Katzin² and Gaffney and Sachs³. The latter authors described their phenomenon as 'poly-agglutinability' of red cells.

In 1943 we observed two cases which were similar to those eventually published by Gaffney and Sachs.

Case 1. ♀ aet. 29, Group O— incomplete abortion. Fresh, washed red cells were agglutinated at room temperature but not at 37° C. by 33/39 sera, selected from all four ABO groups. The degree of agglutination was variable. Repeated washing of the red cells with ice-cold saline and saline at 45° C. did not affect the agglutinability. The patient's serum contained α and β iso-agglutinins active at room temperature and 37° C. Non-specific cold agglutinins active against the patient's cells and group O cells though present at 5° C. were only very weak. The patient's red cells haemolysed with tap water did not transmit the poly-agglutinability to other normal group O cell suspensions. They thus differed from red cells showing the Hübener-Thomsen-Friedenreich phenomenon.

The agglutinating property of normal sera for the patient's red cells could be removed by absorption at 5° C. with equal volumes of the patient's washed red cells. Recovery in saline at 37° C. of the agglutinin was also carried out from the cold-washed cells used for the absorption. The recovered agglutinin agglutinated at room temperature the patient's red cells but not normal red cells of groups O, A, B and AB. Therefore, though a cold agglutinin, it appeared to be specific for the patient's cells, and not the non-specific cold agglutinin.

Case 2. ♀ aet. 37, Group O— hysterectomy for parametritis. Qualitatively all the findings in Case 1 applied to Case 2. She was met six weeks after Case 1 and a further sample of Case 1 was obtained for comparison. By this time the red cells of Case 1 were agglutinated at room temperature by 97 only out of 144 sera; the red cells of Case 2 were agglutinated by 142 out of 143 sera. The reactions of Case 2's red cells were stronger than those of Case 1 at this time. The agglutinin recovered in saline from the red cells of Case 1 six weeks previously still agglutinated at room temperature the fresh red cells of Case 1 and more strongly those of Case 2. The two sera absorbed with the red cells of Case 1 six weeks earlier gave no reaction with the fresh sample of Case 1: one serum did not react with the red cells of Case 2, the other gave only a very weak agglutination. It is probable, therefore, that the atypical agglutinogens in both cases were identical.

These two cases appear to be similar to those of Gaffney and Sachs in so far as their red cells could absorb from normal sera the agglutinins against themselves. They may differ from the case of Basil-Jones *et al.* in that the recovered agglutinin was specific at room temperature for the peculiar cells of the two patients and did not react with normal O cells. Gaffney and Sachs make no report on a recovered agglutinin.

Prof. Sachs kindly supplied us with a culture of Friedenreich's M bacillus which consistently, when grown in suspensions of red cells, leads to 'pan-agglutinability' of such suspensions by normal sera. Suspensions of three group O red cells were inoculated with M. bacilli; after nine days they were pan-agglutinable.

These cells were set up against six normal sera, saline extracts recovered from the agglutinated red cells of Cases 1 and 2, sera absorbed with the red cells of Case 1, and the sera of Cases 1 and 2.

The normal sera and the saline extracts of the patients' agglutinated cells both caused, at room temperature, strong agglutination of the transformed cells. The absorbed sera gave no agglutination with one of the transformed red cell suspensions and weak agglutination with the other two. The serum of Case 1 also showed a diminished agglutinating power, agglutinating one of the suspensions weakly but not the other two. The serum of Case 2, however, agglutinated almost as strongly as normal sera all three suspensions.

The results do suggest that the agglutinin in normal serum for the cells of these patients is related to the anti-F' (of Friedenreich)⁴

which agglutinates red cells transformed with *M* bacillus, in that the saline extracts agglutinated transformed cells and in that the absorbed sera showed diminished activity. In view of the fact that the serum of Case 2 agglutinated the transformed cells but not the red cells of Case 2 it is not yet possible to show more than a relationship. Shortage of material precluded further investigations. (Case 2 died. The husband of Case 1 did not approve.)

Neither our own cases nor those previously reported by Levine and Katzin, Gaffney and Sachs, and Basil-Jones *et al.* have been as exhaustively investigated as they might have been. One required to know whether the anti-*T* agglutinin or the non-specific cold (auto-) agglutinin of normal sera or both may be responsible for the poly-agglutinability of these peculiar cells. Also it is suggestive that all the six cases so far noted have been of group *O*. If they all are instances of the same condition the probability of this occurrence is < 0.01 (1/120).

K. E. BOORMAN
J. F. LOUITT
D. B. STEABEN

South London Blood Supply Depot,
Sutton, Surrey.

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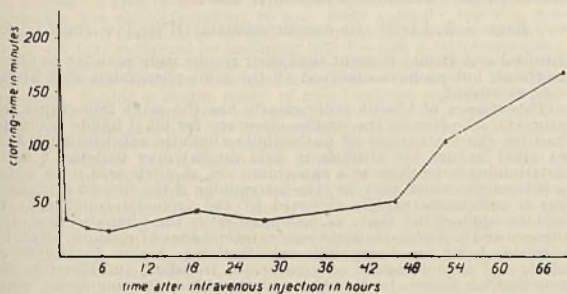
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Use of Normal Human Plasma Fractions in Hæmophilia

THE availability of separated human plasma proteins resulting from recent advances in fractionation methods¹ has provided the possibility of further investigations into the clotting mechanism in hæmophilia. It is of particular interest to find with which normal plasma fraction is associated the coagulation-promoting substance effective in hæmophilia², and to make a closer examination of this material. Important results have already been published on this subject³.

As Kekwick, Mackay and Record⁴ have developed a somewhat modified method of separating protein fractions, involving the use of ether rather than alcohol as in Cohn's method, it seemed desirable to examine the effect of their fibrinogen fraction in cases of hæmophilia. The clinical properties of the electrophoretically homogeneous fibrinogen obtained by these authors have not yet been examined, but we have been able to study the effect, in some hæmophilic patients, of a product containing 82 per cent fibrinogen, 2.3 per cent albumin, 4.2 per cent γ -globulin, 11.2 per cent 'ill-defined' globulins migrating in the α and β region.

In vitro and *in vivo*, a 2 per cent solution of this 'fibrinogen' appeared to have a marked coagulation-promoting effect on hæmophilic blood. Repeated intravenous injection produced no disagreeable reaction, nor was it followed by a refractory period.



The accompanying graph shows the effect of the intravenous injection of 24 ml. of the fibrinogen solution into a patient with sporadic hæmophilia. To produce a comparable effect, both with regard to the shortening of coagulation time, and the duration of this shortening, would require at least ten times the volume of plasma. In some other cases in which a smaller amount of fibrinogen was injected, the effect lasted for a shorter time, but the antihæmophilic effect was about the same.

S. VAN CREVELD
G. G. A. MASTENBROEK

The Children's Clinic,
Municipal University of Amsterdam.
Sept. 2.

¹ Cohn, E. J., *et al.*, *J. Clin. Invest.*, 23, No. 4 (1944).

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Loss of Available Phosphate in Soil due to Micro-Organisms

WHILE there is a considerable fund of knowledge on the physical and chemical factors affecting the loss of available phosphate, or 'phosphate fixation', in soils, there is very little published work on the part played by soil micro-organisms in the process. Phosphorus can either be utilized by micro-organisms as cell substance and hence locked up temporarily, or permanently, in much the same way as nitrogen, or according to unconfirmed work by Rudakov¹, phosphate can be reduced to phosphine and lost from the soil as such. In order to assess the importance and magnitude of these possible processes, some preliminary work on the problem has been carried out.

The amounts of phosphate taken up by different soils from solutions of KH_2PO_4 and commercial (19 per cent water-soluble P_2O_5) superphosphate were determined by shaking experiments and by use of a modified Lees and Quastel apparatus². From the results obtained a garden soil with a relatively low uptake of phosphate was chosen for detailed experiments. A large sample of the soil was air-dried, sieved through a No. 6 B.S.S. sieve, thoroughly mixed and stored in cardboard containers. 100 gm. portions of soil were either shaken at intervals with 200 ml. of a solution of KH_2PO_4 or superphosphate containing 150 mgm. P_2O_5 , or perfused continuously with a solution of the same concentration, for periods usually not exceeding two weeks. Determinations of P_2O_5 in the filtered solutions were made at various intervals.

The design of the experiments was to modify the microflora of the soil by physical and chemical treatment and to compare the subsequent uptake of P_2O_5 from solution with the microbiological activity, which, in turn, was measured by the carbon dioxide evolved.

(1) Sterilization of soil by heat, formalin, or phenol, or re-wetting air-dried soil, did not significantly alter the amount of phosphorus fixed. The increase in microbial cell substance following the re-wetting was evidently insufficient to affect markedly the amount of phosphorus fixed.

(2) The addition of certain substances such as peptone, urea, blood meal, at amounts calculated to give 0.07 per cent nitrogen and also of dextrose (0.5 per cent), which are easily decomposed by micro-organisms, substantially increased the amount of phosphorus fixed by soil; ammonium sulphate gave no significant increase in perfusion experiments.

The results are shown in the accompanying table.

EFFECT OF ADDITION OF NITROGENOUS COMPOUNDS (0.07 PER CENT N) AND DEXTROSE (0.5 PER CENT) TO SOIL ON THE AMOUNT OF P_2O_5 FIXED AND THE CO_2 EVOLVED

Substance added	Method of treatment	P_2O_5 fixed greater than control (mgm./100 gm. soil)	CO_2 evolved greater than control (mgm./100 gm. soil/100 hr.)
Peptone	Shaking	50	190
	Perfusion	30	
Urea	Shaking	30	68
	Perfusion	19	
Bloodmeal	Shaking	30	35
	Perfusion	13	
Ammonium sulphate	Shaking	11	-2
	Perfusion	3	
Dextrose	Shaking	51	—
	Perfusion	*	

* Soil column became water-logged on every occasion.

Using superphosphate in shaking experiments the amounts of phosphorus fixed were somewhat lower, but the different substances added were similarly effective (peptone 25, urea 15, bloodmeal 15, $(\text{NH}_4)_2\text{SO}_4$ negligible, and dextrose 22 mgm./100 gm. soil).

Additional proof that the excess phosphorus fixed by treated soils was due to micro-organisms was obtained by carrying out an experiment with sterilized soils and substances, under sterile conditions, the results of which showed that treated soils fixed no more phosphorus than the controls. In addition it was found that in the previously recorded perfusion experiments the additional amount of phosphorus fixed in soil treated with peptone or urea could not be removed by leaching.

From the preliminary work carried out it appears that the addition of phosphates only to the soil is unlikely to stimulate the microflora sufficiently to produce any significant fixation of phosphorus, unless the amount of phosphorus previously present is limiting for growth of micro-organisms. When, however, phosphates are added in conjunction with substances which are easily available as nutrients for growth of micro-organisms the biological fixation may be appreciable. Thus application of phosphatic fertilizers together with any substances which singly or together stimulate the soil microflora will tend to increase the total amount of phosphorus fixed.

All attempts to confirm the work of Rudakov¹ were unsuccessful. Samples of different soils to which 1.0 per cent KH_2PO_4 was added were adjusted to different moisture contents, with and without the addition of different substances such as glucose, and were incubated for long periods. A slow current of air was passed over the soils and into sodium hypochlorite solution. In no case were significant amounts of phosphorus found in the hypochlorite solution, and it is consequently concluded that if phosphate is reduced to phosphine biologically in soils the conditions must be rare and specialized.

C. B. TAYLOR

Imperial Chemical Industries, Ltd.,
Research Department,
Billingham Division,
Billingham, Co. Durham.
Aug. 22.

¹ Rudakov, K. I., *Zbl. Bakt.*, II, 70, 202 (1927).

² Lees, H., and Quastel, J. H., *Chem. and Ind.*, No. 26, 238 (1944).

Leather-jacket Control with Benzene Hexachloride and with D.D.T.

THE leather-jacket is a serious pest in fine turf culture and annually takes toll of considerable acreages. In the past the chief methods of control have involved the use of lead arsenate or an emulsion of orthodichlorobenzene. Lead arsenate is costly while the orthodichlorobenzene emulsion is not lethal and its use involves the necessity of sweeping the anasthetized grubs from the surface. The possibilities of the new insecticides D.D.T. and 'Gammexane' have been investigated by us in a series of trials in the autumn (1945) and spring (1946). Field trials were laid down at a number of suitable centres chiefly on the Lancashire seaboard, and confirmation of the results obtained has come from practical tests carried out throughout the British Isles.

Using a replicated random block lay-out on areas of turf known to be infected, various rates of both D.D.T. and 'Gammexane' were tested. The living leather-jacket population at all relevant times was measured by counting the leather-jackets which could be brought to the surface by means of orthodichlorobenzene emulsion within a 6-in. sq. frame, making nine random throws on each experimental plot. The original population varied from as few as 50 per sq. yd. at one centre (where little damage was evident) to well over 1,000 per sq. yd. at another (where the turf was being seriously damaged). Satisfactory results were obtained in one to three weeks from application of either D.D.T. or 'Gammexane' at very low rates of application.

Using certain commercial 5 per cent D.D.T. powders, 100 per cent control could be obtained from $\frac{1}{2}$ oz. per sq. yd., which represents only 0.025 oz. commercial D.D.T. per sq. yd. or about 0.02 oz. of the pure para para compound. Even lower rates of D.D.T. application were required when a 5 per cent emulsion was used. One gallon of such emulsion diluted with water to 400 gallons proved sufficient to give complete control over 800 sq. yd. of infected turf. This rate is equivalent to only 0.01 oz. of commercially pure D.D.T. per sq. yd. 'Gammexane' was tested in the form of powders containing 3 $\frac{1}{2}$ per cent and 5 per cent benzene hexachloride, of which 13 per cent is actually gamma isomer. A suitable rate of application for complete control proved to be the equivalent of 1 oz. of the 3 $\frac{1}{2}$ per cent formulation per sq. yd. This provides only 0.045 oz. of the gamma isomer of benzene hexachloride.

A liquid preparation of benzene hexachloride was not available to us in time for the trials. It is proposed to test this and a further number of D.D.T. preparations (including pastes and wettable powders) this autumn. At the same time it is hoped to find out whether from last season's treatments there are any residual effects on this season's broods of leather-jackets.

A fuller account of this work will be published in the next issue of the *Journal of the Board of Greenkeeping Research*.

R. B. DAWSON
J. R. ESCRITT

Board of Greenkeeping Research,
St. Ives Research Station,
Bingley, Yorkshire.
Aug. 22.

Modern Insecticides and their Use against Wireworms

NO chemical means of wireworm control have so far been effective and the farmer's only means of combating the ravages of this pest have been cultural.

In view, therefore, of the potentialities of the new insecticides, D.D.T. and 'Gammexane', in this connexion, simple laboratory experiments were designed to investigate their possibilities.

Wooden boxes of known area were filled with soil and a definite number of wireworms (*Agriotes obscurus*) introduced into each. The population (wireworms in 1,000's per acre) was thus known. Before introduction the wireworms were graded in size, so that the potential attacking power was the same in each box.

A series of eight boxes, in four pairs, was used, boxes Nos. 2, 4, 6 and 8 being untreated controls, while Nos. 1, 3, 5 and 7 were treated as follows:

Box No.	Treatment
1.	'Gammexane', 2 cwt. per acre, broadcast.
3.	D.D.T. (Guesarol E.C. 5 per cent), 1 cwt. per acre, broadcast.
5.	'Gammexane', 1 cwt. per acre, 1 cwt. per acre, drilled with seed.
7.	D.D.T. (Guesarol E.C. 5 per cent), $\frac{1}{2}$ cwt. per acre, drilled with seed.

In the case of boxes Nos. 1 and 3, the insecticide was evenly broadcast over the surface and lightly raked in, while in boxes Nos. 5 and 7 it was evenly placed along the bottom of two 'V-shaped' furrows, 1 in. deep and 5 in. apart, running along the length of the box.

Spring oats, previously soaked until germination had begun, were then sown at the rate of 1,500,000 seeds per acre, being placed in two drills 1 in. deep and 5 in. apart (in boxes Nos. 5 and 7 the seeds were placed in the previously prepared furrows directly on top of the D.D.T. and 'Gammexane') and covered with soil.

It should be pointed out that conditions were in favour of wireworm attack, no manual treatment being given to assist the plants to 'grow away' and no consolidation and preparation of a good seed bed taking place. Also the fact that the seeds had germinated before sowing ensured that they were all viable.

All boxes were then placed outside and examined daily to determine (1) the number of plants which successfully appeared above the surface; (2) the number of plants afterwards attacked.

After nineteen weeks, the oats from each box were threshed, the yield weighed and the soil examined to determine wireworm mortality. The results, which it is hoped to publish in detail later when parallel field trials have been completed, are of much interest and show definite beneficial effects from the use of D.D.T. and 'Gammexane'.

Briefly, they are as follows:

Box No.	% plants successfully appearing above surface	% plants afterwards attacked	Yield
1. 'Gammexane' broadcast	100	0	8.5 gm.
2. Control	81	50	3.3 gm.
3. D.D.T. broadcast	92	9	9.6 gm.
4. Control	70	23	4.8 gm.

Regarding wireworm mortality, all those recovered from the controls were normal, healthy and active, while those from the treated boxes, several of which were dead, were sluggish and apparently unable to control their movements. In view of previous observations on wireworms after D.D.T. and 'Gammexane' treatment (unpub.), it was considered that none would recover and therefore mortality was classified as 100 per cent as against none in the controls.

Boxes Nos. 5, 6, 7 and 8 generally did not give such definite results because for some unknown reason wireworm attack did not occur on any scale even in the controls. However, here again, on examining the soil, the mortality was much higher in the treated boxes, although some (up to 14 per cent) did occur in the controls.

Therefore, although the above conditions are somewhat artificial and from them field deductions cannot be definitely made, it appears that with further investigations using these insecticides, the answer to the wireworm menace may be in sight.

W. H. GOLIGHTLY

Department of Agriculture,
King's College,
Newcastle-upon-Tyne.
Aug. 28.

Kinetics of Aromatic Nitration: the Nitronium Ion

MARTINSEN (1904) first obtained a definite kinetic order for the nitration of aromatic substances. His solvent was sulphuric acid, and his demonstration¹ of second-order kinetics in this medium has since been fully confirmed^{2,3}:

$$\text{Rate} = k_2[\text{ArH}][\text{HNO}_3] \quad (\text{in } \text{H}_2\text{SO}_4) \quad (1)$$

Benford and Ingold obtained the first well-defined kinetic results in any solvent other than sulphuric acid. With nitromethane as solvent, and nitric acid in constant excess, they demonstrated zeroth-order kinetics⁴:

$$\text{Rate} = k_0 \quad (\text{in organic solvents, } [\text{HNO}_3] = \text{const.}) \quad (2)$$

This insensitiveness of the rate to the concentration and nature of the aromatic compound applied only to relatively reactive compounds, such as benzene and toluene. With less reactive compounds, such as chlorobenzene, some dependence of the rate on the compound was observed. We have continued these experiments, and, for considerably less reactive compounds, such as *p*-dichlorobenzene and ethyl benzoate, have established first-order kinetics:

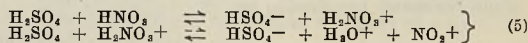
$$\text{Rate} = k_1[\text{ArH}] \quad (\text{in organic solvents, } [\text{HNO}_3] = \text{const.}) \quad (3)$$

Benford and Ingold thought that their results were peculiar to nitromethane, but we have observed all the same phenomena with acetic acid as solvent.

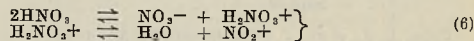
This change of kinetic order clearly has the same importance for aromatic nitration as the similar discovery for alkyl halide reactions had for the mechanism of nucleophilic aliphatic substitution. Just as alkyl halides (or alcohols in acid media) may undergo a rate-determining heterolysis to a carbonium ion, so nitric acid must suffer a heterolysis, which may be rate-determining if the formed nitronium ion is sufficiently rapidly removed by the aromatic compound. (It will be appreciated that, as compared with the aliphatic case, the organic and inorganic reagents possess interchanged functions, aromatic nitration being an electrophilic substitution.) A slow heterolysis of nitric acid cannot depend only on proton transfers, and therefore the rate-limiting fission, leading to an electrophilic nitrating agent, must occur in an NO-bond, the only plausible interpretation being



The actual mechanism is considered to involve a preliminary proton uptake (as in the formation of carbonium ions from alcohols in acid media). The details differ according as the medium is more or less strongly acidic than nitric acid. Thus in sulphuric acid we assume



and in organic solvents,



We have observed a strong acceleration on the addition, in organic solvents, of an acid (for example, H_2SO_4) stronger than nitric acid, the catalysed reaction still showing zeroth-order kinetics under suitable conditions.

Euler (1922) first envisaged the nitronium ion, NO_2^+ , as a nitrating entity⁵, and the idea has since been frequently supported^{6,7}. Our deduction¹ alike of the formation and effectiveness of NO_2^+ from the change of kinetic order on nitration seems particularly certain and direct. Since an independent species is needed to remove the aromatic proton, the rate equation for the nitration mechanism may be written

$$\text{Rate} = k[\text{ArH}][\text{NO}_2^+][\text{Base}] \quad (7)$$

In a later note in *Nature* we shall offer proof that nitric acid in sulphuric acid as solvent is in fact converted completely into NO₂⁺. Reactions (5) thereby become consistent with kinetics (1) for nitration in sulphuric acid. Bennett and Williams have shown that the bisulphate ion is the principal proton acceptor in this case³.

Reactions (6) likewise correspond to kinetics (2) and (3) for nitration in organic solvents. Sufficiently reactive aromatic compounds remove the NO₂⁺ as fast as it is formed, whereas much less reactive compounds allow it to approach a small equilibrium concentration. Both the zeroth- and first-order rate constants are reduced by added nitrate ions, according to a law of the same hyperbolic form. This can be explained by equations (6), essentially as a consequence of the assumed preliminary proton transfer leading to the nitracidium ion, H₂NO₃⁺. Both the zeroth- and first-order reactions are retarded by 'nitrous acid', but this effect we refer back to that observed with nitrate ion.

The connexion between the two effects emerged in the course of another investigation, which was undertaken jointly with Mrs. F. M. Garforth, in order to elucidate the nature of 'nitrous acid' in solvents containing nitric acid. Studies by the methods of optical absorption and electrical conductivity have led to the conclusion that the condition of 'nitrous acid' is essentially the same as that of added N₂O₃, but that this exists as a binary electrolyte, one of its ions being the nitrate ion.

E. D. HUGHES
C. K. INGOLD
R. I. REED

Sir William Ramsay and Ralph Forster Laboratories,
University College, London.
Sept. 2.

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Influence of the Nature and Concentration of Supporting Electrolyte on Polarographic Diffusion Current

WHEN determining traces of impurities in zinc alloys it was found to be of interest to study the behaviour of the diffusion current in supporting electrolytes of high concentration.

Shaikind¹ has found that the diffusion current of Pb²⁺ and Cd²⁺, when present at constant concentration, decreases with increasing concentration of supporting electrolyte, when the latter is ZnCl₂ or ZnSO₄, but remains constant when it is KCl or Na₂SO₄. He ascribes the decrease in current to the increase in viscosity, but has not made any direct measurements concerning this.

Gentry² has investigated the relation between the diffusion current of Tl⁺ and viscosity in ethylene glycol-water mixtures, and has found the product of the diffusion current and the square root of the viscosity of the medium to be constant. This paper was not published until our investigation was finished.

We have studied the systems set out in the accompanying table.

Supporting electrolyte	Concentration range of supporting electrolyte moles/lit.	Metal
ZnCl ₂	1-5-10	Cd, Pb, Bi, Tl
ZnSO ₄	0-3-2-4	Cd
Zn(NO ₃) ₂	0-5-4-8	Cd, Pb
NaCl	0-9-4-6	Cd
NH ₄ Cl	0-9-4-6	Cd
Na ₂ SO ₄	0-1-0-9	Cd
MgCl ₂	0-5-4-2	Cd
CaCl ₂	0-5-4-0	Cd
AlCl ₃	0-3-2-7	Cd
KSCN	1-0-9-2	Ni

All measurements have been carried out in a thermostat at 25.0° C. The solutions were freed from oxygen, and gelatin was added in some cases at a concentration of 0.005 per cent as a maximum suppressor.

The concentration of the metal is given by *x*, and that of the supporting electrolyte by *c*.

In all the cases investigated, a strict linear relationship was found between *x* and the diffusion current *i*_d, when *c* was constant.

The experiments were carried out in two different ways: (1) Varying *c*, keeping *x* constant. (2) Varying *x/c*, keeping *x/c = p* (a constant).

(1) In the first series the diffusion current was found to be a linear function of *c*, *i*_d in most cases decreasing with increasing *c* (Fig. 1).

Structure of Catalytic Metal Films

EVAPORATION of metals on to the walls of a glass tube at room temperature is known to yield films of high catalytic activity in many instances. In the case of tungsten a film of apparent area 140 cm.² and estimated weight of order 1 mgm. was found¹ by two methods to possess an area of 450 cm.². It was concluded "that the film was probably not microcrystalline to any great extent", but this conclusion is now found to be invalid. These results, together with other data, are best explained by assuming that the film is microcrystalline, in accordance with the results of electron diffraction². The crystallites of a sputtered platinum film have a side of ~ 0.005 μ by the latter method. Taking a simple model of equal spheres exposing all their surface to the reacting gas, we calculate for the above tungsten film a crystal diameter of 0.007 μ. By itself, of course, the chemical evidence cannot decide whether the particles are crystalline or amorphous.

The results of Beek, Smith and Wheeler³ would seem to allow an extension of the argument. They found that films of nickel on glass formed by evaporation in high vacuum showed crystalline electron diffraction patterns, and that the true area measured by the chemisorption of hydrogen or carbon monoxide increased linearly with the weight of metal deposited, over the range examined (5-50 mgm.). The 50 mgm. film had an area of 4,200 cm.², which they discuss in terms of pore structure. On our view, complementary to theirs, the film is made up of approximately uniform crystallites of diameter 0.043 μ. During evaporation, once a crystal reaches this diameter approximately, it ceases to grow and a new nucleus starts, this diameter probably being a function of the experimental conditions.

The 0.1 mgm. nickel film of A. and L. Farkas⁴ possessed a true area of 150 cm.², corresponding to a particle diameter of 0.005 μ. The first crystallites in this film (average thickness 1 atom) may still be in the growing stage. On the other hand, the difference from 0.043 μ may reside in the conditions of deposition, and traces of a strongly chemisorbed gas may well have a profound effect here. It may be calculated for the case of hydrogen on tungsten (taking Roberts's value of ΔH²) that adsorption from a pressure of 10⁻⁴ mm. might lower the surface tension of the metal by as much as 500 dynes/cm. This may well help to increase the degree of dispersion of the film.

It is seen that the relatively small ratio of true to apparent area observed with films of only a few atoms average thickness is, in fact, misleading. The present view is in much better accord with the physical evidence.

D. D. ELEY

Chemistry Department,
University,
Bristol.

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- ² Thomson, G. P., Stuart, N., and Murison, C. A., *Proc. Phys. Soc.*, **35**, 381 (1933). Thomson, G. P., and Cochrane, W., "Theory and Practice of Electron Diffraction" (Macmillan, 1939).
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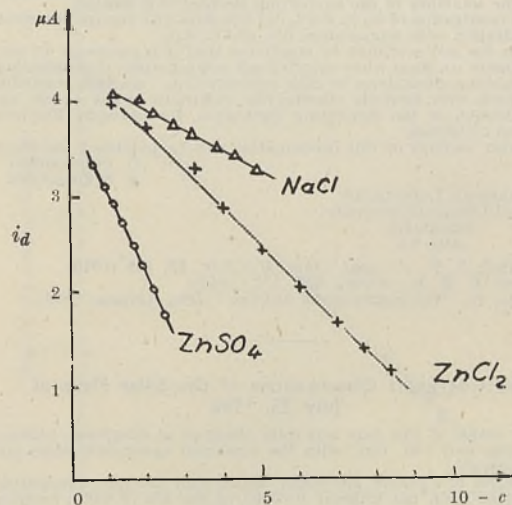


Fig. 1. Cd²⁺ IN VARIOUS SUPPORTING ELECTROLYTES (*x* IS CONSTANT)

The fundamental Ilkovic equation may in this case be written:

$$i_d = \text{const. } D^{1/2} \quad (1)$$

where *D* is the diffusion coefficient. According to Stokes-Einstein

$$D \cdot \eta = \text{const.} \quad (2)$$

where *η* is the viscosity coefficient of the medium.

Measurements of viscosity have shown that there is a linear relationship between *η*^{-1/2} and *c* in the concentration ranges given above:

$$\eta^{-1/2} = - a \cdot c + b \quad (3)$$

where *a* and *b* are constants depending on the nature of the supporting electrolyte.

Combining (1), (2) and (3) we obtain

$$i_d = \text{const. } (- a \cdot c + b) \quad (4)$$

In most cases it has been verified experimentally that the constants *a* and *b* are the same for any given supporting electrolyte, whether determined by polarographic or viscosimetric measurements.

It is interesting to note that in the case of a supporting electrolyte of NH₄Cl, where *η* decreases with increasing *c*, the diffusion current of Cd²⁺ also increases with increasing *c*, as was to be expected.

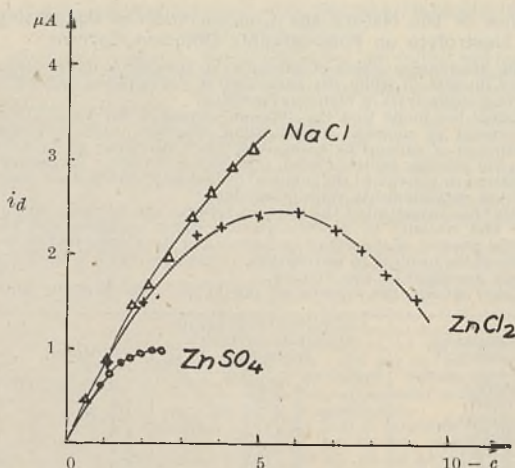


FIG. 2. Cd²⁺ IN VARIOUS SUPPORTING ELECTROLYTES (α/c IS CONSTANT)

(2) In the second series the diffusion current was found to be a parabolic function of c in solutions where (3) is valid (Fig. 2). The Ilkovic equation may now be written:

$$i_d = \text{const. } D^{1/2} \cdot x \quad (5)$$

Substituting $x/c = p$ and (4) in (5) we obtain

$$i_d = \text{const. } (-a \cdot c + b) \cdot c \cdot p \quad (6)$$

This equation shows that i_d has a maximum at $c = b/a$. In order to obtain the greatest possible accuracy in determining traces of impurities in a product, when the product itself serves as the supporting electrolyte, this concentration $c = b/a$ should be the optimal. However, it is not always possible to reach this optimal concentration, since the solubility of the supporting electrolyte is limited.

An investigation of Cd in ZnCl₂ did not show any change in optimal concentration with temperature (25, 50, 75° C.).

From the above it may be concluded that it is necessary to keep c absolutely constant when carrying out polarographic determinations in supporting electrolytes of high concentration. Another possibility is to work with methods allowing for variations in the nature and concentration of the supporting electrolyte, for example, Forché's pilot ion technique.

A fuller account of this investigation will be published elsewhere.
O. COLLENBERG
A. SCHOLANDER

Inorganic Department,
Royal Technical University,
Stockholm.
Aug. 24.

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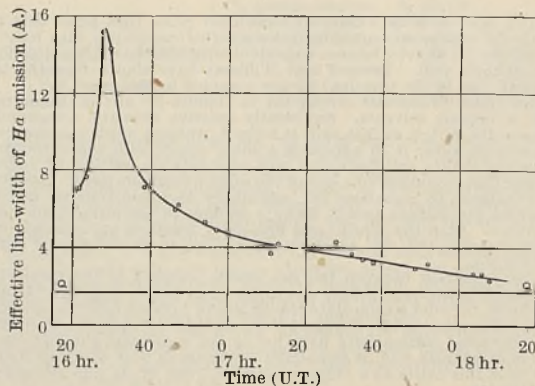
Spectrographic Observations of the Solar Flare of July 25, 1946

THE course of this flare was fully observed at Sherborne between 16h. 15m. and 18h. 10m. with the combined spectrohelioscope and spectrograph¹.

Measures of effective line-width, made with the spectrohelioscope line-shifter upon the brilliant reversal of the H α (λ 6563) contour, establish that the peak intensity of the flare radiation occurred at 16h. 27m. \pm 1m. The shape of this curve, illustrating the variation of line-width against time, confirms previous results² obtained here by indicating the occurrence of what can be most appropriately described as a *radiation burst*, lasting for two or three minutes, at the commencement of a great flare. The subsequent history was one of slow decay over a period of about two hours.

Seven spectra (λ 4750- λ 6800), in the first and second orders of the 13-ft. spectrograph, were obtained between 16h. 25m. and 17h. 15m. One of these, taken at 16h. 27m., being closely coincident with the peak of flare intensity, is of special interest. The principal features are: (1) the brilliant reversal of the H α -line, at least 15 Å. wide; (2) strong emission of helium, λ 6678, and reversals of two silicon lines, λ 6347.1, 6371.4; (3) a narrow bright streak, representing enhancement of the continuous spectrum, commencing at about λ 6450 and gradually increasing in intensity towards shorter wave-lengths. A plate of the D-region of the spectrum, taken at 16h. 35m., shows helium D₂ (λ 5876) in emission over the flare filament and in absorption over the penumbra of the sunspot. On the other hand, the sodium lines, D₁ and D₂, reported as seen in reversal during previous flares, were not appreciably affected at this time.

From the appearance of helium λ 6678 (2¹P-3¹D) in emission, we can infer the existence in the flare radiation of λ 584 (1¹S-2¹P), with its powerful influence upon atmospheric ionization. Allen has previously reported³ an observation of this line in emission, but Richardson and Minkowski⁴ were unable to detect it in any flares seen upon the disk.



○. VISUAL MEASURES WITH SPECTROHELIOSCOPE; + (NEAR PEAK), MEASURED FROM SPECTRUM PLATE AT 16 HR. 27 MIN. ○○. LINE-WIDTH OF QUIESCENT BRIGHT HYDROGEN.

Former flares have been recorded by monochromatic light, usually of the H α -line. The sole exception was the phenomenon of September 1 1859, which, by reason of its characteristic geomagnetic effects, was recognized by H. W. Newton⁵ as the earliest, and possibly the greatest, of recorded flares. This became visible for a few minutes in integrated light and was seen independently by Carrington and Hodgson as a pair of brilliant patches over the giant sunspot, both observers using ordinary telescopic means. The enhancement of the continuous spectrum may be taken to represent the occurrence of a similar phenomenon on July 25, 1946.

Comparisons of the spectra taken before and after the peak intensity of 16h. 27m. lead to the conclusion that most of the characteristic features referred to are confined to the very short period of the radiation burst. It is also to be expected that the maxima of those immediate geophysical effects of a great flare (magnetic 'crochet' and radio fade-out) will be found to coincide in time with this flash of radiation.

A more detailed examination of the spectra will be published later.
M. A. ELLISON

St. Edmund's, Westbury,
Sherborne.
Aug. 12.

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Interpretation of the Meson Spectrum Near Sea-Level

THE spectrum of the mesons near their place of production can be deduced from the spectrum observed near sea-level. The probability of a meson reaching sea-level with a final momentum p is, according to Euler and Heisenberg¹, given as follows:

$$P_{p_1}(p) = \left\{ \frac{q}{p_1} \left(1 + \frac{q - p_1}{p} \right) \right\} - \frac{p\tau}{p + q} \quad (1)$$

All quantities have been expressed in terms of momenta, the symbols having the following meanings:

$q = 2,000$ Mev./c., the momentum loss on traversing the atmosphere.
 $p_1 = 200$ Mev./c., the momentum loss on traversing the atmosphere lying above the meson-producing layer.

$P\tau = \mu c \frac{H}{c\tau} = 1,270$ Mev./c., with H the height of the homogeneous atmosphere, τ the average life of the meson, μ mass of the meson.

Equation (1) is based on the assumption that all mesons are formed at the same height. We have investigated the alternative assumption that the mesons are formed by primaries which are absorbed exponentially in the atmosphere, thus giving rise to an extended production layer. The average probability of a meson formed in this layer reaching sea-level with a final momentum p is thus

$$\bar{P}_{p_1}(p) = \int_0^q e^{-p_1'p} P_{p_1'}(p) \frac{dp_1'}{p_1'} \quad (2)$$

We find that the integral (2) is in good approximation given by

$$\bar{P}_{p_1}(p) \approx \left(\frac{p\tau}{p + q} \right)! P_{p_1}(p) \quad (3)$$

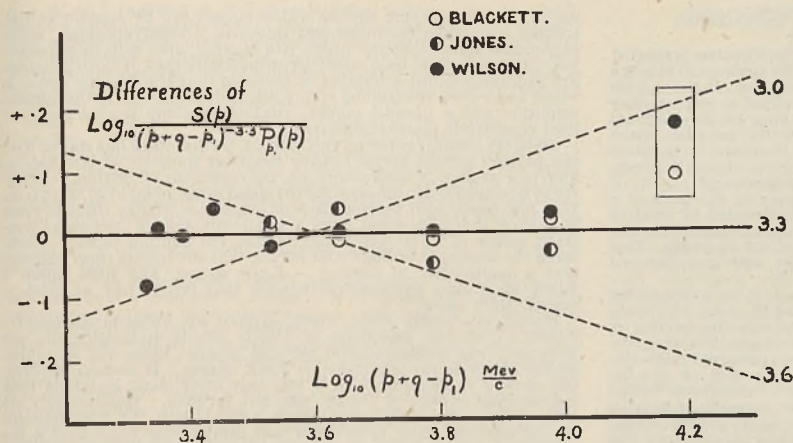
The factorial appearing in (3) always has numerical values between 0.9 and 1.0. Thus the difference between \bar{P} and P is unimportant and the expression (1) can be assumed to refer to an extended layer as well as to a single layer of production.

The differential meson spectrum at sea-level, S , can be expressed in terms of S_0 , the spectrum at production, in the following way

$$S(p) = S_0(p + q - p_1) P_{p_1}(p), \quad (4)$$

except for the very small range, irrelevant for our purpose, in which increased ionization takes place at sea-level.

Using the experimentally observed spectrum given in a preceding letter², and assuming that



$$S_0(p) \sim p^{-3.3} \dots (5)$$

we find (4) to be reasonably satisfied. To show the agreement we have plotted in the accompanying illustration differences of

$$\log \left\{ \frac{S(p)}{(p+q-p_1)^{-3.3} P_{p_1}(p)} \right\}$$

from an arbitrary zero against

$$\log \{p + q - p_1\}.$$

The observed points lie reasonably well on a horizontal line, supporting equation (5).

We indicate by broken lines in the illustration the changes of slope in the scale of the diagram, which correspond to exponents 3.0 and 3.6 in place of 3.3; the experimental points are clearly inconsistent with so large a variation from the latter figure.

The above analysis is very similar to that of Euler and Heisenberg, which leads to an exponent 2.87 instead of the exponent 3.3 we find here. The present value is based on much more extensive observational material and is, therefore, probably the more reliable value.

An appreciable deviation is noticeable in the diagram for the points at $\log_{10}(p+q-p_1) = 4.18$. This undoubtedly occurs because at this momentum the limit of resolution of the measuring equipment is approached. It was first pointed out by Blackett that at momenta greater than this limit the apparent measured differential spectrum is determined solely by errors of measurement and must be of exponent -2. The deviation which occurs is in accord with the observed resolution of the spectra concerned.

L. JANOSSY
J. G. WILSON

Physical Laboratories,
University of Manchester.
Aug. 16.

¹ Euler and Heisenberg. *Ergeb. exakt. Naturwiss.*, 17, 1 (1938).

² *Nature*, 158, 414 (1946).

Thermal Migration of Macromolecules

DEBYE has reported¹ that the velocity of thermal diffusion, relative to that of ordinary diffusion, is much greater in polymer solutions than in simple solutions. This result is likely to arouse a great deal of interest, and the following recent observations of our own concerning thermal diffusion in solutions of polymethyl methacrylate in various solvents may therefore be opportune.

Unlike Debye and his co-workers, we have not found it necessary, in order to demonstrate the effect, to use a method as elaborate as that of Clusius and Dickel. The process is so rapid, and the concentration gradient so great, that the reduction of viscosity in the region of high temperature is often more than compensated for by the local increase in concentration of the polymer solution. A very simple demonstration of these special features of the process is to place a beaker containing a cold solution of the polymer in toluene on a hot surface and then, a few seconds later, to detect the formation of a treacly layer at the bottom by careful scraping with a glass rod, or by watching adventitious bubbles. Alternatively, if a glass or metal tube, heated by a current of steam, be immersed in the polymer solution for about 10 minutes and then cooled, it will be found, on withdrawal, to have become coated with a layer of jelly.

In more elaborate experiments where the polymer solution was placed between two vertical brass plates, one heated and the other cooled, we have found the concentration of that part of the solution immediately in contact with the hot surface to increase two- or three-fold in a short period of time. For example, when a monochlorobenzene solution containing 3.1 per cent of polymethyl methacrylate by weight was confined in the cell for 2 hours, the temperatures of the hot and cold surfaces being approximately 115° C. and 14° C. respectively, and the distance between them 1 cm., the jelly adhering to the 'hot' wall when the cell was dismantled (after cooling) contained 8.8 per cent solute.

In thermal diffusion it must be supposed that the molecules have a real mean velocity caused by the unsymmetrical field of force arising

from the temperature gradient. The resultant force will increase with the size of the molecule and the velocity therefore will remain of the same order of magnitude, or will increase with molecular size, as does the velocity of migration of polymer ions in an electric field. For this reason we consider that the process could more aptly be called 'thermal migration' rather than thermal diffusion.

G. S. HARTLEY
B. A. TOMS

Courtaulds, Ltd.,
Research Laboratories,
Maidenhead, Berks.
Aug. 12.

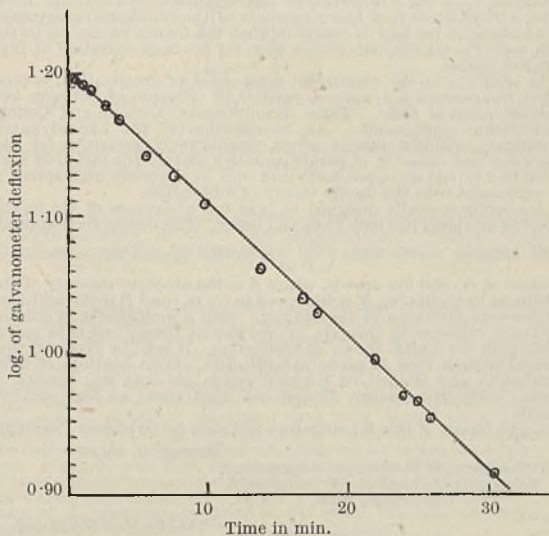
¹ Debye, P., Abstract of Address, *Rubber Age*, New York, 58, 596 (1946).

Fluorescence Fatigue

THE fact that substances which fluoresce show a 'fatigue' or 'fading' when exposed continuously to the radiation causing fluorescence has been noted sporadically. Beese and Marden¹ investigated the 'fatigue' of several substances, mostly solids, and found that with intense radiation equilibrium was attained in about ten minutes, and that complete recovery was attained in the dark.

Little notice seems to have been taken of fatigue in the biological literature, although it is well known that certain substances such as riboflavin are light labile. The fading fluorescence of vitamin A, however, has been used in histological investigations and has been studied by Sobotka, Kann and Loewenstein².

In preliminary experiments designed to investigate the physics of the fluorescence of biologically important substances, I have found that fluorescent fatigue is present in all liquids so far investigated: for example, vitamin A, riboflavin, eosin, fluorescein, coproporphyrin. Moreover, the curves for the intensity of fluorescence against time are in some cases strikingly similar to curves of radioactive decay. For example, a dilute watery solution of comparatively pure riboflavin gives a straight line when the logarithm of the intensity of the fluorescent light is plotted against time. The figure shows a curve for a solution which had been kept in the dark up to the moment of irradiation.



It can be seen that the fluorescence of this sample had a constant rate of decay. The galvanometer readings continued to decrease until the change in a given time interval was of the same order as the fluctuations ordinarily present. Every experiment ended, not with an 'equilibrium' state of the fluorescing material, but with a rate of fading which could no longer be measured because of the limitations of the experimental set-up.

Apart from the importance of such data for an understanding of photodynamic action, fluorescent fatigue has an important practical aspect in that measurements of fluorescence intensity have become popular for the assay of biologically important substances. It is, however, apparent that the result of the 'fluorimetry' or 'fluorophotometry' of samples will depend on their previous history as regards exposure to light.

TIKVAH ALPER

University of the Witwatersrand,
Medical School,
Hospital Street,
Johannesburg.
Aug. 20.

¹ Beese, N. C., and Marden, J. W., *J. Opt. Soc. Amer.*, 32, 317 (1942).

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Role of Inertia in Hydrodynamic Lubrication

On the basis of the hydrodynamic theory of lubrication presented by Prof. Osborne Reynolds in 1886¹, plane parallel surfaces in relative motion are incapable of developing a load-supporting oil film. This theory requires that the bearing surfaces be inclined to one another in the direction of motion. Recently, Mr. A. Fogg of the National Physical Laboratory reported² load capacities for parallel thrust surfaces, operating at high speeds, that were comparable to those obtained with conventional Michell or Kingsbury type thrust bearings. Similar results have also been noted by other researchers³.

Mr. Fogg explains these anomalous observations on the basis of a temperature gradient along the oil film in the direction of relative motion. He likens the expansion of the lubricant accompanying this temperature gradient to an equivalent hydrodynamic oil wedge. This theory is shown to be in qualitative agreement with the observed data by a process of reasoning by analogy.

A mathematical analysis of the development of a load-supporting oil film by lubricant expansion has been made. As Mr. Fogg predicted, the expansion of the lubricant as it passes through the bearing is significant, particularly in the case of parallel surfaces. However, the results of this analysis are not in quantitative agreement with Mr. Fogg's observation that at high rotative speeds a pair of parallel plates will carry very nearly the same load as a comparable tilting pad bearing. The analysis rather shows the load capacity of parallel surfaces to be of the order of 1/5 to 1/10 that for an equivalent tilting pad bearing, the exact value depending upon the temperature rise and coefficient of expansion obtaining. Although Mr. Fogg's theory nicely explains why parallel thrust surfaces, for use at ordinary speeds, are generally designed to support a unit load of approximately 50 lb. per sq. in. while tilting pad bearings are designed to carry a load of the order of 500 lb. per sq. in., it does not explain the excellent performance of parallel surfaces at high rotative speeds. As Mr. Fogg points out in his paper², the influence of the coefficient of expansion of the lubricant should be included in the analysis of slider and journal bearings which operate with a large rise in temperature.

The unexpected load capacity of parallel plane surfaces can be qualitatively explained on the basis of the inertia-induced pressure developed in an oil film at high rotative speeds. Here the density of the lubricant is the physical property of interest. The inertia of the lubricant has been considered negligible in nearly all hydrodynamic lubrication investigations since the time of Osborne Reynolds. The relatively good agreement between theory and experiment for ordinary slider and journal bearings operating at slow or moderate speeds has amply justified the exclusion of inertia terms. The late Dr. A. Kingsbury⁴ has stressed the need for an investigation of the influence of inertia upon the hydrodynamic characteristics of a bearing. However, a consideration of the magnitude of the centripetal component of acceleration led him to conclude⁵ that the inertia of the oil in the film was of negligible importance even for bearings operating at high rotative speeds.

In addition to the centripetal component of acceleration, several other components act upon a particle of oil confined between two parallel rotating disks. These include linear, angular and Coriolis acceleration components. An examination of the hydrodynamic equations including inertia terms qualitatively accounts for the observed load capacity of parallel rotating disks. The fact that such a bearing carries an appreciable load only at relatively high speeds is in agreement with the inertia theory of lubrication.

A bearing specially designed to take full advantage of the inertia effect at all speeds has been built and tested. This device gives appreci-

ably different curves when $\left(\frac{ZN}{P}\right)$ is plotted against the coefficient of

friction at several low speeds, where Z is the absolute viscosity of the lubricant in centipoise, N is the speed in r.p.m., and P is the unit load on the projected area of the bearing. Such a multiplicity of friction curves is contrary to ordinary hydrodynamic theory but is in agreement with the inertia theory of lubrication. It is to be expected that careful friction tests of plane parallel disks, thrust bearings of fixed inclination and Michell- or Kingsbury-type bearings will indicate a similar, although smaller, dependence upon speed at high rotative speeds.

A full report of this investigation will soon be published elsewhere.

MILTON C. SHAW

Department of Mechanical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass.

CHARLES D. STRANG, JR.

Cleveland, Ohio.
June 20.

¹ Reynolds, O., *Phil. Trans. Roy. Soc.*, 177, 157 (1886).

² Fogg, A., *Engineering*, 159, 138 (1945).

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⁴ Kingsbury, A., *Trans. Amer. Soc. Mech. Eng.*, 50, 6 (1928).

⁵ Kingsbury, A., *Trans. Amer. Soc. Mech. Eng.*, 53, 59 (1931).

finish. The fixed-taper surface will obviously fail by contact at the trailing edge when the mean film thickness is relatively large, while experiment shows that the tilting pad bearing, also, fails in the same way. It has, in fact, been shown experimentally that, if taper bearings are cautiously failed a number of times so that the bearing metal is wiped away from the trailing edge without deterioration of the surface condition and a parallel portion established along the surface, the load capacity is thereby increased.

Since my original paper on this subject, further work has shown that the parallel surface thrust bearing functions similarly at low speeds, and, in a number of cases examined, the coefficient of friction — ZN/P curve is substantially the same for the speed range 1,000 to 20,000 r.p.m. In a few cases, with bearing pads of longer arc length, there is some indication that high speed gives a small reduction in friction at constant values of ZN/P well removed from the limiting values. Thus, using the argument of Shaw and Strang that the inertia theory should give a multiplicity of friction — ZN/P curves, and with which I agree, these later experiments indicate that inertia has, at most, a second order effect.

During my earlier work, which covered the speed-range 10,000–20,000 r.p.m., the possibility of inertia effects accounting for the behaviour was considered and rejected because there was no multiplicity of coefficient of friction — ZN/P curves. It seemed, at first, the obvious explanation, and it was only after much searching that the thermal expansion theory was put forward. Qualitatively, it seemed the only explanation which agreed with the experimental results, and the letter from Shaw and Strang does not convince me otherwise. I shall, however, look forward with great interest to seeing their promised full report on their investigations.

Motor Industry Research Association,
Great West Road,
Brentford, Middlesex.
Aug. 24.

A. FOGG

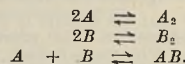
Spectroscopic Arguments for Isomeric Structures in α -Chloro-Acids

In a recent paper, Renard¹ has applied a method by which the qualitative analysis of the hydrolysates of proteins seems easily realized. The first step of the process consists in transforming the α -mono-amino mono-carboxylic acids resulting from hydrolysis into α -chloro-acids; the latter having been separated into different groups by fractional distillation, Raman analysis is used to identify the compounds. The fundamental assumption made by Renard is that the spectrum of the mixture results from the superposition of the spectra of the constituent acids.

It is perhaps worth while pointing out that the Raman spectra published by Renard have certain characteristic features which indicate that this assumption is unjustifiable. Thus we observe that in each spectrum of the mono-chloro acids (propionic, valeric, isovaleric, caproic, isocaproic, β -methyl valeric) two large, diffuse bands at about 1,660 and 1,730 cm^{-1} occur, one of which is presumably due to association. By analogy with the behaviour of other acids² we suggest that the latter should be correlated with the $\text{C}=\text{O}$ frequency in the monomeric molecule and the former with the same frequency in the dimer. The intensities are difficult to evaluate on the enlargements, but 1,660 cm^{-1} is clearly the most intense line, which indicates considerable polymerization.

It should also be noted that a band situated at about 1,450 cm^{-1} is a double one. In some cases, we have been able to evaluate the distance between the components at about 20 cm^{-1} . This could possibly be due to the splitting of the simple $\text{C}=\text{O}$ frequency in the dimer. Many other lines seem to be double, but their exact interpretation would be difficult with the data available at present.

Furthermore, when acids A and B are mixed, the existence of the following equilibria should be considered, namely:



A and B being very similar, it seems that AB must play an important part and give rise to new Raman lines the frequencies of which lie between those of A_2 and B_2 . Thus, Renard's assumption on the additivity of the spectra seems premature, and for this reason alone no qualitative analysis can be undertaken before this point has been cleared up. May we remark that this is only one of the numerous points which, in our opinion, are open to criticism in Renard's paper. Among them, we might mention the precision of the measurements, which is illusory, and the contradiction between the intensity ratios of the spectral lines, which do not remain constant in the different mixtures.

University of Liège.
Sept. 5.

JULES DUCHESNE

¹ Renard, M., *Mem. Soc. Roy. Sci. de Liège*, 7 (1946).

² Davies, M. M., and Sutherland, G. B. B. M., *J. Chem. Phys.*, 6, 755 (1938). Herman, R. C., and Hofstadter, R., *J. Chem. Phys.*, 7, 460 (1939).

Fisher's "Problem of the Nile"

THE following problem is of central importance in the theory of statistical estimation: k unknown parameters are to be estimated from a sample S consisting of n independent observations from the same parent population; how far can the information in S , relevant to the estimation of the k parameters, be confined to k degrees of freedom? Fisher¹ has shown that a complete solution is possible

THE letter from Messrs. Shaw and Strang states that the behaviour of lubricated parallel surfaces, which I reported in a paper to the Institution of Mechanical Engineers in January 1945, is mainly due to the inertia and not, as I suggested, to thermal expansion of the lubricating fluid. While agreeing that the influence of thermal expansion must be included in the analysis of film lubricated bearings, they suggest that its effect is only of the order of 1/5 to 1/10 of a corresponding geometrical wedge. I should like to ask on what basis this comparison has been made. Has it, as seems probable, been made on the basis of a given mean film thickness with corresponding relative velocity and oil viscosity? If so, I suggest that this is not the correct basis for comparison, since the parallel surface bearing will run with a much lower film thickness before contact takes place than will a fixed taper or tilting pad bearing, for a given degree of surface

if a set of k sufficient or of k quasi-sufficient statistics can be found, and it is known (from the work of Segal², further discussed by Bartlett³) that a simultaneous fiducial distribution will then exist, though it may not be complete in the sense of Bartlett. The most general parent population admitting a set of sufficient statistics has been determined by Koopman⁴, but the parallel problem for quasi-sufficiency (Fisher's "Problem of the Nile") is still unsolved.

Fisher considered quasi-sufficient estimation in relation to two important examples: (1) the estimation of a location parameter; and (2) the estimation of a pair of parameters defining the location and scale of the distribution. In each example he showed that the whole of the relevant information is contained in the estimating statistics provided that these are considered in association with the configuration of the sample from which they have been derived. In the first example the configuration is the set of differences between the observations (arranged in descending order); in the second it is the set of ratios of these differences.

I have now generalized Fisher's results, taking the configuration of a sample of n members to consist of $n-k$ functionally independent symmetric functions of the observations, such that the configuration of a sample determines the configurations of all included sub-samples once the observations have been arranged in descending order. The integer k , the order of the configuration, corresponds to the number of parameters to be estimated. With this definition (and subject to certain restrictions of detail) it appears that a first-order configuration is always equivalent to the set of differences between the observations on some transformed scale, while a second-order configuration is similarly always equivalent to the set of ratios of the differences. There is a formal analogy with the theory of continuous groups which suggests that a third-order configuration is always equivalent to the set of cross-ratios of tetrads of the transformed observations, and that higher-order configurations do not exist.

Now suppose that samples from a one-parameter distribution $\varphi(x; \theta)dx$ admit a first-order configuration in the sense defined above, for which the $n-1$ defining functions have a joint distribution independent of θ . A quasi-sufficient statistic for θ will then exist, and it can be shown that the wider class of distributions described by Fisher¹ and permitting quasi-sufficient estimation of the parameter by virtue of their invariance under certain transformations are included within the present formulation. By means of a characteristic-function argument I have proved that in these circumstances the parent distribution must be of the form $\varphi(X-\lambda)dX$, where $X=X(x)$ and $\lambda=\lambda(\theta)$. (Dr. Olav Reiersøl has pointed out to me that this result bears some resemblance to one mentioned by Segal², the precise content of which cannot be determined as the necessary details are not given.)

In the two-parameter case the corresponding situation is less simple, and a number of additional restrictions have to be made; apart from these, however, it appears that the parent distribution must have the form

$$\varphi\left(\frac{X-\lambda}{\mu}\right)\frac{dX}{\mu}, \quad X=X(x),$$

where (λ, μ) are functions of (θ_1, θ_2) .

Thus, within the limitations of the present approach, the two examples for $k \leq 2$ discussed by Fisher are not only representative but exhaustive.

Apart from three-parameter distributions of the form

$$d\Phi\left(\frac{\alpha X + \beta}{\gamma X + \delta}\right), \quad \alpha\delta - \gamma\beta = 1, \quad X=X(x),$$

the parameters of which can be estimated by a set of quasi-sufficient statistics associated with the 'cross-ratio' type of third-order configuration, my results do not lead to any essentially new solutions of the notoriously difficult "Problem of the Nile", but they cover exhaustively one outstanding line of approach, and suggest that further progress in this field is most likely to be made by attempting to generalize Fisher's solution in a way which does not preserve one of its characteristic features—the determination of the configurations of sub-samples by the configuration of their parent.

A detailed account of this work will, it is hoped, be published during the course of the coming year.

DAVID G. KENDALL

Magdalen College,
Oxford.
Aug. 2.

¹ Fisher, R. A., *Proc. Roy. Soc., A*, 144, 285 (1934).

² Segal, I. B., *Proc. Camb. Phil. Soc.*, 34, 41 (1938).

³ Bartlett, M. S., *Ann. Math. Stat.*, 10, 129 (1939).

⁴ Koopman, B. O., *Trans. Amer. Math. Soc.*, 39, 399 (1936). Darmois, G., *C.R.*, 222, 164 and 266 (1946), and Féraud, L., *ibid.*, 1272, should also be consulted.

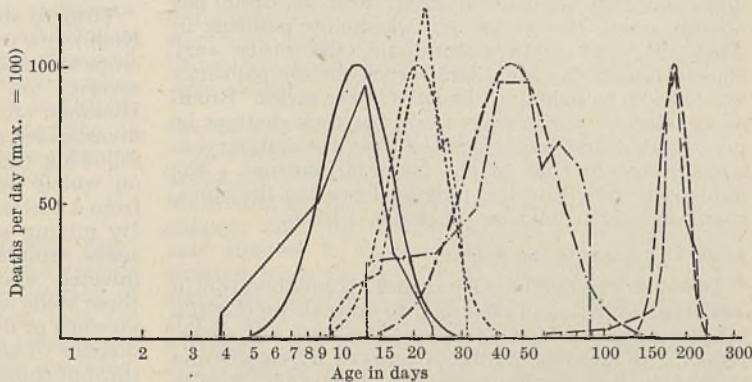
I AGREE entirely with the opinion of Dr. Kendall that future progress in this field should not be restricted to the consideration of cases in which the configuration of sub-samples is determined by the configuration appropriate to the whole sample. Such a restriction is new to me, and indeed appears artificial; it is not surprising that within its limitation the method I had illustrated should be applicable to only a few special cases. Dr. Kendall makes no mention of other illustrations I have given of the use of ancillary information.

R. A. FISHER

Representation of Relative Variability on a Semi-logarithmic Grid

THERE are two types of semi-logarithmic grids: one, called arith-log grid (a system of rectangular co-ordinates, in which the axis of abscissae is divided arithmetically and that of ordinates logarithmically), is frequently used for graphical representations because, on such a grid, the relative increase or decrease of the intensity of a phenomenon is shown immediately by the slope of the curve obtained by plotting its value at different times; the other, which may be termed 'log-arith' grid (a system of rectangular co-ordinates in which the axis of abscissae is divided logarithmically and that of the ordinates arithmetically), is used rarely, although this type of grid has some very useful peculiarities. It has been recognized that many moderately skew frequency distributions arising from empirical data¹ or fulfilling certain theoretical conditions² are reduced to normal curves of errors when plotted on a log-arith grid. Whereas the log-arith grid shares this peculiarity with other grids where the abscissa is scaled according to different functions³, another feature, peculiar to the log-arith grid and corresponding to the well-known peculiarity of the arith-log grid, seems to have never been appreciated.

Consider two equal segments, x_1' , x_1'' and x_2' , x_2'' , situated on the x -axis of a log-arith grid, and let their mid-points be x_1 and x_2 respectively. Then it is obvious that $\frac{x_1'' - x_1'}{x_1} = \frac{x_2'' - x_2'}{x_2}$. If now x_1 and x_2 represent the averages of two frequency distributions and x_1' and x_2' the respective lower (and x_1'' and x_2'' the higher) quartiles, or $x'' - x'$ any other measure of dispersion, other than the inter-quartile range, the two distributions will have equal relative dispersions. In general, distribution curves which exhibit equal broadness on a log-arith grid have equal relative dispersions, higher relative dispersion is shown by a broader curve and lower by a narrower one. The log-arith grid is thus eminently suitable for the study of relative dispersion, and, in particular, in the case of distributions approaching a type which has been termed 'log-normal'⁴.



DEATH CURVES PLOTTED ON A 'LOG-ARITH' GRID AS FREQUENCY POLYGONS, AND NORMAL CURVES OF ERRORS FITTED TO THEM, SHOWING THE DISTRIBUTION OF STARVED TICKS BY AGE AT DEATH AT A CONSTANT TEMPERATURE AND DIFFERENT HUMIDITIES (— 20%; - - - 50%; ····· 80%; - · - · 95%)

Other methods for the graphical representation of relative dispersion have been devised⁵, but their respective advantages and drawbacks will not be discussed here. Yet, the presentation of a practical example is well suited for illustrating the utility of the present method. In the figure, death curves resulting from starvation experiments on ticks (the data were communicated to me by Dr. Feldman-Muhsam, Department of Parasitology of the Hebrew University, and full details will soon be published elsewhere) have been plotted on a log-arith grid, the abscissae being the logarithm of the age at death in days and the ordinates the number of individuals dying per day at any particular age. It can be seen from the diagram that three of the death curves present approximately the same relative dispersion, the fourth presenting a somewhat higher one. Relative dispersion, as measured by the ratio of the standard deviation to the mean, assumes corresponding values shown in column (4) of the following table.

Relative humidity	Mean length of life (days)	Standard deviation	Coefficient of variation (4) = (3) : (2)
(1)	(2)	(3)	(4)
20%	13.7	3.7	0.27
50%	23.1	4.5	0.20
80%	48.0	22.4	0.47
95%	162.7	37.0	0.23

At the same time the table shows that both the mean length of life and the standard deviation vary so widely that it would have been impossible to plot these data on an axis of abscissae divided arithmetically.

H. V. MUHSAM

Department of Statistics,
Government of Palestine,
Jerusalem.
July 14.

¹ Gaddum, J. H., *Nature*, 156, 624 (1945).

² Curtiss, J. H., *Ann. Math. Statist.*, 14, 107 (1943).

³ Edgeworth, F. Y., *J. Roy. Statist. Soc.*, 61 (1898).

⁴ Pearl, R., "Introduction to Medical Biometry and Statistics" (Philadelphia, 1930).

RESEARCH ITEMS

Prehistoric Finds from Abyssinia

Mr. J. DESMOND CLARK, curator of the Museum at Livingstone, has published two papers (*Trans. Roy. Soc. South Africa*, 31, Pt. 1) as a result of his visit to Abyssinia on war service. One article deals with a "Fauresmith" site about sixteen miles from Gondar on the edge of the Gondar-Debat plateau. Here the material used was a fine-grained basalt, and a number of typical hand-axes, cleavers, side-scrapers, etc., were collected, as well as several stone balls, which may have been used as 'bolas' stones. These latter are not uncommon in the earlier Stone Age industries of Africa. It is interesting to have found these "Fauresmith" implements so far north as Gondar. The second article deals with several rock-shelter sites near Yavello, a village in the Galla-Sidama province about five hundred miles south of Addis Ababa and seventy miles from the Abyssinia-Kenya border. The finds include Stillbay points, pigmy tools, scrapers of various kinds, flakes, etc. Some of the rock-shelters had been painted, the drawings being very conventionalized. Prof. H. Breuil has already noted two styles of rock-shelter painting in Abyssinia, one more naturalistic, the other very conventionalized. Mr. Clark's rock-shelter paintings would seem to belong to Breuil's latter series. Breuil also collected implements from the rock-shelters he investigated and has suggested that the industry as a whole recalls that of the Magosian culture. The industries from Yavello, judging from the drawings, could equally belong to the same culture.

Alloxan Diabetes in the Rabbit

It was shown by Shaw Dunn and his collaborators in 1943 that injection of alloxan into animals produced a selective necrosis of the β cells of the islets of Langerhans. The animals exhibited marked hypoglycaemia during the first few hours (due to liberation of insulin from the necrotic β cells) and afterwards hyperglycaemia until death, which usually occurred within a day or two. E. Duffy (*J. Path. Bact.*, 57, 199; 1946) has succeeded in tiding rabbits over the initial acute and (hitherto fatal) stage by appropriate treatment with glucose or insulin. Such animals survived for many months and exhibited classical symptoms of diabetes mellitus—hyperglycaemia, glycosuria, polyuria, polyphagia. Ketonuria was not present on ordinary diets, though, surprisingly, it could be induced by feeding excess of glucose but not by high fat diets. Post-mortem, the only findings were degeneration and reduction in number of the β cells. It is therefore proved that the classical picture of diabetes can be produced by selective damage to the β cells of the pancreatic islets.

Accelerated Storage Tests to Assess the Quality of Dried Whole-Egg Powder

EGGS in powdered form have become a well-known commodity during the war years, and the extent to which this commodity will compete with other egg products during normal times will depend largely on how well its quality can be maintained not only during production but also in handling and storage. Fluorescence appears to be related to protein decomposition in foods, which show more decomposition as spoilage proceeds; and it has been found that the addition of sucrose to egg powder, prior to drying, is effective in delaying fluorescent development at 118° F. R. L. Hay and J. A. Pearce (*Canad. J. Res.*,

F, 24, 168; 1946) now show that 33 per cent sucrose in the egg powders has a marked effect in retarding decrease in quality in egg powder as assessed by all quality tests used. Loss in quality is less for sugar-egg powders prepared with granulated sugar than for those prepared with sucrose syrup; and in addition, powder made from fresh shell eggs is more desirable than powder prepared from frozen melange. Present indications are that this sugar-egg powder will find a ready peace-time market for baking and other trade purposes.

Seed Germination and Light

J. A. HONING (*Genetica*, 23, 1; 1944) has shown that the seeds of *Nicotiana Tabaccum* from Sumatra in general require light for germination, but those from Java are light-indifferent. Pure lines are light-indifferent or light-needing. Hybrids between these lines show reciprocal differences when stored in the presence of lime, but the differences largely disappear when storage is done without lime. *N. texana* also contains strains which have light-sensitive seeds.

Stem Rot of Outdoor Tomatoes

TOMATO stem and fruit rot (*Didymella Lycopersici* Kleb.) is a frequent cause of loss in outdoor tomato crops and may persist from year to year with varying severity on regularly cropped holdings. C. J. Hickman (*J. Pom. and Hort. Sci.*, 22, 69; 1946) has investigated sources of infection in the Evesham area, following the observation that the disease occurred on widely separated holdings supplied with plants from a particular nursery where it had been identified. By mixing seeds from diseased fruits with healthy seeds, samples containing 2 per cent and 70 per cent infected seeds were obtained. Plants raised from these seeds were grown on separate plots, and though no signs of disease were apparent at planting time, a quarter of those from the 2 per cent sample and a third of those from the 70 per cent sample eventually succumbed. Plants from healthy seed became diseased when propagated at nurseries having a previous history of infection, whereas no losses occurred where there was no such history and hygiene was good. Plants in the field were not prone to infection from the soil, even when diseased plants had been ploughed in the previous year. Plants staked with old canes, however, became 38 per cent infected, whereas new canes, or old canes sterilized with formaldehyde, produced no infection. It is concluded that the most probable causes of the disease are spores in propagating soil and spores which have overwintered in cracks of old canes.

Mitotic Activity in the Mouse

W. S. BULLOUGH (*Phil. Trans. Roy. Soc.*, B, 231, 435; 1946) has made an extensive analysis of mitosis in the adult mouse. The reproductive system, the urinary system, the alimentary canal, various exocrine and endocrine glands and other organs of the female mouse all exhibit increased mitotic activity in response to oestrogenic hormones. In the ovary the cells are highly resistant to the mitosis-stimulating effect of the oestrogen. The evidence shows the presence of mitosis inhibitors which may be classified as (1) the cell inertia, (2) mitosis depressors. The latter show their effect by taking control immediately after an excess of mitotic activity has been stimulated by oestrogen. Therefore in the presence of a stimulant and the depressant, mitosis proceeds in waves. The proliferating cells of the intestinal lymph appear to

lack the depressant, and continued excessive mitosis may occur. Both in the neighbourhood of wounds and in cancerous growth there is a maximum response to oestrone; the two regulators would appear to be in abeyance. These results are discussed in relation to ovarian function, pregnancy and cancer.

Magnetic Field Calculation by Relaxation Method

IN a paper by H. Motz and W. D. Worthy (*J. Inst. Elec. Eng.*, 92, Pt. 2, No. 30, December 1945), a method of computing magnetic and electric fields is explained with reference to the problem of the magnetic flux distribution between stator and rotor of dynamo-electric machines. Mathematically, the problem is that of solving Laplace's or Poisson's equation. It is shown how approximate solutions are obtained with the help of a simple arithmetical technique. The differential equations are first replaced by a system of algebraic equations which are then solved by means of the computation method due to R. V. Southwell. The process is outlined and illustrated by a simple example which shows all the essential steps involved. A solution is given for two idealized examples of pole shoe and armature for which rigorous solutions are known. The agreement between the rigorous and approximate solutions is found satisfactory. Sharp corners of pole shoe and armature present a problem for which various solutions are possible, and some of these are indicated. The flux distribution of a complete machine is computed and presented as an example of a complex problem not amenable to a rigorous solution.

High-Frequency Alternators

A PAPER by Dr. J. H. Walker (*J. Inst. Elec. Eng.*, 93, Pt. 2, No. 31, February 1946) reviews the various types of alternators available for the generation of frequencies up to 50,000 c./s., and shows that for the majority of applications the modern heteropolar inductor alternator is the most suitable machine. It demonstrates that this alternator is superior to the older homopolar and heteropolar types, owing, in the case of machines required for frequencies of 400–3,600 c./s., to a system of field and armature windings which substantially reduces the number of armature conductors required to generate a given electromotive force. For frequencies greater than 3,600 c./s. this superiority is due to a combination of these windings with a stator-slotting arrangement which permits, for a given frequency and speed of rotation, a large reduction in the number of wound stator slots. The electrical characteristics and mechanical construction of these alternators are discussed, together with their application to the melting of metals and surface-hardening of steel. An appendix gives a brief mathematical treatment of the theory of their novel features.

Physical Properties of Aliphatic Hydrocarbons

CONSIDERABLE interest has recently been shown in the determination of the physical properties of pure hydrocarbons, and the results of A. I. Vogel (*J. Chem. Soc.*, 133; 1946) on the parachors and refractivities of the normal hydrocarbons from *n*-pentane to *n*-hexadecane add some valuable material to this field. The results differ markedly from hitherto accepted figures, and since the atomic and structural parachors and refractivities depend on the values of the CH_2 grouping, the calculations based on these will require modification. The mean values for CH_2 are: $[P] =$

39.98, $R_C = 4.618$, $R_D = 4.643$, $R_F = 4.687$, $R_G = 4.731$ and $Mn_D^{20} = 20.63$. Taking into account the values found for *n*-alkyl chlorides, bromides and iodides, the average values $[P] = 40.02$, $R_C = 4.624$, $R_D = 4.647$, $R_F = 4.695$, $R_G = 4.735$, and $Mn_D^{20} = 20.59$ are found. It is suggested that the data of Eisenlohr for the refractivities are less accurate than has been supposed.

Structure of Vanadium Tetrachloride

THE structure of the vanadium tetrachloride (VCl_4) molecule has been determined by electron diffraction by W. N. Lipscomb and A. G. Whittaker (*J. Amer. Chem. Soc.*, 67, 2019; 1945). The molecule is a regular tetrahedron, with $\text{V}-\text{Cl} = 2.03 \pm 0.02$ Å. and $\text{Cl}-\text{Cl} = 3.32 \pm 0.03$ Å. The $\text{V}-\text{Cl}$ distance is in good agreement with that calculated on the assumption that six orbitals are involved in bond formation to the four chlorine atoms and each bond has $\frac{1}{2}$ double bond character. The unpaired electron probably occupies one of the $3d$ orbitals not involved in bond formation, and it is interesting that this electron does not take any significant steric role (similar to that ordinarily played by an unshared electron pair) in the structure, the observed tetrahedral configuration being that which would be expected if this electron were absent.

Structure of the Globular Star Clusters

E. FINLAY-FREUNDLICH (*Mon. Not. Roy. Ast. Soc.*, 105, 4, 237; 1945) has attempted to explain the existence of isolated globular star clusters in the vicinity of the galaxy. The main problem presented by the globular star clusters is their existence as finite systems, isolated from the field of the galactic stars. Their structure must be determined solely by the gravitational field set up by the stars which constitute such a cluster. But whether the influence of the gravitational field of the whole cluster alone, or in addition, the influence of irregular forces, arising from critical approaches of individual stars, is considered as a decisive factor, it has been shown by Charlier and Martens that the final state should correspond in every case to an isothermal distribution. It has been recently discovered that globular clusters have wide envelopes of faint stars and, taking into consideration these 'atmospheres', the clusters have well-defined finite radii. From these facts the theory is developed that the globular clusters are settling down from an initially adiabatic state, and have reached an intermediate, quasi-stationary state consisting of an isothermal core surrounded by an adiabatic atmosphere. On this view an explanation is afforded of the fact that the most strongly elliptical cores have the lowest atmospheres, and in addition, the fact that the ellipticity, frequently shown in the bright stars, is restricted to the cores, is explained. From the width of the spectral lines in the spectrum of the bright cores, it is possible to determine approximately the masses of globular star clusters, and preliminary estimates show that these masses are very large—of the order 10^8 that of the sun. Although such masses exceed those previously assumed for the masses of the globular clusters, corroborative evidence for the large mass is afforded by the high spatial velocities of the few cluster-type variables discovered outside globular clusters in the galaxy; and these velocities, it is assumed, can be interpreted as velocities of escape. Such velocities correspond to a mass of about 4×10^8 times the mass of the sun.

THE BIOLOGICAL INSTITUTE OF TIHANY, HUNGARY

THE Hungarian Biological Research Institute is situated near the village of Tihany on a small peninsula running out from the northern shore of Lake Balaton. It is about a hundred miles southwest of Budapest in an attractive position on the edge of the lake with wooded hills behind.

The Institute, founded in 1926, was well known before the War as the largest freshwater biological station in Europe; and the plant and animal life of the lake and its shores have been the subject of intensive study. The lake itself is fifty miles long, 6-9 miles wide and 10 ft. deep on the average; near Tihany the depth increases to about 30 ft.

During the War the Institute was fortunate in having suffered comparatively little material damage and has now become the main centre for biological research of all kinds in Hungary. With Dr. A. B. L. Beznak as director, accommodation has been afforded to workers who would otherwise have been deprived of facilities for research by the destruction of their laboratories in other parts of Hungary; in this manner an isolated residential community has been created of some seventy scientific workers, many of whom had earned international reputations before the War. The isolation is partly physical due to the present lack of transport, and partly scientific due to difficulties in maintaining contact with men of science in other countries; in recent months institutions and individuals in Great Britain have been sending a certain amount of scientific literature which has been very gladly received and has helped to keep research going at the Institute.

The work of the hydrobiological department is directed by Dr. Bela Entz, assisted by Dr. Olga Sebestyen. Research is concerned mainly with limnological problems; in particular, investigations on organic detritus, on biocoenosis, on *Cladocera*, on phytoplankton and on sponges are being carried out or are projected.

Dr. J. Horvath is now working on soil fertility, sterility and exhaustion, and later intends to work on soil bacteriology.

Research in plant physiology is being carried out by L. J. Havas, mainly in relation to colchicine; he proposes to investigate effects of vegetable substances on animal tumours and pathogens.

Dr. L. Felföldi is concerned with plant geography and plant sociology; he is also interested in cytogenetics and hopes to study polyploid plants with a view to their practical applications.

Drosophila research is being done by Dr. G. Fabian, who has found and bred his own special stock. Present work is concerned with inheritance of fertility and sterility; it is later intended to work on the biochemistry of gene substances.

Work on the sociology of birds is carried out by Dr. N. Udvary, who studied bird life on the Hortobagy during the War.

Dr. S. G. Maltoltsy is investigating cell physiology and has recently been working on the hereditary effects of carcinogenic materials on *Drosophila* and on plants, and on the biological effects of ultra-violet rays.

Research on animal physiology is being done by the director, Dr. A. B. J. Beznak, by his wife, Dr. M. Beznak, and by Dr. I. Hajdu; the work is mainly concerned with the physiological mechanism of the

hyperglycæmia caused by the thrombosis or ligation of one of the heart vessels. The physiological mechanisms of heart hypertrophies and of suprarenal hypertrophies as well as the physiology of nutrition have also been studied by these workers.

Dr. T. Csaky plans to study the biochemistry of nutrition and also the production of protein food-stuffs for human and animal nutrition by the action of synthesizing agents such as yeast and nitrogen-fixing bacteria.

Dr. A. G. B. Kovacs is concerned mainly with animal metabolism. He is now working on the physiological mechanism of the temperature response following histamine injections. In the future he wants to work on the part played by histamine in the central nervous system, and on surgical shock.

Dr. Zsuzsanna Rady works mainly on human nutrition, and after completing the results of a survey of nutritional conditions at the comparatively wealthy village of Valko, intends to carry out a similar research at the poorer village of Tihany. She hopes in this way to relate the needs of the population in a particular locality to the agricultural conditions of the country, and hence to make recommendations for the manner in which agriculture should be developed. At present she is working on the protein metabolism of fish, on fungal diseases in fish and on the bactericidal action of their skin secretions.

Biochemistry is represented by Dr. M. Gerendas, who is working at present principally on blood-clotting and the isolation and inactivation of thrombin and also (in collaboration with Prof. Szent-Györgyi) on muscle structure.

In addition to the researches mentioned above, work on organic (sterol) chemistry is being done by Dr. A. Kramli and on experimental animal psychology by Dr. M. Nagy.

THERMODYNAMIC EQUILIBRIA OF HIGHER ORDER

FOR two phases of the same substance to be in equilibrium, the thermodynamic potential, G , must have the same value in both phases. P. S. Epstein ("Textbook of Thermodynamics", p. 131; 1937) has suggested that, in order to derive the equilibrium conditions, the Taylor series for G should be expanded to terms of high order. If, in this expansion, the n th order derivatives of G are the lowest which have different values in the two phases, and all derivatives of lower order are equal in the two phases, then $d^n G' = d^n G''$ is the condition for equilibrium of the n th order, where the symbols ($'$) and ($''$) indicate the separate phases. E. F. Lype (*Phys. Rev.*, 69, 652; June 1946) has followed Epstein's suggestion and derived from the above condition the set of thermodynamic relations, which, in addition to the equivalence of the potentials, must hold for a system of a single substance which is in n th order equilibrium.

The relations for the equilibria of the first four orders, and the equations of the corresponding equilibrium curves, are examined in some detail. For a system in first-order equilibrium, the equation of the equilibrium curve is simply the Clausius-Clapeyron equation. The transitions, between the two modifications of liquid helium, and between those of solid methane, have been interpreted as second-order equilibria. Adequate descriptions of the

transition curves, and of the thermodynamic properties of these substances along the curves, have been given (for helium by Keesom, and for methane by Clusius and co-workers), so that the theoretical relations obtained by Lype can be checked by comparison with experiment. It is shown that the relations yield values for the physical properties which are in excellent agreement with those observed, even when Ehrenfest's equation (*Leiden Comm. Supp.*, 75b., 1933), which has been applied to second-order equilibria, leads to values twice as high as the observed values.

Certain transformations in metals, such as the transition at the Curie point from the ferromagnetic to the paramagnetic state, or between two forms of a crystal lattice, as observed, for example, for cobalt at 450° C., have been considered to represent equilibria of the third order. The equation for the third-order transition curve is used to calculate the variation of the transition temperature with pressure, and in the case of nickel at the Curie point, for which reliable experimental data exist, good agreement is obtained between the value calculated by Lype and the experimental value determined by Englert (*Z. Phys.*, 97, 94; 1935).

Although the existence of a fourth-order equilibrium has not yet been observed, this order of equilibrium is of interest, as a means of extending the vapour pressure curve beyond the critical point. It is shown that the points of inflexion of various thermodynamical functions in the overcritical region can be regarded as such an extension, and some verification for this, though sufficient data are lacking, is obtained by comparison with the experimental values of the specific heat of high pressure steam in the overcritical region as measured by Havlíček and Miškovský (*Helv. phys. Acta*, 9, 161; 1936).

NATIVE CULTURE OF THE MARIANAS ISLANDS

THE Marianas Islands in Micronesia have not received so much attention from anthropologists as have most of the other island groups, and yet they present an extremely interesting field of study ("Native Culture of the Marianas Islands." By Laura Thompson, *Bernice P. Bishop Museum Bull.*, 185; 1945). Discovered by Magellan in 1521, these islands were a regular stopping place for the early voyagers, but the inhabitants were left practically undisturbed for about 150 years. In the middle of the seventeenth century, a permanent mission was established by a band of Jesuits supported by Spanish soldiers. The natives, who numbered about 100,000, were friendly but resisted conversion; however, with the help of the soldiers their resistance was overcome and the reduced population gave in to Spanish domination. The population was further diminished by other factors (disease, etc.), and in the first census early in the eighteenth century, only some 3,678 natives survived. These intermarried with the Spaniards, Filipinos and others, and a mixed population completely replaced the indigenous one, the cultures blending with influences both from the Old and the New Worlds to form a new pattern. To-day only the Chamorro language, altered by Spanish additions, persists.

There are, however, archæological remains and a number of old Spanish documents from which much

can be deduced concerning the Chamorro, who are remarkable for their size and strength and for their fondness for the water. From these documents, Laura Thompson has pieced together a reasonably detailed account of the daily life and social structure of the vanished tribe, together with their material culture, and much of interest emerges. It is clear that the ancient Chamorro had an elaborate social organisation with matrilineal clans and village chiefs whose power was based mainly on inherited wealth and monopolies. The society was divided into three classes, the upper and middle consisting of sailors, carpenters, fishermen and warriors, which professions were not open to the lower and physically inferior class. Their economy was of the usual South Sea type, based on gardens, food collecting and fishing, but different in that rice was also cultivated.

Taking it all round, the ancient Chamorro had a highly developed neolithic culture which rivalled in interest the high centres of central and marginal Polynesia, and may be compared to the Indonesian or pre-Malay level in the Philippines.

K. RISHBETH

FORTHCOMING EVENTS

Wednesday, October 2

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. J. T. Ellingham: "Chemical Metallurgy".

Thursday, October 3

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, London, W.C.2), at 3 p.m.—Mr. N. E. G. Hill: "The Recognition of Coloured Light Signals which are near the Limit of Visibility" and "The Measurement of the Chromatic and Achromatic Thresholds of Coloured Point Sources against a White Background".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. V. Z. de Ferranti: Inaugural Address as President.

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. Max Jakob: "Some Experiments on Forced Convection".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 4

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (in the Lecture Theatre, Central Library, St. Peter's Square, Manchester), at 6.30 p.m.—Prof. E. K. Rideal, M.B.E., F.R.S.: "Physical Chemistry in the Dyestuffs Industry" (Ivan Levinstein Memorial Lecture).

Saturday, October 5

ASSOCIATION FOR THE STUDY OF SYSTEMATICS IN RELATION TO GENERAL BIOLOGY (at the Royal Botanic Gardens, Kew), at 2.15 p.m.—Exhibits and demonstrations on Modern Plant Systematics.

APPOINTMENTS VACANT

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

ASSISTANT CHEMISTS in the Chief Inspector's Department—The Clerk and Solicitor, West Riding of Yorkshire Rivers Board, 71 Northgate, Wakefield, Yorks, endorsed "Assistant Chemist" (October 1).

LECTURER IN ELECTRICAL ENGINEERING—Acting Clerk to the Governors, South West Essex Technical College and School of Art, Forest Road, London, E.17 (October 3).

HORTICULTURAL INSTRUCTOR at the Pibwrlwyd Farm Institute, Carmarthen—The Director of Education, County Education Offices, County Hall, The Castle, Carmarthen (October 5).

UNIVERSITY READERSHIP IN EXPERIMENTAL PHYSIOLOGY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 7).

LECTURER IN CIVIL ENGINEERING—The Principal, Technical College, Normanton Road, Derby (October 7).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (October 11).

Other Countries

LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (October 14).

RESEARCH WORKER IN THE COAL TREATMENT LABORATORY OF THE Department of Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (October 15).

TEMPORARY LECTURER IN CIVIL ENGINEERING (appointment for three years) at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 15).

HEAD OF THE DEPARTMENT OF CHEMISTRY—The Principal, Chelsea Polytechnic, London, S.W.3 (October 17).

RESEARCH ASSISTANT FOR CANCER RESEARCH in the Department of Pathology—The Registrar, The University, Sheffield (October 19).

ASSISTANT PHYSICIST—The Secretary, Sheffield National Centre for Radiotherapy, "Broom Cross", Tree Root Walk, Sheffield 10 (October 21).

SENIOR LECTURER IN CHARGE OF THE DEPARTMENT OF POLITICAL SCIENCE at the University of Melbourne, Vic., Australia—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 28).

ENGINEER FOR AUSTRALIAN ALUMINIUM PRODUCTION COMMISSION, in Australia—The Deputy High Commissioner for Australia, Room 115, Australia House, London, W.C.2 (October 31).

DIRECTOR OF RESEARCH in a new Mechanical Engineering Research Organisation to be established by the D.S.I.R.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1631 (November 8).

DIRECTOR OF RESEARCH in a new Hydraulics Research Organisation to be established by the D.S.I.R.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1632 (November 8).

ZOOLOGIST and a BOTANIST—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (November 15).

SCIENTIFIC OFFICER at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon—Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4 (November 30).

ZOOLOGIST in "Scientific Officer" class—The Director, Freshwater Biological Association, Ambleside, Westmorland (November 30).

LECTURER IN INDUSTRIAL HEALTH—The Registrar, The University, Manchester 13 (December 1).

ADVISORY OFFICERS (3) for Association's Scientific Department, Assam—The Secretary, Indian Tea Association (London), 39 Lombard Street, London, E.C.3.

ASSISTANT BACTERIOLOGISTS for Research Department at Port Sunlight, Cheshire—Lever Brothers and Unilever, Ltd., TD/R, Unilever House, Blackfriars, London, E.C.4.

ASSISTANT CHEMIST for research in fruit and vegetable preservation—The Director, Research Station, Campden, Glos.

ASSISTANT IN THE DEPARTMENT OF NATURAL HISTORY (preference will be given to applicants specially qualified in Invertebrate or Agricultural Zoology)—H. J. Butchart, Secretary, The University, Aberdeen.

ASSISTANT LECTURER IN BOTANY AND ZOOLOGY—The Principal, Chelsea Polytechnic, London, S.W.3.

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

CHIEF PLANT PHYSIOLOGIST for Research Division, Department of Agriculture and Forests, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1.

HEAD OF THE DEPARTMENT OF BIOLOGICAL SCIENCES—The Secretary-Registrar, Wye College, near Ashford, Kent.

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

VACANCIES ON THE SCIENTIFIC STAFF, for research and development work on flax bleaching, spinning and weaving—The Director of Research, Linen Industry Research Association, The Research Institute, Lambeg, Co. Antrim, Northern Ireland.

LECTURER IN ZOOLOGY—The Registrar, Municipal College, Portsmouth.

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 131, Nr. 14: 'The Determination of the Harmonic Constants from Tidal Observations made in Danmarks Havn. By J. Egedal. Pp. 6. 0.50 kr. Bd. 132, Nr. 1: Die Triasablagerungen von Ostgrönland. (Geologisk Ekspedition til Ostgrönland, 1936-38.) Von Hans Stauber. Pp. 326+7 plates. 15 kr. Bd. 133, Nr. 1: Die Postdevonische Tektonik von Ostgrönland zwischen 74° und 75° N. Br. Von Andreas Vischer. Pp. 194+6 plates. 12 kr. Bd. 134, Nr. 1: Kommissionens Historie, 1878-1943. Af H. Bistrup. Pp. 92. 4 kr. Bd. 134, Nr. 2: The East Greenlanders Possibilities of Existence, their Production and Consumption. By Ejnar Mikkelsen, in conjunction with P. P. Sveistrup. Pp. 244+1 plate. 11.50 kr. Bd. 134, Nr. 3: Den økonomiske Udvikling i Christianshaab, Jakobshavn og Ritenbenk Distrikten, 1899-1938. Af E. Friis-Nielsen og P. P. Sveistrup. Pp. 162+1 plate. 8 kr. (København: C. A. Reitzels Forlag, 1942-1944.) [73]

La bimanità: sintesi sommale dei principi fondamentali del pensiero bimano. Pp. 32. (Milano: Casa Editrice Polini, n.d.) 5 lire. [123]

Bernice P. Bishop Museum. Special Publication 37: Studies in Hawaiian Pollen Statistics, Part 1: The Spores of the Hawaiian Pteridophytes. By Olof H. Selsing. Pp. 87+7 plates. (Honolulu: Bernice P. Bishop Museum, 1946.) [123]

Publications of the South African Institute for Medical Research. No. 47: Statistical Results of Ten Years of Typhoid Endotoxin Immunization on the Witwatersrand Gold Mines (1934-1943). By Dr. E. Grasset. Pp. 163-206. (Johannesburg: South African Institute for Medical Research, 1945.) [123]

Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Twenty-second Annual Report, 1945. Pp. 4. (Boston, Mass.: Dr. J. C. Aub, Secretary, Massachusetts General Hospital, 1946.) [123]

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 135, Nr. 3: A Geological Reconnaissance of the Southern Part of the Svartehuk Peninsula, West Greenland. (De Danske Nugsuaq Ekspeditioner, 1938 og 1939.) By Alfred Rosenkrantz, Arne Nøe-Nygaard, Helge Gry, Sole Munck and Dan Laursen. Pp. 72+5 plates. 4 kr. Bd. 135, Nr. 8: Contributions to the Quaternary Geology of Northern West Greenland especially the Raised Marine Deposits. (De Danske Nugsuaq Ekspeditioner, 1938 og 1939.) By Dan Laursen. Pp. 126+7 plates. 8 kr. Bd. 137, Nr. 3: On the Geology and Petrography of the West Greenland Basalt Province, Part 3: The Plateau Basalts of Svartehuk Peninsula. (De Danske Nugsuaq Ekspeditioner, 1938 og 1939.) By Arne Nøe-Nygaard. Pp. 78+10 plates. 4.50 kr. Bd. 137, Nr. 5: On the Geology and Petrography of the West Greenland Basalt Province, Part 5: Two Major Doleritic Intrusions of the Nugsuaq Peninsula. (De Danske Nugsuaq Ekspeditioner, 1938 og 1939.) By Sole Munck. Pp. 62+15 plates. 4.50 kr. Bd. 138: Studies on Triassic Fishes, 1. (Palaeozoologica Greenlandica.) By Eigil Nielsen. Pp. 394+30 plates. 22 kr. Bd. 141, Nr. 3: Studies on the Orbitatids and Collemboles of Greenland. By Marie Hammer. Pp. 210. 10 kr. Bd. 142, Nr. 1: Contributions to the Geography of Ingolfs Fjord and the Interior of Kronprins Christians Land. By Elmar Drastrup. Pp. 28. 1 kr. (København: C. A. Reitzels Forlag, 1942-1945.) [133]

Oversigt over Meddelelser om Grønland afsluttet i Marts 1941. Udarbejdet af H. Bistrup. Pp. 84. 4 kr. Supplement afsluttet den 31 December 1943 til Oversigt over Meddelelser om Grønland afsluttet 1 Marts 1941. Udarbejdet af H. Bistrup. Pp. 32. 1.50 kr. (København: C. A. Reitzels Forlag, 1941-1945.) [133]

Havsforskningsinstituttets Skrift. No. 113: Översikt av isarna under vintern 1938-37. Av Risto Jurva. Pp. 71. No. 115: Översikt av isarna under vintern 1925-26. Av Risto Jurva. Pp. 55. No. 116: Översikt av isarna under vintern 1921-22. Av Risto Jurva. Pp. 45. No. 117: Översikt av isarna under vintern 1923-24. Av Risto Jurva. Pp. 44. No. 121: Ström- og Windbeobachtungen an den Feuerschiffen in den Jahren 1936 und 1937. Von E. Palmén. Pp. 57. No. 123: Zur Frage des prognostischen Wertes der Wassertemperatur im Schärenmeer. Von Eugenie Lisitzin. Pp. 21. No. 124: The Thalassological Cruise April-May 1938. By Risto Jurva. Pp. 16. No. 125: Havsforskningsinstituttets verksamhet under år 1938. Av Gunnar Granquist. Pp. 17. No. 126: Regular Observations of Temperature and Salinity in the Seas around Finland, July 1937-June 1938. By Gunnar Granquist. Pp. 43. No. 127: The Thalassological Cruise in July 1939. By Gunnar Granquist. Pp. 25. No. 128: Hydrographical Observations made on board the S.S. *Aranda* during the International Investigation of the Central Baltic, July-August 1939, 1: Temperature, Salinity and Oxygen. By Gunnar Granquist. Pp. 24. (Helsinki: Havsforskningsinstituttet, 1939-1944.) [133]

Havsforskningsinstituttets Skrift. No. 129: Regular Observations of Temperature and Salinity in the Seas around Finland, July 1938-June 1939. By Gunnar Granquist. Pp. 40. No. 130: Vattenståndsvarden 1937 och 1938. Av E. Palmén. Pp. 92. No. 131: Hydrographische Beobachtungen an bord vom Finnischen Forschungsdampfer *Aranda* während der Internationalen Ostsee-Expedition im Juli und August 1939, 2: Strombeobachtungen. Von Ilmo Hela und Erkki Laurila. Pp. 14. No. 132: Über die wasserstandsschwankungen in Liinahamari (Petsamo). Von Eugenie Lisitzin. Pp. 20. No. 133: Wasserstandsregistrierungen in Hangö, 1904-1920. Von E. Palmén. Pp. 41. No. 134: Über die Schwankungen des wasserstandes in der Ostsee mit besonderer Berücksichtigung des wasserstandes durch die dänischen Gewässer. Von Ilmo Hela. Pp. 108. No. 135: Regular Observations of Temperature and Salinity in the Seas around Finland, July 1939-June 1940. By Gunnar Granquist. Pp. 37. No. 136: Vattenståndsvarden 1939 och 1940. Av E. Palmén. Pp. 80. (Helsinki: Havsforskningsinstituttet, 1940-1945.) [133]

Northern Rhodesia: Department of Agriculture. Annual Report for the Year 1944. Pp. 12. (Lusaka: Government Printer, 1945.) 1s. [143]

Zoologisk Museum in København gennem tre aarhundreder. Af Ragnar Sparck. Pp. 110. (København: Ejnar Munksgaard, 1945.) [143]

Dyr i Natur og Museum: Aarbog for Universitetets Zoologiske Museum 1944-45. Pp. 142. (København: Ejnar Munksgaard, 1945.) [143]

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Nuffield College. The Further Education of Men and Women: a Task of the 1944 Education Act. Pp. 72. (London: Oxford University Press, 1946.) 1s. net. [65]

Wilberforce House, Hull: its History and Collections. Pp. 20. (Hull: Mortimer Museum, 1946.) 4d. [85]

South-West Essex Technical College and School of Art. Annual Report, Session 1944-45. Pp. 32. (London: South-West Essex Technical College and School of Art, Walthamstow, 1946.) [85]

Ministry of Health: Department of Health for Scotland. Report of the Inter-Departmental Committee on Remuneration of General Practitioners. (Cmd. 6810.) Pp. 31. (London: H.M. Stationery Office, 1946.) 6d. net. [135]

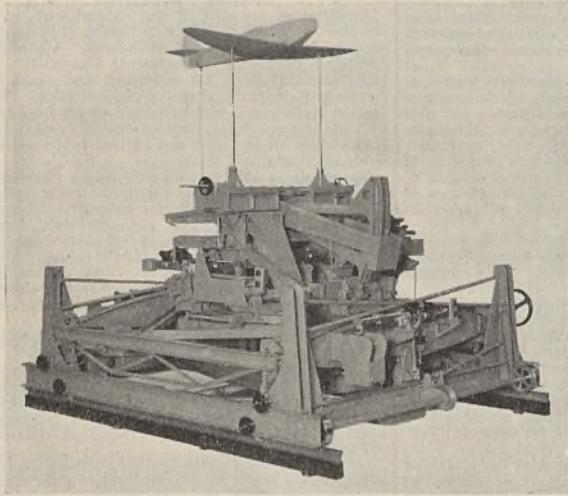
Current Affairs, No. 1: Food and Famine. By F. Le Gros Clark. Pp. 20. Current Affairs, No. 2: Treaty Making. By Harold Nicolson. Pp. 16. (London: Bureau of Current Affairs, 1946.) Fortnightly, 8s. 6d. per annum. [135]

Map Review, No. 1: From April 8th to April 17th, 1946. 40 in. x 30 in. No. 2: From April 18th to May 1st, 1946. 40 in. x 30 in. (London: Bureau of Current Affairs, 1946.) Fortnightly, 18s. 6d. per annum. [135]

Soil-less Cultivation of Carnations. Pp. 38. (London: British Carnation Society, 1946.) 2s. 6d. [135]

Weather. Vol. 1, No. 1, May. Pp. 32+4 plates. (London: Royal Meteorological Society, 1946.) Monthly, 1s. 6d.; 18s. per annum. [135]

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COMMONWEALTH OF AUSTRALIA**COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH**

APPOINTMENT No. 998 OF STAFF—PHYSICAL METALLURGY SECTION

Applications are invited for appointment to one of three positions (one of Principal Research Officer and two Senior Research Officer) on the staff of the Physical Metallurgy Section of the Council.

This Section is being built up in conjunction with the Research School of Metallurgy, of the University of Melbourne, under the direction of Prof. J. Neill Greenwood. The successful applicants will have their headquarters in the University laboratories.

- The immediate programme of the Section includes:
- The constitution and physical properties of alloys of the high melting point metals;
 - The nature of the crystal boundary in metals;
 - The constitution and physical properties of the alloys of lead; and
 - The nature of creep.

The three appointments envisaged are:

- An X-Ray Metallographer.
- A Metallurgist of high calibre.
- A Physicist to work in the field of the physical properties of metals—thermal expansion, specific heat, thermal and electrical conductivity, etc.—at high temperatures.

An applicant should have a University degree, with honours, or its equivalent, and have had considerable post-graduate research experience in the appropriate field of work.

Salary: Dependent on qualifications and experience the commencing salary will be determined within the range of either Principal Research Officer (£A796-£A940 p.a. actual); four equal increments, first automatic, remainder discretionary) or Senior Research Officer (£A665-£A790 p.a. actual); five equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present an additional £A40 p.a.). **Note:** Salary will commence from the date the successful applicants take up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination the successful applicants will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, referring to appointment No. 998, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by not more than four testimonials, should reach the undersigned not later than November 4, 1946.

(Sgd.) LEWIS LEWIS,

Australia House, Secretary,
Strand, Australian Scientific
London, W.C.2. Research Liaison.

BENARES HINDU UNIVERSITY

Applications are invited for the following posts:

- College of Mining and Metallurgy. (1) University Professor of Mining. Persons with Research Degree with first-class colliery Manager's certificate or extensive experience of metal mining required.

- College of Engineering. (2) University Professor of Mechanical Engineering. Grade—Rs. 1000-50-1500. Research Degree with experience of teaching Degree Classes and administrative experience essential.

- College of Technology. (3) University Professor in Silicate Technology. (Ceramics and Glass Technology.) Candidates with Research Degree and practical experience required. (4) Professor in Chemical Engineering. Candidates should possess Research Degree with qualifications in Mathematics.

Note. 1. The grades of salaries of the teaching posts are: University Professor—Rs. 700-50-1000/E.B./50/4-1200. Professor—Rs. 400-25-600/E.B./25-700. 2. Higher starting salary admissible. 3. Probation—one year. 4. Applications should reach the Pro-Vice-Chancellor, Benares Hindu University, Benares, India, on or before October 16, 1946.

PRO-VICE-CHANCELLOR.

COMMONWEALTH OF AUSTRALIA**COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
DIVISION OF FOREST PRODUCTS
APPOINTMENT (No. 999) OF OFFICER—TIMBER MECHANICS SECTION**

Applications are invited for appointment to a position of either Senior Research Officer or Research Officer—Division of Forest Products, Melbourne, Australia.

Duties: To take part in fundamental investigations in the Timber Mechanics Section, in connection with the mechanical properties of timber and plywood and their application in structures. Examples of such investigations at present in hand are: (a) Investigation of elastic and plastic properties of timber, and the effect of long continual loading of connector joints and columns; (b) investigation of the relationship between the structure and properties of timber and abnormal wood.

Qualifications: University degree, with honours, in engineering, or in science with either physics or mathematics as a major subject or equivalent qualifications.

Salary: Dependent on qualifications and experience, commencing salary will be determined within the range of Senior Research Officer (£A665-£A790 p.a. actual; five equal increments, first automatic, remainder discretionary), or Research Officer (Male: £A560-£A640 p.a. actual; Female: £A485-£A565 p.a. actual; four equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present: Male, additional £A40 p.a.; Female, £A27 p.a.). **Note:** Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination, the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications referring to appointment No. 999, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials, should reach the undersigned by October 26, 1946.

(Sgd.) LEWIS LEWIS,

Australia House, Secretary,
Strand, Australian Scientific
London, W.C.2. Research Liaison.

MYCOLOGIST FOR THE TEA RESEARCH INSTITUTE OF CEYLON

Applications are invited for the post of Mycologist at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon. Applicants should possess an honours degree in Botany and produce definite evidence of ability to carry out independent research. Preference will be given, other qualifications being equal, to a man with experience of fungus and virus diseases of plants.

Alternatively, arrangements might be made for a suitable man to obtain further training in the latter subject before proceeding to Ceylon. Salary in the scale £600-40-1,200 (payable in Ceylon at Rs. 15s. to the £) with free quarters and heavy furniture. A higher initial salary may be given to a man with special experience. A temporary Dearness Allowance (at present Rs. 200s. a month for a married officer or Rs. 125s. for a bachelor) will also be granted. The officer appointed will be required to contribute to the Ceylon Planters Provident Society at the rate of 10 per cent of salary to which the Board will contribute a similar amount. The appointment is non-pensionable. Home leave will normally be granted at the rate of eight months' leave for each four years and four months service in Ceylon. Travelling expenses in Ceylon will be payable at the rates allowed to officers of similar status in Ceylon Government Service. The appointment will be subject to confirmation after three years service in Ceylon.

Applications giving full details of previous training and experience and accompanied by copies of any published papers and the names of three persons to whom reference may be made, should be sent before October 14 to the Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4, from whom further particulars concerning the appointment may be obtained.

ROLAND V. NORRIS,

Director, Tea Research Institute of Ceylon.

Spare-time work available for skilled glass-blower with own facilities. Samples and material supplied. Apply by letter. Box 700, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

COMMONWEALTH OF AUSTRALIA**COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
SECTION OF TRIBOPHYSICS
APPOINTMENT (No. 982) OF PRINCIPAL RESEARCH OFFICER (PHYSICIST)**

Applications are invited for appointment to a position of Principal Research Officer (Physicist), Section of Tribophysics, Melbourne, Australia. **Location:** Chemistry Department, University of Melbourne. **Duties:** To undertake, and assist in direction of, research on the physics of solids. The Section is concerned with problems arising from the friction between solid surfaces and the effect of deformation on the bulk and surface properties of solids, particularly of metals.

Qualifications: High qualifications as a physicist, combined with considerable experience in the initiation and direction of physical research. **Salary:** Dependent on qualifications and experience, commencing salary will be determined within the range of Principal Research Officer (£A796-£A940 p.a. actual; five equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present an additional £A40 p.a.).

Note. Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination the appointee will be eligible to contribute to and receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, referring to appointment No. 982, and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials, should reach the undersigned not later than November 4, 1946.

LEWIS LEWIS,

Australia House, Secretary,
Strand, W.C.2. Australian Scientific Research
Liaison Office.

WOOLWICH POLYTECHNIC,

S.E. 18

The Governing Body invite applications for the following posts:—

(a) Senior Assistant in the Department of Physics. Candidates should possess such high academic qualifications and industrial experience as will enable them to teach up to Honours Degree standard and to undertake and supervise Research. The salary is £600-£25-£750 (plus London allowance and training allowance).

(b) Lecturers in (i) Mathematics, (ii) Physics, (iii) Chemistry, (iv) Chemistry with Biology, and (v) Mechanical Engineering. Candidates will be required to teach to Honours Degree standard in the particular subject. Salary is in accordance with the Scales of Salaries in Technical Colleges.

Full particulars of the posts and application forms may be obtained from the Clerk to the Governors, to whom they should be returned within two weeks from the date of this advertisement.

CHELSEA POLYTECHNIC,

LONDON, S.W.3

HEAD OF DEPARTMENT OF CHEMISTRY

The Governors invite applications for the post of Head of the Department of Chemistry which becomes vacant through the retirement of Dr. J. C. Crocker. Candidates must possess high qualifications in Chemistry and have had experience in both teaching and research.

Salary in accordance with Burnham Technical Teachers' Scale for Heads of Departments, Grade III, £900-£25-1,000, plus London allowance and possible additional allowance for training. Duties to commence January 1, 1947. Further particulars and form of application may be obtained by sending stamped addressed foolscap envelope to the undersigned, to whom applications must be returned not later than October 17, 1946.

F. J. HARLOW, M.B.E., Ph.D., B.Sc.,
Principal.

UNIVERSITY OF MANITOBA

WINNIPEG, CANADA

Applications are invited for the post of Lecturer in Chemistry, duties to commence January 1, 1947. Candidates should be Honours graduates and should have research experience. They should have specialized in organic chemistry. Salary \$2400. The equivalent of one month's salary will be paid in lieu of travelling expenses. Applications, accompanied by the names of three referees, should be sent by air mail, to the undersigned.

A. N. CAMPBELL,
Professor of Chemistry.

PORTSMOUTH MUNICIPAL COLLEGE

Principal—Leonard B. Benny, M.A., B.A.
DEPARTMENT OF CHEMISTRY AND BIOLOGY
Head of Department—Dr. C. G. Lyons, M.A., Ph.D.
Applications are invited for the post of Lecturer in Zoology; duties to include teaching of that subject to Final Degree standard.
Forms of application and particulars can be obtained from the Registrar.

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

UNIVERSITY OF LEEDS

Applications are invited for the post of Brotherton Research Lecturer in Physical Chemistry in the Department of Textile Industries. Apart from occasional advanced lectures to research workers, the successful candidate will be able to devote his time to research within the field of high polymers. Salary £600–£800 a year according to qualifications and experience. Further particulars may be obtained on request. Applications should reach the Registrar, The University, Leeds, 2, not later than October 21, 1946.

THE UNIVERSITY OF MANCHESTER

DEPARTMENT OF BACTERIOLOGY AND PREVENTIVE MEDICINE

Applications are invited for the post of Lecturer in Bacteriology. Candidates should possess a registrable medical qualification and should have had appropriate experience in Bacteriology. Duties to commence as soon as possible. Salary £750–£1,000 per annum according to qualifications and experience. Applications should be sent not later than November 9, 1946, to the Registrar, The University, Manchester, 13, from whom further particulars may be obtained.

CAMBRIDGE UNIVERSITY ENGINEERING DEPARTMENT

The Vice-Chancellor gives notice that the Appointments Committee of the Faculty of Engineering intend to appoint several University Lecturers and University Demonstrators in Engineering. The appointments will be subject to the Statutes and Ordinances of the University. Further particulars and forms of application may be obtained from the Secretary of the Appointments Committee, Engineering Laboratory, Cambridge, to whom applications should be sent so as to reach him by Monday, November 4, 1946.

UNIVERSITY OF ABERDEEN

LECTURESHIP IN THE DEPARTMENT OF PHYSIOLOGY

Applications are invited for a Lecturer in the Department of Physiology. Salary £600–£750, placing according to qualifications and experience. Applications should reach the Secretary to the University (from whom Forms of Application and Conditions of Appointment may be obtained) not later than October 11, 1946.

H. J. BUTCHART,
The University, Secretary,
Aberdeen.

CHELSEA POLYTECHNIC

MANRESA ROAD, S.W.3

A Course of 24 Lectures on Biochemistry will be given by G. A. D. Haslewood, Esq., D.Sc. (Reader in Biochemistry in the University of London).

These lectures are for students who have a knowledge of chemistry to degree standard and wish to obtain a knowledge of biochemistry. Further particulars and forms of enrolment may be obtained on application to the Secretary, Mondays, 7.15–8.30 p.m. commencing October 7. Fee for course, 30/-.

LONDON COUNTY COUNCIL

MENTAL HEALTH SERVICES

Applications are invited from registered medical practitioners for the appointment of Senior Biochemist at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School, Denmark Hill, S.E.5. The duties of the appointment are entirely research and teaching in biochemistry. Salary £1,050 rising to £1,250 a year, plus cost-of-living addition. Commencing salary according to experience. Application forms, returnable by October 14, 1946, from Medical Officer of Health (B), Mental Health Services, County Hall, Westminster Bridge, S.E.1 (2437).

QUEEN'S UNIVERSITY, BELFAST

DEPARTMENT OF MATHEMATICAL PHYSICS

A Temporary Assistant is required for the Department of Mathematical Physics. The salary offered is £300 to £400 per year according to the experience and qualifications of the successful candidate. Applications should be sent to Professor P. P. Ewald, Queen's University, Belfast.

UNIVERSITY COLLEGE, LONDON

Research Assistant required for the Phonetics Laboratory. Applicants should hold an honours degree in either Physics or Electrical Engineering, and should in addition possess an aptitude for, and considerable interest in, foreign languages. The successful applicant will be concerned mainly with experimental research work in Speech and Hearing, but will also be expected, after a period of training, to undertake some of the teaching work of the laboratory. Salary according to age and qualifications. Applications should be addressed to the Secretary, University College, Gower Street, London, W.C.1, and should be received by the College not later than October 31, 1946.

ESSEX EDUCATION COMMITTEE

MID-ESSEX TECHNICAL COLLEGE, MARKET ROAD, CHELMSFORD

SCIENCE DEPARTMENT

Applications are invited for the post of Laboratory Steward. Salary £3 10s. per week, rising by increments of 5s. to £4 15s. There is a cost-of-living bonus of 23s. per week in the case of a man.

The qualifications looked for include competence in Laboratory arts, including simple glass-blowing, ability to construct simple apparatus and to carry out running repairs and adjustments, experience in laboratory organization and the capacity to organize the work of juniors.

Further particulars and forms of application may be obtained from the Clerk to the Governors, Mid-Essex Technical College, Market Road, Chelmsford, on receipt of a stamped addressed envelope.

B. E. LAWRENCE,
Chief Education Officer.
County Offices,
Chelmsford.

GUY'S HOSPITAL MEDICAL SCHOOL

Applications are invited for the post of Demonstrator in Pharmacology, duties to commence in October 1946. Commencing salary £450 p.a. with superannuation. Applications with the names of two referees should be sent to the Dean, Guy's Hospital Medical School, London Bridge, S.E.1, not later than October 19, 1946.

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Research Biochemist required. Some experience in cholesterol metabolism desirable. Salary according to qualifications and experience. Applications to Secretary.

NORTHAMPTON POLYTECHNIC

ST. JOHN STREET, LONDON, E.C.1

Applications are invited for appointment to the Full-time Teaching Staff of the Applied Optics Department. Candidates should have qualifications in Natural Science or in Physics with an interest in Optics. Salary in accordance with the Burnham Scale for Technical Teachers in London, minimum £336 p.a., maximum £573 p.a., with additions according to qualifications and experience. Particulars and form of application from the Secretary.

UNIVERSITY OF LONDON

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL
Department of Anatomy—Applications for the post of Demonstrator are invited at an initial salary of £350–£450 according to experience. Successful candidate will be required to contribute to superannuation under the F.S.S.U. Applications (6 copies) should be lodged at the Dean's Office by October 7.

The Civil Service Commissioners

invite applications for appointment as head of a small unit for the development of specialized communications equipment near Farnborough, Hants., under the Ministry of Supply.

Candidates should be British subjects aged not less than 31 and preferably under 45 on August 1, 1946. They must have a First or Second Class Honours Degree in Physics, Mathematics or Electrical Engineering and wide experience in high-grade audio-frequency development, including speech secrecy. Experience of teleprinter equipment will be an additional qualification.

The appointment is permanent with Superannuation benefits under the Federated Superannuation System for Universities and is graded as Principal Scientific Officer on the provincial scale of £750 × £30–£1,020, plus consolidation addition ranging from £90 to £105.

Forms of application are obtainable from the Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1639, to whom completed applications must be returned not later than October 30, 1946.

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An important British firm in a Branch of the Chemical Industry is considering the appointment of a Managing Director who would be responsible for the administrative control and further development of several manufacturing and selling units in the United Kingdom and overseas.

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A man of exceptional qualifications is required, and a salary corresponding to this standard will be paid. Applications, stating age and experience, should only be made by those who have already filled a position where important responsibilities have been successfully carried. The age required is about 40. Write Box 8038, Frost-Smith Adv., 64, Finsbury Pavement, London, E.C.2.

The British Drug Houses, Limited,

has vacancies for the following: (a) Chief Analyst at its factory in London, responsible for maintaining standards of the Company's pharmaceutical and chemical products; (b) Chief Analyst at its new factory in Poole, Dorset, responsible for maintaining standards of laboratory and "AnalaR" chemicals. In both posts knowledge of modern physical and microchemical methods is essential, and successful candidates will be responsible for analytical research in their respective fields.

Applications are invited from persons of good academic or industrial standing in Analytical Chemistry of age about 35–45; commencing salary will be according to qualifications, with superannuation and good prospects. Applications should be addressed to: The Production Manager, The British Drug Houses, Limited, Graham Street, City Road, London, N.1.

A graduate chemist is required for

research in the synthetic and varnish department of the laboratory of a well-known N.W. London firm manufacturing aircraft and industrial finishes. Previous experience with a specialized knowledge of synthetic resins and varnishes and the formulation of finishes therefrom will be regarded as an essential qualification for the post, which will offer scope for the right type of worker. The salary envisaged is about £500 p.a., but will depend to some extent on age, qualifications and experience. Applications, giving all relevant details, should be forwarded to the Chief Chemist, Box 699, T. G. Scott & Son, Ltd., 9 Arundel St., London, W.C.2.

Required by October 1, 1946, a

Demonstrator in Biochemistry, Department of Physiology, Royal Veterinary College, Camden Town, London, N.W.1. Applicants should possess an Honours Degree (or equivalent) in Chemistry. A practical knowledge of one biological subject is desirable but not essential. The appointment will be in the first place for one year, renewable yearly for a maximum of three years subject to satisfactory service. Commencing salary will be £300. Applications should reach the Bursar, Royal Veterinary College, by October 1.

Organic Research Chemist required

for research work on chemotherapy by Company in Home Counties manufacturing Fine Chemicals and Synthetic Medicinal Specialities. Candidate should have M.Sc. or Ph.D. or F.R.I.C. qualifications and preferably, but not necessarily, a few years' industrial experience. Good progressive salary offered. Box 698, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Physical Chemist or Physicist required

for Research Department at Works situated in Derbyshire. High Honours degree, with a good knowledge, and, preferably, experience of X-Ray Crystallography desirable. Recent graduate would be suitable. Salary £450–£700, dependent upon age, qualifications and experience. Box 702, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Physicist required for development

work on problems connected with the filtration of liquids and gases. Scope for candidate with original ideas, mechanical ability and keenness. Modern laboratory in ideal surroundings. Minimum commencing salary £275. Apply, giving particulars of qualifications, experience and present salary, to the Secretary, British Filters, Ltd., Old Court, Cox Green, Maidenhead, Berks.

Assistant Chemist required for general

research work. Some experience desirable but not essential. Inclusive salary will be £333 p.a. or more according to qualifications. Applications should be sent as soon as possible to the Director, Experimental and Research Station, Cheshunt, Herts.

(Continued on page cxii)

(Continued from page cxi)

Instrument Maker/Service Engineer required by small department of large Company in South-West London area. Young man preferred with some knowledge of electrical or electronic instruments. Previous experience in chemical plant instrumentation an advantage. Apply, stating age, experience and present wage to Box 703, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist required to undertake development work into the manufacture and application of tungsten carbide products. University degree preferred and experience in this field essential. Northampton or Swindon districts. Write, stating age, experience, qualifications and salary required, to Box 704, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

A. Boake Roberts & Co., Ltd., of Carpenter's Road, Stratford, E.15, have a vacancy in their Essence Department for an experienced chemist aged 25 to 35. Applicants are asked to write in the first instance to the Personnel Manager giving full details of their qualifications.

Process Chemist, with analytical experience and degree or equivalent in Chemistry, required to supervise pilot plant production and carry out development work in connection with electronic components. Northampton or Swindon districts. Write, stating age, experience, qualifications and salary required, to Box 705, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chemist required for development work on new type of cellulose acetate film for acoustic applications. Degree or equivalent in chemistry essential, plus experience of band casting machines. Northampton or Swindon districts. Write, stating age, experience, qualifications and salary required, to Box 706, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory technician required by petroleum research laboratory in Wirral area. Light machine shop experience an advantage, some glass-blowing preferable. Duties will include store-keeping. Give details, salary required, etc., to Box 701, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Factory situated in East London has a vacancy for Production Chemist. Progressive and interesting job dealing with all aspects of Plant Control required in the manufacture of chemicals. Qualifications: B.Sc. or A.R.I.C. This vacancy would be suitable for University Graduate willing to undertake shift work. Experience desirable but not essential. Applicants should state salary required. Box 708, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistant Metallurgist required for development work on the manufacture of electric cables. Age 20-25; B.Sc. with some industrial or research experience. Knowledge of Lead an advantage. Salary £300-£400 per annum. Apply Staff Officer, B.I.C.C., Belvedere, Kent. Reference: S.R.6.

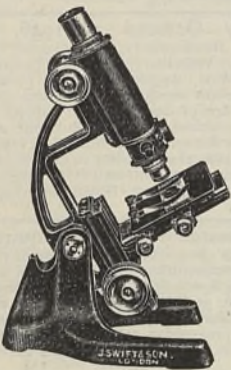
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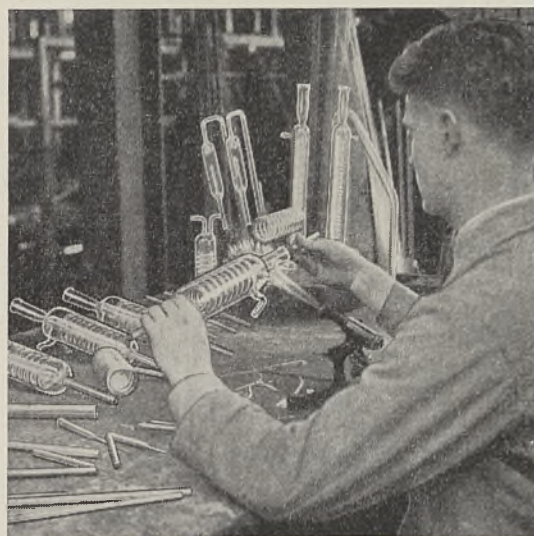
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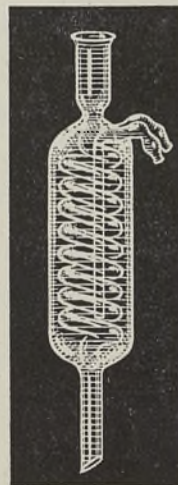
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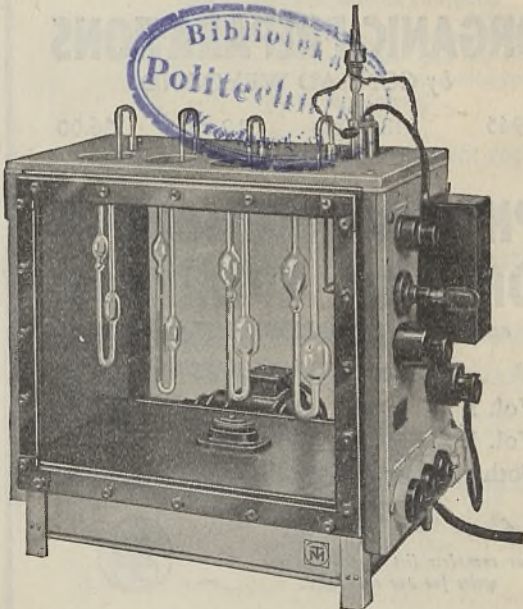
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