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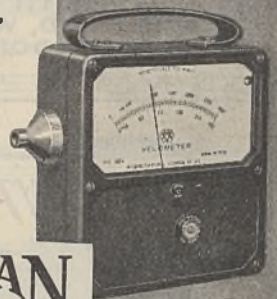
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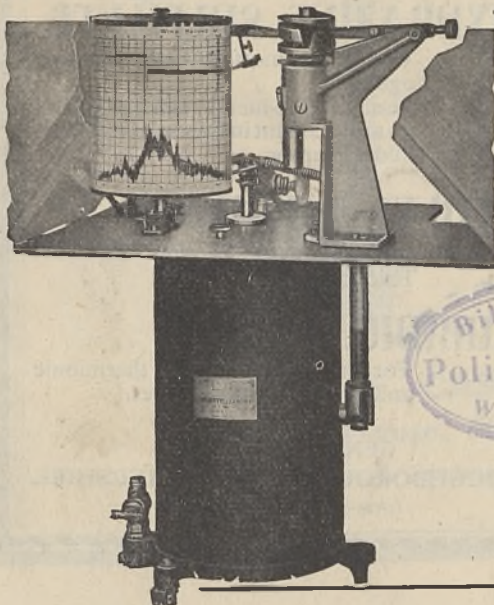


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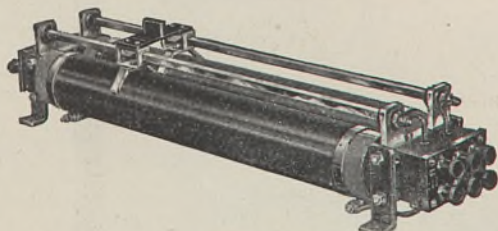
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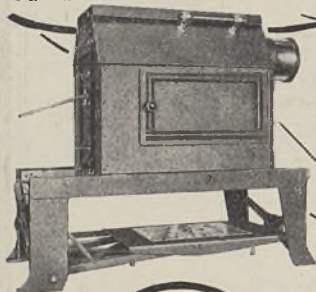
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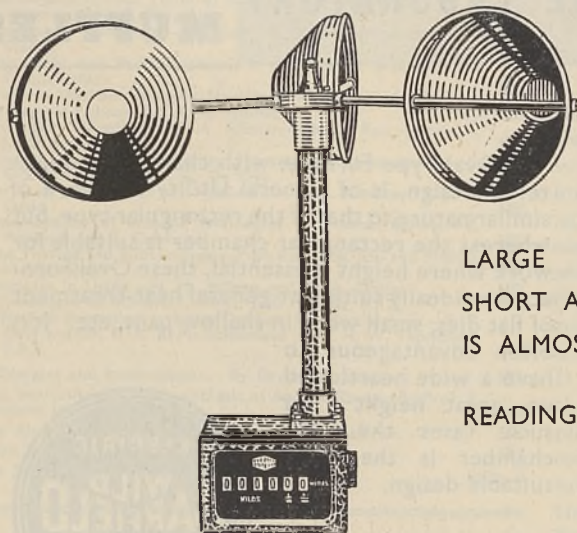
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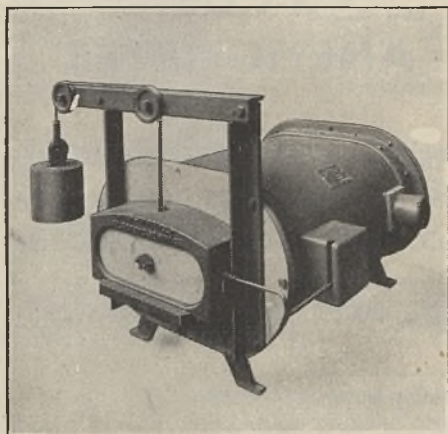
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# NATURE

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## FREEDOM IN SCIENCE

ON p. 574 of this issue we publish an article by Dr. John R. Baker and Prof. A. G. Tansley on "The Course of the Controversy on Freedom in Science", based mainly on the history and development of the Society for Freedom in Science; on p. 590 appears Prof. J. D. Bernal's communication criticizing the two editorial articles on "Conditions of Survival" recently published in *Nature*. Though the article and the letter were submitted to the Editors independently, they raise similar issues, though from different points of view, so it was considered desirable that both should be published simultaneously, not with the view of raising an argument, but rather in the hope of clearing up certain misunderstandings.

Baker and Tansley in their article clearly support the conception of freedom in scientific research and exposition, citing science in Soviet Russia as an example of science in chains. Bernal, on the other hand, implies that Communism supports freedom of investigation. It is quite obvious that taken on their face value both contentions cannot be correct; but no useful purpose is being served, we think, by entering the lists of argument before all doubts and misunderstandings are cleared away. It was in this spirit that the Society for Freedom in Science was offered space in *Nature* to state its aims and objectives. While not necessarily agreeing entirely with all the points of view put forward on behalf of the Society, it seems desirable that its aims should be set forth before the world of science, for there is undoubtedly sound *raison d'être* for the Society at the present time, and its main objectives are worth striving for. We would suggest, however, that the Society be wary of attacking a selected target before making quite sure that it deserves attack. For example, though it is clear that the attitude of the powers in Soviet Russia towards science does not conform to the views held and expressed by the Society for Freedom in Science, it is not so certain that the U.S.S.R. initiated "a movement against pure science and against freedom in science". It would be absurd to claim that there is in the U.S.S.R. that freedom in scientific research and in the expression of opinion of things scientific which is still enjoyed in countries such as Britain and the United States; science in the U.S.S.R. is subject to the State and its policy. It seems to us to be unfair to state categorically, therefore, that the Soviet authorities are deliberately planning an attack on pure science and freedom in science. Things are not so tangible as that, and we have much to learn of each other's points of view. Until then, there should be toleration and real attempts to find out the facts and avoid jumping to conclusions.

For example, *Nature* has repeatedly pleaded for conscious planning of scientific research. This does not mean that the individual research worker must essentially be absorbed into a planned team. Neither does it necessarily involve surrendering one's freedom of choice in scientific research. By planning according to what problems reveal themselves and the capabilities and attitude of the personnel available, we

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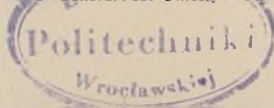
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believe that the best ground and background can be provided for the man of science—individually or in a team—so that he can give of his best. The policy of *laissez-faire* must disappear as the man of science and the layman become more and more aware of science and the impact of science on society. This, we feel sure, is where the pioneers of the Society for Freedom in Science have betrayed the misunderstanding of the points of view of certain other scientific institutions, including *Nature*; for though we claim that the impact of science on society is now achieving such importance as to command constant study which is bound to result in conscious planning, we are equally as convinced that it is the man of science who must be allowed to do the planning in consultation with others. In this way his freedom need not be impaired. We suspect the Society is opposed to political influences being brought to bear in the scientific field—an opposition which receives our support. Provided we are sure of this, then we believe that the five propositions set out as indicating the principles of the Society are of cardinal importance and worthy of full support.

The Society for Freedom in Science is certainly right in insisting that human welfare does not mean only material welfare, and above all the claim that the understanding of Nature is in itself good, apart altogether from the use of that understanding in practical affairs. The Society will do good work by pressing this point of view, for the pursuit of science for its own sake is as important a cultural discipline as the arts and the humanities, and it is therefore of inestimable value in education. Also by pursuing this policy the Society can do much to prevent scientific research becoming degraded to nothing but a search for material developments; for if that happens, fundamental science might well receive a mortal blow and freedom in scientific research disappear entirely from our culture.

The main objectives of the Society for Freedom in Science will best be achieved by constructive proposition. We would not deny the right to criticize opposing views provided it has been made certain that such opposition is real and not merely apparent. Furthermore, as in the case of Bernal's interpretation of the two editorial articles in *Nature*, it is desirable to recognize that there may be other points of view which are not necessarily wrong or, worse still, mischievous. We feel, for example, that Baker and Tansley's charges against the Association of Scientific Workers, the British Association for the Advancement of Science, and the scientific Press for supporting and even taking part in the "new propaganda" are too dogmatic. Their charges imply deliberate action. We do not think such charges are supported either by present-day facts or past history. That there is a threat to freedom in science we would not deny; but we do not consider it is a mutation which appeared in the form of propaganda suddenly in 1931. Civilization is now going through very severe changes, many of them initiated by science itself, and with these changes science, and all that it implies, must move. Never before, therefore, has there been such a need for the Society, provided it

chooses its objectives in the light of up-to-date observations and experiences. Failing this, the Society will succeed only in setting up factions, each of which would in no circumstances see good in the other. But with such principles as the Society is propounding, we think it will successfully go along the right lines. Already two of its officers discern what they claim to be a change of front in those whom they originally suspected of being propagandists against pure science and against freedom in science. It may be that they are right and that such a change of front has occurred; perhaps it is being realized that totalitarianism in science does not work. On the other hand, it is quite conceivable that at any rate the British Association and the Society for Freedom in Science do not differ so much in ideals as in methods of approach. It is clear that the British Association, which stands for the advancement of science, would benefit by collaboration with the Society for Freedom in Science, since in a democratic country it cannot be accepted that advancement is possible in the absence of freedom.

Prof. Bernal's communication reveals keen support for the Soviet political views and attitudes towards science; we are not prepared to discuss these points of view. Readers of *Nature* must be left free to come to their own conclusions. We do not consider it necessary to change or modify the views as set out in the two editorials to which he refers. We feel, however, that supporters of Soviet political and scientific policy should realize that to accuse anyone who attempts to criticize that policy of being a victim of the late Dr. Goebbel's propaganda is now surely outmoded. We do not consider any political doctrine above criticism, and therefore in so far as political doctrines when put into practice frequently affect science, education and research, we must reserve the right to raise our voices. This applies not only to communism but also to democracy. It is quite clear, for example, that the Society for Freedom in Science and *Nature* have not seen eye to eye in the past, but it is equally as clear that since the aims and objectives of both are so similar, in due course misunderstandings can be cleared up.

We agree with Bernal, on the other hand, that "respect for human personality, freedom of worship, freedom of investigation" are far from being an exclusive mark of Christian ethics". So also have we on several occasions expressed similar views to his own that "the cultures of Islam, India and China have contributed their share to the common heritage"; but we are sure that most men of science would support us in the view that science must beware of the incursion of national and party politics into its field. For example, is it really true that "the Soviet Union has assisted and upheld . . . freedom of investigation"; when we think of such as the 'genetics controversy' we feel rather doubtful. When science is utilized to support any political doctrine, then it is not above suspicion of veering from its main (and only true) objective—the search for and exposition of the truth. By jealously guarding its right to freedom in expression of opinion, science makes its strongest and most worthy contribution to

that new international unity which Bernal clearly hopes will be eventually attained. Though this does not imply freedom to defy the laws of one's own country, it does imply freedom to criticize any political doctrine when it is having a tangible effect on science itself (in this respect the Society for Freedom in Science will prove most valuable). We have, therefore, on several occasions criticized certain communist attitudes; there is no question of "ill-considered intrusions into political topics", for it is useless to close one's eyes to the fact that political creeds do affect science and scientific workers, and when we think the effect is a bad one then we reserve the right to say so. Is the only way to prove one's respect for Soviet Russia to refrain entirely from criticism and become communist oneself? No true man of science can deny another the right to a conflicting opinion, but he should denounce those who persist, as Mr. Bernard Baruch recently put it, "in errors as to facts". We are glad that the Scientific Committee to the Atomic Energy Commission has declared that control of atomic energy is possible, though we note that Prof. Bernal does not consider the refusal of the U.S.S.R. to surrender a part of her national sovereignty such an important issue as "the refusal of the United States to accept prohibition of the atomic bomb, and its insistence on attaching to the Lilienthal report the political condition of the abolition of the veto". On October 8, when Mr. Baruch was presented with the annual plaque of Freedom House for his work as United States member of the United Nations Atomic Commission, he referred to the Russian view that international inspection of atomic research would violate national sovereignty, saying: "better that than international disaster. America is willing to accept inspection, and for some time America would be the most inspected". This statement is worth pondering. We consider Mr. Baruch is right, and the Russian point of view wrong, and surely in saying so we are not putting a stumbling block on that trail to international unity which all clear-thinking men and women wish to see blazed.

We cannot agree with Prof. Bernal that inherent in Anglo-American culture there is a "holier than thou" attitude: if there were, it would indeed be a dangerous weakness. Neither does it seem necessary to warn scientific workers in Great Britain against accepting such a flattering ascription to themselves of the monopoly of moral values. But this surely does not imply, therefore, that they become divested of any right to think, and say what they think, of other cultures, political creeds, other hypotheses and other points of view. We think it is Bernal who is allowing politics to intrude upon his scientific views, and this is the type of attitude which we feel must be checked. This can be done best by ensuring that freedom in scientific research which the Society for Freedom in Science stands for, bearing in mind at the same time the duties that scientific workers owe to their fellow men. Men of science can do best by not allowing their political views to colour their scientific work and attitudes, and in refusing to allow political forces to dictate or in any way influence their work.

## BABBAGE'S DREAM COMES TRUE

### A Manual of Operation for the Automatic Sequence Controlled Calculator

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 1.) Pp. xiii+561+17 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 10 dollars.

THE black mark earned by the government of the day more than a hundred years ago for its failure to see Charles Babbage's difference engine brought to a successful conclusion has still to be wiped out. It is not too much to say that it cost Britain the leading place in the art of mechanical computing. Babbage then conceived and worked on his 'analytical engine', designed to store numbers and operate on them according to a sequence of processes conveyed to the machine by cards similar to those used in the Jacquard loom. This, however, was never completed.

The machine now described, "The Automatic Sequence Controlled Calculator", is a realisation of Babbage's project in principle, although its physical form has the benefit of twentieth century engineering and mass-production methods. Prof. Howard H. Aiken (also Commander, U.S.N.R.) of Harvard University inspired the International Business Machines Corporation (I.B.M.) to collaborate with him in constructing a new machine, largely composed of standard Hollerith counters, but with a superimposed and specially designed tape sequence control for directing the operations of the machine. The foremost I.B.M. engineers were assigned to the task; many of their new inventions are incorporated as basic units. When the machine was completed, Thomas J. Watson, on behalf of the Corporation, presented it to Harvard University—yet another token of the interest I.B.M. has shown in science. Would that this example were followed by their opposite numbers in Great Britain! One notes with astonishment, however, the significant omission of "I.B.M." in the title and in Prof. Aiken's preface, although President Conant's foreword carefully refers always to the "I.B.M. Automatic Sequence Controlled Calculator".

The machine contains seventy-two storage counters, each capable of holding twenty-three digits and a sign. For smaller numbers each counter can be split into two, while for larger numbers they can be teamed up. There are also sixty switch-set 24-figure registers, for holding constants; these likewise can be split. There are several special units, two being for multiplying and dividing; these first form nine multiples of the multiplicand or divisor. In multiplication the multiples directed by the multiplier are chosen and added step by step. In division the dividend or remainder is compared with the multiples in succession; that which is just less than the dividend is subtracted, and the appropriate figure of the quotient recorded. When working to the full 23-figure capacity of the machine, multiplication takes about six seconds, and division twice as long; additions and subtractions are done at the rate of three a second, whatever their length.

Three special units (which share many of the machine components) are for calculating logarithms, antilogarithms (or exponentials) and sines (or cosines). The process of calculating a 21-figure logarithm is a combination of the factor method and of the series log  $(1 + x) = M(x - x^2/2 + x^3/3 - x^4/4 \dots)$ . The

machine first finds four factors, one each from the groups 2 . . . 9, 1.1 . . . 1.9, 1.01 . . . 1.09 and 1.001 . . . 1.009, the logarithms of which are specially stored. In the fifth factor  $x$  is less than  $10^{-3}$ , so that six terms of the above series suffice, in the form

$$\left(\left(\left(\left(-\frac{M}{6}x + \frac{M}{5}\right)x - \frac{M}{4}\right)x + \frac{M}{3}\right)x - \frac{M}{2}\right)x + M)x.$$

To find a number from its logarithm, if  $a$ ,  $b$ ,  $c$  are the first three digits of the mantissa, and  $d$  the remaining digits, we have a power of 10 (depending on the characteristic) multiplied by

$$10^{.1a} \cdot 10^{.01b} \cdot 10^{.001c} \cdot 10^d$$

The first three of these factors are obtained from a store in the machine for the 27 values corresponding to  $a$ ,  $b$  or  $c = 1 \dots 9$ . The last is computed from

$$1 + D + \frac{D^2}{2!} + \frac{D^3}{3!} + \frac{D^4}{4!} + \dots \text{ where } D = d/M.$$

This unit is known as the exponential unit.

The sine unit first ascertains in which octant  $x$  (which must be in radians) lies. This determines the sign of the function, and instructs the machine whether to use the series for  $\sin x$  or  $\cos x$  for  $x$  less than  $\frac{1}{4}\pi$ . In the worst possible case, 11 terms suffice to give 23 decimals.

It will be seen that these three units give access to all logarithmic, exponential, circular and hyperbolic functions without tables, although other functions can be entered via tapes or cards. Each logarithm, antilogarithm (or exponential) or sine, if to the full capacity of the machine, takes about a minute, which is comparable with the time required by a good computer to look up and interpolate a linear table with ten decimals only.

The brains of the machine lie in the control tape, which is code-punched in three sections. The first instructs the machine where to find its data; the second gives the destination of the data or answer; the third dictates the process. Very often these tapes, being simply a sequence of processes and independent of the actual figures used, as in the evaluation of integrals by quadrature, can be stored in a tape library, and used over and over again.

A problem that has been solved is that of conveying computed results to many users. Tables produced by the machine can be typed by an electromatic typewriter, with vertical and horizontal spaces as required. Reproduction by photolithography eliminates many fruitful sources of error and much drudgery, transcription, composition and proof-reading. Volume 2 of this series is such a table of Hankel functions of order one third, and other tables are in the press.

Prof. Aiken estimates that the calculator is nearly a hundred times as fast as a well-equipped manual computer; running twenty-four hours a day, as it does, it may do six months' work in a day. Perhaps his examples, chosen for their simplicity, do not do the machine justice, because they could be done almost as quickly, and certainly more economically, with a Brunsviga and a National.

The question naturally arises: Does the calculator open up new fields in numerical and mathematical analysis—especially in such pressing problems as the solution of ordinary and partial differential equations, and the solution of large numbers of simultaneous linear equations? It is disappointing

to have to record that the only output of the machine of which we are informed consists of tables of Bessel functions, which are not difficult (to the number of figures required in real life) by existing methods and equipment. If the machine is to justify its existence, it must be used to explore fields in which the numerical labour has so far been prohibitive.

A useful 65-page bibliography of numerical analysis will be welcomed by all interested in computation.

L. J. COMRIE

## SOCIAL PÆDIATRICS

Child and Adolescent Life in Health and Disease  
A Study in Social Pædiatrics. By Dr. W. S. Craig.  
Pp. xvi+667. (Edinburgh: E. and S. Livingstone,  
Ltd., 1946.) 25s. net.

IN writing this book Dr. Craig has broken new ground and made available, for the first time, a history of social pædiatrics. The scope of the work is formidable, and the enthusiasm and industry which he has brought to his task impressive. Everyone concerned with the care of children, whether expert pædiatrician or general practitioner, health visitor or social worker, will be grateful for the wealth of information which has now been placed at their disposal, and it seems reasonable to predict that this work will remain a standard book of reference for many years.

In the first part of the book there is given a lucid and unemotional account of the philanthropic and State-aided services for infants and children in Britain from the earliest times "when vice and lust predominated to such an extent that little compassion prevailed for the child". The needs of the poor in those far-off days were dealt with by the monastic orders. Later, with the dissolution of the monasteries, these responsibilities were taken over by the 'hospitals' and charity schools. In 1601, the Act for the Relief of the Poor was passed by Parliament, and thus we have the first attempt to secure a systematic form of relief. In 1740, workhouses, orphanages and the founding hospitals came into being. Then followed the industrial era with its terrible conditions of child labour; but all the while, the record shows steady progress being made through voluntary effort and by Act of Parliament. Such institutions as the Ragged School Movement (1780), later to be known as the Shaftesbury Society, Dr. Barnardo's Homes (1870) and the Invalid Children's Aid Association (1888) were established, and these still contribute to the welfare of poor children. The voluntary hospitals and the development of pædiatrics as a branch of general medicine, the child welfare centres and the education authority with its medical services all receive their due share of the credit for the steady improvement brought about.

Dr. Craig then goes on to describe, in detail, the present services for the healthy and handicapped child as they exist to-day, not forgetting to mention the problems of total war. He rightly complains of the overlapping and lack of co-ordination of the existing measures, and in these days when the shadow of a State service looms large there is an urgent need for some plan to prevent wastage. But is this all to be controlled by the State? It would be well to look back over the years and remember the magnificent work done by voluntary effort. In the field of pædiatrics, either medical or social, there is a great



need for the 'human touch', and to organise too rigidly on purely clinic and institutional lines would be unfortunate. One problem which, to the reviewer, does not seem to have been given the attention it deserves is that of housing. If one regards the family in the home as the unit—and surely this is right—provision of adequate housing and labour-saving devices for the housewife should rank in the forefront of any scheme to improve the lot of the less fortunate children. The net reproduction-rate is below unity in Great Britain, and the population is being maintained by the greater expectation of life now existing. Whatever aspect of social pædiatrics one discusses, from the birth-rate to juvenile delinquency, adequate housing of the poorer classes is a fundamental problem. Dr. Craig rightly states that "ultimately public opinion will determine the standards of provisions to be made for the care of child life and health". There is evidence now that the public regard adequate housing as one of the essential provisions.

This is a stimulating book, and in every chapter problems are raised which, when the time of planning gives way to the time of action, will require to be solved. "It is only from the past that one can judge the future", and here we have the past arrayed before us for our study, and it is to be hoped that good use of it will be made by the planners.

The book shows no evidence of war-time austerity. It is printed on excellent paper and is profusely illustrated, a credit to the author and to the publishers.

STANLEY GRAHAM

## SOFT FRUITS

**The Cultivation of Berried Fruits in Great Britain History, Varieties, Culture and Diseases.** By Chas. H. Oldham. (Agricultural and Horticultural Handbooks.) Pp. 374+8 plates. (London: Crosby Lockwood and Son, Ltd., 1946.) 21s. net.

JUDGED on the basis of commercial acreage, the cultivation of small fruits in Great Britain is not great in comparison with other classes of crops. In 1939 the total area devoted to berried fruits in England and Wales was 47,000 acres, and the restrictions of war-time reduced this to 33,000 acres in 1944. This is very small compared with the 250,000 acres of so-called 'top' fruits, apples, pears, plums and cherries. Nevertheless, the high economic returns per acre of the soft fruits and their value in the diet make their cultivation an important item in the horticultural production policy of Great Britain. In spite of their relatively short season, strawberries remain the most popular of the small fruits and account for nearly half of the total acreage. Dietetic research during the last ten years has shown that the blackcurrant is by far the richest source of vitamin C of all cultivated crops, and it is probable that we may look to a considerable increase in its production in the future.

Financial returns with soft fruits, however, vary enormously with differences in cultivation, choice of varieties and, above all, incidence of pests and diseases. Strawberries, to take the extreme example, may give crops of as much as five or even six tons per acre, but the average yield over a series of years for the whole of Britain is less than a ton, due largely to the prevalence of virus diseases in commercial stock.

It is clear, therefore, that an authoritative book

on the cultivation of these kinds of fruits is of the greatest value to the grower in advising him of the best methods of production and the pitfalls to avoid. Mr. Oldham, in his position as a horticultural inspector of the Ministry of Agriculture, speaks with this requisite authority from his years of experience among growers, and he has prepared a volume containing a great deal of invaluable information on the history and commercial production of our principal small fruits.

It is clear that the book was mainly written before the War; the statistical and economic data refer only to 1939 and earlier, and are therefore in many cases of little present value even without the occasional errors as, for example, on p. 206 where the acreage of gooseberries in the Tamar Valley and the Exeter area is stated to be about four hundred acres, though on p. 202 the total area of this crop in Devon is given as 185 acres.

Here and there also are other more serious errors which it is hoped will be corrected in a future edition. For example, in the account of the breeding work on the cultivated species of *Rubus* at the John Innes Horticultural Institution, there is confusion over the origin of the varieties 'John Innes' and 'Merton Thornless'. The former, a tetraploid variety, was raised by crossing the thornless diploid, *R. rusticanus inermis*, with the thorny, tetraploid, *R. thyrsiger* (incorrectly spelt throughout as "*R. thyrsiger*"), an unreduced egg-cell of the former combining with the normal haploid sperm-cell of the latter. The new variety was as thorny as the male parent, but some seedlings in the  $F_2$  generation were thornless, and one of these was the valuable tetraploid, "Merton Thornless", to which no reference is made in the book.

It is also to be hoped that a second edition will receive more careful editing. Sub-headings, always difficult in a book of this type, are very confused, most particularly in Chapter 38; the numbering of tables seems without rhyme or reason, some receiving a number, others, of precisely the same type, remaining unnumbered. Incidentally, the strange practice is followed of printing the number in words.

In the section on raspberries, Chapters 24 and 26 are confused in their substance and need to be combined into a single chapter.

In the classifications of varieties in each kind of fruit the value would be greatly enhanced by giving one classification only and confining it to the varieties in cultivation at the present time. In gooseberries, for example, two lengthy classifications are given, one quoted verbatim from Hogg and containing long lists of varieties now entirely lost.

The treatment of pests and diseases is usually adequate, though Latin names are often misspelt; but in the section on strawberries, in general the most valuable and authoritative part of the book, more attention might be given to the all-important virus diseases and especially to the great work of East Malling Research Station in raising and distributing virus-free clonal stocks. Following on this, the omission of reference to the present-day system of official certification of stocks is a serious gap.

The black-and-white illustrations, to the author of whom no acknowledgment is made, are delightful, and it is a pity that half-way through they give place to photographs, some of which are of little value.

Two other matters calling for attention in a second edition are the symptoms of mineral deficiencies and the causes and avoidance of frost damage.

R. H. STOUGHTON

### "999—Emergency!"

By Arthur W. Spencer-Bragg. (Social Science Series, No. 4.) Pp. 64. (London: Social Science Association, 1946.) 2s. 6d.

THIS fourth pamphlet in the Social Science Series is a great advance in style, printing and content over the third pamphlet ("Post-mortem on Fascism", by Morris Richards), and in spite of a tendency to quote excessively from journalism, and himself to display some of its poorer characteristics, Mr. Spencer-Bragg has produced a more readable pamphlet than his title might suggest. He presents fairly enough some of the dangers of an uneducated or partly educated democracy in the world to-day, and his examination of the different conceptions of democracy which divide the world to-day and of the question whether a single world system in which economic democracy and political democracy co-exist is possible is reasonable. He sees such a system as the only condition upon which civilization can survive, and he appears to rest his hopes on a comparatively small number of scientifically minded persons being able to obtain mass support and approval, if not full understanding, of their outlook and policy. But while Mr. Spencer-Bragg emphasizes the need for scientific understanding of human society and for the scientific study of such problems, he shows himself strangely insensitive to values, and above all to the need for a moral and spiritual basis for world order. The materialistic outlook is rather too prominent for the author's diagnosis to be entirely convincing, and one's distrust is increased by his partiality for ideology which, somewhat prematurely as it seems to one reader, he exalts to the level of a science.

R. B.

### Rationalism in Education and Life

Papers read at the First Annual Conference of the Rationalist Press Association, held at Wadham College, Oxford, August 1945. Pp. v+149. (London: Watts and Co., Ltd., 1946.) 5s. net.

THE book under notice contains a full report of the papers read at the first annual conference of the Rationalist Press Association, held at Wadham College, Oxford, during August 1945, under the presidency of Sir John Hammerton. Besides dealing with more general problems, the programme was designed to elicit discussion of the rationalist policy for religious education in schools. It is to be noted that during the war years this subject was not neglected in the columns of *Nature*: witness, for example, a review of January 23, 1943, of Mr. A. G. Whyte's pamphlet maintaining that the omission from religious instruction of all non-Christian faiths would be hard to justify in those times. Again, in an editorial in *Nature* of November 14, 1942, it was pointed out that on the question of religious education men of science differ as much as other intelligent people, for, as Pascal said long ago, "the heart has its reasons, of which reason itself knows nothing".

The present volume gives a comprehensive survey of the problem of rationalism in education, of the theoretical basis of rationalism, and of rationalist philosophy. A movement associated with such names as those of Gilbert Murray, John Dewey, R. A. Gregory, Albert Einstein, Julian Huxley, to mention only a few, has a valuable part to play in purging contemporary thought and practice of the taint of superstition.

### Four Dialogues of Plato, including the 'Apology of Socrates'

Translations and Notes by John Stuart Mill. Edited, with an Introductory Essay, by Ruth Borchardt. Pp. vi+194. (London: Watts and Co., Ltd., 1946.) 10s. 6d. net.

DR. RUTH BORCHARDT has performed a valuable service in rescuing from oblivion—as she puts it—these translations by John Stuart Mill of four Platonic dialogues, namely, the "Protagoras", the "Phaedrus", "The Georgias", and the "Apology of Socrates". They appeared originally in the *Monthly Repository* of 1834–35, and have been almost neglected ever since. In addition, we are given a reprint of the essay "On Genius", written over the signature "Antiquus", in which 'J. S. M.' probed the depths of knowledge, as he saw it, with unrivalled skill of phrase.

The present brief notice firmly resists the temptation (and presumption) to review Mill: enough, therefore, to say of this essay that perhaps its chief claim to distinction lies in the high place accorded to conceptive genius. Dr. Borchardt herself contributes a pleasing introduction entitled "John Stuart Mill and the Ancients". From it, students may catch a glimpse of that great nineteenth century mind, weighed down by contemporary problems, nevertheless sustained and fortified by the remote past; continuity and tradition each playing its part in a true education.

All very excellent; yet why must the editor disfigure her book by a choice of word in the dedication so utterly inappropriate and graceless?

F. IAN G. RAWLINS

### Preliminary Check List of the Flowering Plants and Ferns of Griqualand West (Southern Africa)

By M. Wilman. Pp. vii+382. (Cambridge: Deighton Bell and Co., Ltd.; Kimberley: Alexander McGregor Memorial Museum, 1946.) 45s. net.

IT appears from the preface that "this volume is a substitute, but only a temporary one we hope, for the more ambitious work . . . in course of preparation at the outbreak of war". The author was apparently impressed by the need for a text-book dealing with the plants of Griqualand West, and this preliminary check list appears to be the outcome of this impression.

The volume contains, in addition to the list of plants with localities, a glossary of the terms used, a list of the common names with their botanical equivalents and a "Farm Map of Griqualand West", which covers all the localities where collections were made.

It is to be hoped that in the more ambitious work contemplated opportunity will be taken to correct certain nomenclatural errors which stand in need of amendment. While consulting the list it is difficult to resist the impression that insufficient care was taken in checking the manuscript, probably due to war-time difficulties. Produced as a result of field work extending over thirty years, often handicapped by bad local conditions, the author, in spite of these slips, is to be congratulated in the production of an interesting and useful volume, which will form a valuable basis for future work.

It is probable that the sale of a work of this type, which should be available to all field botanists, will be restricted on account of its high price.

## PHYSICS AND CHEMISTRY OF SWELLING AND SHRINKING

THE general discussions of the Faraday Society are usually notable for the breadth of their scope, and the latest, held during September 24-26 at the Royal Institution, London, was outstanding in this respect. More than thirty papers were presented under the general title of "Swelling and Shrinking", dealing with topics ranging from the thermodynamics of liquid mixtures to the behaviour of complex biological and technical systems. These were grouped in three sections: fundamental, biological, and technical. Prof. J. D. Bernal gave a general introductory talk, and the second and third sections were introduced respectively by Prof. E. K. Rideal and by Dr. L. G. Gabriel.

In attempting to summarize briefly some of the salient features of the discussion, attention may first be directed to two diametrically opposed methods of attack. The first is concerned with the simplest possible types of system, comprising essentially non-polar polymers and liquids, and as free as possible from structural features. At the other extreme lie certain aqueous systems which have been found by X-ray examination to possess very definite structural regularities.

Various methods of investigation have been applied to non-polar systems, and a great deal of progress has been made in recent years in the interpretation of the thermodynamic properties of polymer liquid mixtures. Lattice models have been made the basis of statistical calculations of the heat and entropy of solution of polymers. Discussion of recent progress in this field revealed the lack of an adequate treatment of dilute solutions, taking accurate account of the extent to which a single polymer molecule is folded or crumpled by its random thermal motion. Measurements of the intensity of light scattered by a polymer solution, and its distribution about the direction of incidence, are now being used to give direct estimates of the root mean square length of a polymer. Preliminary results reported at the discussion give values some four times larger than those computed for an ideally flexible and volumeless chain, and these lengths do not appear to be very dependent on the nature of the liquid. Mixtures of higher polymer content have been treated with greater success, but evidence was presented that liquids which are only sparingly absorbed are present in the nearly saturated polymer in the form of small clusters. This behaviour, which probably has a counterpart in liquid mixtures, has not been satisfactorily explained.

Less progress has been made in the quantitative interpretation of viscous flow and diffusion in these systems, although the qualitative features observed are readily understood. An outstanding problem in calculating the viscosity of a dilute solution is to decide whether liquid is effectively trapped by the crumpled polymer chain, or flows freely through it. Both assumptions have been made, and the experimental evidence suggests an intermediate state of affairs, possibly somewhat dependent on the solvent. New evidence presented at the discussion was concerned with model suspensions of flexible particles cut from cellulose fibres and swollen. These were, of course, of much more than molecular dimensions, and liquid was observed to flow freely through their folds. Nevertheless, the viscosity was found to depend

on the overall length, rather than the mean length taken up by the particles when suspended in liquid.

Several examples were discussed of systems which possess regular structures when highly swollen by water or aqueous media. One of the most remarkable of these is furnished by dilute solutions of tobacco mosaic virus. X-ray examination shows the rod-like molecules to be arranged in a regular hexagonal pattern, with a spacing which may be as much as 500 Å., depending on the medium, but not on the length of the rods. Regular structures with even larger separations are observed in sols of ferric and tungstic oxides, the plate-like particles of which form 'Schiller layers' with separation as great as 8000 Å. Two types of explanation of these structures assume on one hand a supporting framework, and on the other, the existence of long-range forces. It is difficult to see how the very regular framework needed could arise, and it was generally assumed by contributors to this discussion that long-range forces must be responsible. The origin and nature of these forces is by no means clear, and much difference of opinion was expressed. The two main suggestions were that the necessary free-energy minimum arises from a balance between attractive and repulsive forces, both electrostatic in origin, or between van der Waals' attraction and electrostatic repulsion. On either view it appears difficult to account for the existence of a free-energy minimum sufficiently deep to confer reasonable stability on the structure.

Another very striking example of an aqueous system possessing structure is furnished by protein crystals. X-ray examination of horse methæmoglobin shows the swollen crystals to consist of alternate layers of hæmoglobin molecules and liquid. Swelling and shrinking produce discontinuous changes in the layer spacing and in the  $\beta$  angle of the crystal. In this case the spacing does not exceed 15 Å., so that a definite structure may well extend through the complete liquid layer.

Hydrated clays, such as montmorillonite, show similar laminated structures, in which swelling and shrinking occur by variations in the thickness of the water layers. Experiments on the swelling of dehydrated montmorillonite in polar organic liquids were also reported; as many as three molecular layers of nitromethane or acetonitrile could be intercalated between successive clay layers, the spacing then being of the order of 20 Å. Evidence was presented that these layers were essentially liquid.

A number of systems showing structure on a microscopic scale were described by various contributors to the discussion. When lecithin swells in water, the particle is observed to develop cylindrical excrescences which retain a constant diameter, and do not coalesce on contact. These have been termed 'myelin forms', and similar arrangements have been found with other systems, including the complex formed by association of cholesterol (insoluble) with lysolecithin (soluble). By using complexes of increasing solubility, it has been found possible to produce in succession a series of structural types which had been previously reported. These include (1) 'batonnets', consisting of axially symmetrical particles with characteristic bulges which coalesce on contact, giving new particles of the same type; (2) long spindle-shaped 'tactoids'; (3) 'coacervates' containing spherical particles. It was suggested that the basic molecular organisation in these structures is again laminar, with the fluid content of the swollen phase intercalated between crystalline layers.

An interesting series of transparent 50 per cent oil-water systems was described. If amyl alcohol is added to an emulsion stabilized by sodium oleate, the system becomes transparent, and is believed to contain suspended droplets of the order of 100–200 Å. in diameter. Amyl alcohol can be replaced by other amphipathic compounds, their efficiency depending on the ratio polar/non-polar. This was investigated in the series of aliphatic alcohols, from  $C_1$  to  $C_{10}$ , and it was found that with benzene as the 'oil', the continuous phase changed from water to oil when the chain-length exceeded 5. These results are explicable in terms of the formation of mixed films of soap and alcohol at the interface; such films are known to be stable from experiments in monolayers.

Between these two extremes of structureless and highly ordered systems lie many of considerable importance, which may be treated as approximating more or less closely to one extreme or the other. Two papers discussed the structure and deformation of cellulose gels in the light of the work on ideally elastic rubber-like bodies. Theoretical treatments of the latter have been based on a model consisting of long randomly linked chains joined at a few points into a complete three-dimensional network. A statistical mechanical analysis of this model leads to expressions for the free energy of deformation, and the orientation birefringence. Swollen cellulose shows a limited degree of rubber-like elasticity, but in order to account for this quantitatively it has been necessary to assume a very high degree of cross-linking. It may be considered doubtful whether much significance is attached to the model when the estimated number of statistical chain elements between junction points falls so low as one or two.

The swelling of nitrocellulose is more complicated than that of a purely amorphous polymer, on account of its definite structure. Two types of swelling were reported, depending on whether the crystalline part is affected or not.

The swelling of protein fibres in organic solvents was discussed from the point of view of the fibre structure. The relative effectiveness of a range of acids, amides and alcohols suggests that swelling involves the breakdown of the fibre structure by chemical interactions between the liquid and localized groups in the fibre. No simple generalization of these results, such as may be made for the swelling of non-polar polymers, was found to be valid in this case.

The phenomena of swelling and shrinking are of great importance in many widely divergent fields. In the technical use of materials capable of absorbing water, or other liquids, the resultant change of volume may be less serious than the stresses and strains which are produced. A thermodynamic analysis of the swelling of wood was presented, in which the cell structure was represented by a hollow cylinder of initially isotropic material surrounded by a rigid sheath, so that swelling could only occur into the central lumen. It is then possible to deduce the dependence of the vapour pressure at fixed moisture content on the elastic constants of the swollen cell wall. The swelling of laminated plastics represents a closely related problem. Imbibition of moisture by the reinforcing fibre is mechanically restrained by the surrounding film of polymer, which in general will itself be swollen to a smaller degree.

A very different field of application of the general ideas developed in this conference is presented by systems of biological interest. On the simplest view, a red cell may be treated as a balloon-like body sur-

rounded by a semi-permeable membrane of very low modulus of elasticity. The volume of the cell, which can now be measured with some accuracy, should thus be dependent on an osmotic equilibrium, and would vary with the medium in which the cell is immersed. Experimentally, there are found to be discrepancies which are not at present fully understood. Complications were pointed out also in the swelling of protoplasm. It is not yet clear how far the various physical processes occurring in living matter may be treated as though they are *identical* with those of the dead chemical constituents of the systems. Without in the least suggesting any vitalistic hypothesis, it is necessary to bear in mind the essentially dynamic nature of living cells, and the simultaneous occurrence of complex chemical and physical changes.

GEORGE GEE

## THE MOON AND PLANT GROWTH

By DR. C. F. C. BEESON, C.I.E.

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**B**ELIEFS that the phases of the moon have a differential effect on the rate of development of plants are both ancient and world-wide. Proof by rational experiment seems to have been sought more than two hundred and fifty years ago by La Quintinye, the horticulturist, and some years later by Duhamel du Monceau<sup>1</sup>, the forester. Neither obtained any positive evidence of lunar influence. Since then, scientific interest in the subject has been revived intermittently, either by the 'rediscovery' of lunar rites in the agriculture of civilized countries, or by the impact on Europeans of the impressive faith of primitive peoples, particularly in the tropics and sub-tropics.

The literature on the moon and plants can be assigned to two groups: one comprising reiterations of peasant beliefs, myths and rules, both ancient and modern, and similar unsubstantiated statements; the other comprising experiments supported by numerical data capable of statistical analysis. This second group consists of (a) experiments mainly of the anthroposophical school, which demonstrate the existence of lunar effects on the growth of plants; and (b) experiments of professional horticulturists and foresters, which prove that there are no such effects, or that, if they do exist, they have no value in agricultural practice.

The beliefs which dominate primitive rural economy and the emphatic reports of credulous observers are very numerous, but they provide no significant evidence. Only experimental data need be considered; they may be briefly summarized as follows:

(a) *Kolisko's work.* According to the investigations of L. Kolisko<sup>2</sup> in Stuttgart during 1926–35, the particular phase of the moon at the time of sowing does influence the period and the percentage of germination, as also the subsequent growth of the plant. The most favourable date to sow is two days before the full moon for leaf- and fruit-bearing garden crops (such as cabbages, peas, tomatoes), for root-crops (such as radishes, beetroots, carrots), for flowering garden annuals, and for wheat, maize, etc. In general, these plants show better germination, more vigorous growth, and greater yields than those sown just before the new moon. Kolisko affirms that the lunar influence is not fully effective unless there is rain or artificial watering during the germination period, but the stimulus once acquired remains

decisive throughout the periods of growth, flowering and fruiting. As regards growth during a lunar phase, she found that on the whole the response of wheat is greater during the waxing than the waning phase.

In later experiments to determine the depth to which the action of the moon penetrates the soil, Kolisko found that at a depth of 1 metre the effect on wheat is nearly identical with that at the surface; at 2-3 metres the maximum growth is generally reached in a full-moon period; between 5 metres and 16 metres the influence is weaker but is still shown by greater growth at the time of the Easter full moon. She considers that each year has a certain dominating lunar period, and that the Easter full moon has a special significance for the whole year. E. and L. Kolisko's recent book, "Agriculture of Tomorrow", reviews cosmic influences on plant growth.

(b) *Other investigators' work.* *Germination.* Experiments on the germination of garden crops have been done by Becker (1937-38)<sup>3</sup>, Bergdolt and Spanner (1937-39)<sup>4</sup> at Munich; by Mather and Newall (1940-42)<sup>5,6</sup> at the John Innes Horticultural Institution; similar experiments with spruce seed were done by Rohmeder (1935-37)<sup>7</sup> at Munich. All these investigators agree that no consistent effect of the moon is observable, and that all chance variations possibly assignable to any one of the moon's quarters are evened out with an adequate number of repetitions. At meetings of the Société nationale d'horticulture de France in 1924, several horticulturists testified to the absence of lunar effects on sowings and seedling growth; earlier work of Arago, Flammarion and others in France between 1859 and 1909 was cited in confirmation<sup>8</sup>.

*Reproduction.* Periodicity in the production of sexual cells of the marine alga, *Dictyota dichotoma*, has been demonstrated by Williams (1905)<sup>9</sup>, Hoyt (1907)<sup>10</sup> and Lewis (1910)<sup>11</sup>, but the period is fortnightly on the coast of Wales and Naples, and four-weekly in New Carolina, and the phase dates differ.

*Polarized light.* Semmens (1923)<sup>12</sup> showed that moonlight is plane-polarized and increases hydrolysis of starch with diastase. Esenbeck and Suessinguth (1930)<sup>13</sup> and Macht (1926)<sup>14</sup> showed that polarized light of low intensity may produce a very slight increase in growth in length of plants. Wright (1927)<sup>15</sup> found the highest degree of polarization of moonlight at the ends of the first and third quarters. The anthroposophists consider that the moon's influence works in darkness and below ground.

*Felling dates and seasoning of timber.* Moisture-content is the most important physical condition influencing the rate of decay of wood. The amount of water in the wood of a living tree is known from many careful determinations to differ with the species of tree, and for some species to vary seasonally, for others to be fairly constant throughout the year. No variation related to lunar phases is known for any tree, but Beeson and Bhatia (1936)<sup>16</sup> found a regular lunar rhythm of sap increasing from the full to the new moon and decreasing from the new to the full moon in *Dendrocalamus strictus* in India. Knuchel and Gäumann's (1930)<sup>17</sup> work with spruce and silver fir in Switzerland based on a sequence of fellings in the same phase of the moon is typical of the exact knowledge now available. The season of felling is proved to have no substantial influence on specific gravity, moisture-content, shrinkage, resin-content or working qualities, but it strongly influences the rate of seasoning. The effect of the season of felling on the rate of drying, and the effect of weather on

the activity of decay organisms dominates any effect that may be due to the phase of the moon.

*Borer damage.* Numerous entomological records show that the liability of felled trees to attack (that is, oviposition) by borers depends on one hand on the dates of the emergence period and longevity of the adult insect, and on the other hand on the progress of drying out of bark and sapwood, or the amount of depletion of starch. The two latter factors can be controlled in many species of trees by logging procedure which entirely ignores lunar dates. Beeson and Bhatia (1936)<sup>16</sup> and Gardner (1945)<sup>18</sup> have proved that the intensity of *Dinoderus* damage to bamboos in India depends on the amount of starch present in the felled culm; the starch-content of the living culm varies seasonally, not according to the lunar phase, and no advantage is obtained by felling in relation to the phase date.

Lunar periodicity exists in some animals, but they are marine or aquatic species (Fox, 1924<sup>19</sup>; Hora, 1929<sup>20</sup>).

*Yield of resin, latex, etc.* Variations in the yield of resin, latex, maple syrup, gums and tannin are explicable in terms of tapping systems, genetic factors, weather and environmental conditions; experience is very considerable, but in no case has any advantage attributable to the moon been discovered. For example, Ferrand's work (1941)<sup>21</sup> on *Hevea brasiliensis* in the Belgian Congo revealed that the daily concentration of latex varies with weather conditions, and the local concentration in the same tree depends on the exposure to sunlight of the crown directly above the tapping-point. Changes in the gutta-content of the root of *Euonymus verrucosus* in the U.S.S.R. follow the seasonal development of the plant, and the resin-content varies in inverse proportion (Yurkevich, 1944)<sup>22</sup>. The maximum tannin-content of seeds of *Terminalia chebula* is found in seeds collected in January anywhere in India; this period is also that of optimal germinative capacity (Prasad, 1946)<sup>23</sup>.

*Summary.* The only experimental evidence for the existence of lunar influence on the growth of land plants is that published by L. Kolisko. All other investigators in many parts of the world have been unable to discover any consistent correlation between the moon and the vital processes of land plants; some admit that if a lunar effect does exist it is so obscure as to have no value in agricultural practice.

A more detailed review of the subject will shortly be published by the Imperial Forestry Bureau, Oxford.

<sup>1</sup> Duhamel du Monceau, "De l'exploitation des bois" (1764).

<sup>2</sup> Kolisko, L., "The Moon and the Growth of Plants" (1936).

<sup>3</sup> Becker, A., *Obst. u. Gemüseb.*, 85, 102 (1939).

<sup>4</sup> Bergdolt, E., and Spanner, L., *Bodenk. u. Pfl. Ernähr.*, 16, 270 (1940).

<sup>5</sup> Mather, K., and Newall, J., *J. Roy. Hort. Soc.*, 66, 358 (1941).

<sup>6</sup> Mather, M., *J. Roy. Hort. Soc.*, 67, 264 (1942).

<sup>7</sup> Rohmeder, E., *Forstwiss. Cbl.*, 60, 593 (1938).

<sup>8</sup> Meunissier, A., *J. Soc. nat. Hort. Fran.*, iv, 26, 138 (1925).

<sup>9</sup> Williams, J. L., *Ann. Bot.*, 19, 531 (1905).

<sup>10</sup> Hoyt, W. D., *Bot. Gaz.*, 43, 383 (1907).

<sup>11</sup> Lewis, I. F., *Bot. Gaz.*, 50, 59 (1910).

<sup>12</sup> Semmens, E. S., *Nature*, 111, 49 (1923).

<sup>13</sup> Suessinguth, K., *Mitt. dtsh. dendrol. Ges.*, 42, 97 (1930).

<sup>14</sup> Macht, D. J., *J. Gen. Physiol.*, 10, 41 (1926).

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## THE COURSE OF THE CONTROVERSY ON FREEDOM IN SCIENCE

By DR. JOHN R. BAKER

AND

PROF. A. G. TANSLEY, F.R.S.

THE movement against pure science and against freedom in science was first brought to Great Britain by the Soviet delegation to the International Congress on the History of Science held in London in 1931. Before that time it was accepted as a matter of course that the pursuit of pure science by independent research was a worthy and admirable thing, that it was desirable for qualified people to devote their lives to the increase of knowledge as an end in itself, and that research workers at universities should have full liberty to choose the subjects of their own investigations. One may search the literature in vain for any contrary view, and no such view can have been held by more than a minute fraction of the scientific world.

It was, of course, well known to everyone that many branches of pure science could be, and were, applied to practical uses, and that in fact the material equipment of modern societies had been and was being built up through such applications. But the distinction between pure and applied science, between the pursuit of knowledge for its own sake and the application of such knowledge to practical ends was never called in question.

Owing to the world-wide economic depression, attention in 1931 was naturally focused on economic matters, and this preoccupation lent impetus to the specifically Marxist doctrine, then brought to England from Russia, that all scientific progress was really determined by economic causes and that all scientific work should be consciously and directly devoted, under central control, to the material service of the State. This movement spread slowly at first, and then at an ever-increasing speed, as one powerful organisation after another took up the new theme. First and foremost the Association of Scientific Workers, then the British Association and the scientific Press, all began to support and even take part in the new propaganda. It was spread by many who had no sympathy with Marxism and were often unfamiliar with the philosophical basis and implications of the doctrines they were propagating. Scarcely anyone came forward to uphold the contrary doctrine of freedom of research, on which the progress of the general body of science had for centuries been based.

It was not until 1939 that any real opposition to such materialist propaganda arose. In the following year the Society for Freedom in Science was founded. Its principles are contained in the following five propositions, to which each member gives assent on joining:

(1) The increase of knowledge by scientific research of all kinds and the maintenance and spread of scientific culture have an independent and primary human value.

(2) Science can only flourish and therefore can only confer the maximum cultural and practical benefits on society when research is conducted in an atmosphere of freedom.

(3) Scientific life should be autonomous and not subject to outside control in the appointment of personnel or in the allocation of the funds assigned by society to science.

(4) The conditions of appointment of research workers at universities should give them freedom to choose their own problems within their subjects and to work separately or in collaboration as they may prefer. Controlled team-work, essential for some problems, is out of place in others. Some people work best singly, others in teams, and provision should be made for both types.

(5) Men of science in countries not under dictatorial rule should co-operate to maintain the freedom necessary for effective work and to help fellow scientific workers in all parts of the world to maintain or secure this freedom.

The Society has never denied that organised and directed team-work is necessary for the exploration of many of the complex problems of modern science, as well, of course, as in the applications of science to industry; but a considerable degree of freedom for initiative is desirable in both fields.

A cardinal point in the Society's policy has been to insist that human welfare does not mean only material welfare. Everyone agrees that the results of scientific research should be applied to improve the food of the community, to maintain its health, to raise its standard of living, to provide increased conveniences and facilities of all kinds and adequate leisure for all. But, important as they are, these things, after all, are only means to ends, not ends in themselves. The Society sustains the belief that an understanding of Nature is in itself good, apart altogether from the use of that understanding in practical affairs. This belief has been the mainspring of scientific advance for centuries, and is still its mainspring. The attempt to destroy it is not progress. The true progressive recognizes that genuine and potentially permanent progress has been made in human history, and that further progress must be built upon it. That is the difference between progress and revolution. Two of the most important steps forward in human history have been the emergence and consolidation of pure science and the granting of freedom to all qualified persons to follow their own bent in scientific research. It is for these things that the Society stands.

The defence of scientific freedom contradicted the whole weight of propaganda for the doctrine of narrowly directed research for economic ends, and at first the task of the small, newly formed Society might have seemed impossible. It was unable to get its case made public through most of the recognized channels of publicity in Britain. It had to approach its public by circular letter and memorandum in spite of the difficulties of paper shortage. The Society's efforts were not met by reasoned argument, but by obstruction, abuse, misrepresentation and ridicule. At the meeting of the Division of the British Association for the Social and International Relations of Science, held in London in September 1941, on "Science and World Order", no one was allowed to speak during the three days of the Conference except those previously chosen by the organisers, and the movement against pure science and freedom in science had free play. The meeting was extensively reported. Later on a speaker in a B.B.C. programme made an attack on the movement for freedom in science and its sponsors; and despite repeated requests by the Committee of the Society, the B.B.C. permitted no reply whatever.

In the face of misrepresentation and obstacles of every kind the Society was resolved to push its case forward. Small funds were gradually accumulated,

stencilled communications were sent to an increasing number of people, and in 1945 the publication of the Society's "Occasional Pamphlets"<sup>1</sup> was begun. Books were published and lectures delivered. The results came slowly but surely, aided no doubt by the general reaction against Marxist doctrines. One distinguished research worker after another in various parts of the world began to rally to the cause. A glance through the present list of members will show that the Society is representative of the best scientific talent. Among the members are several Nobel prizewinners, as well as seventy-two fellows of the Royal Society. Certain distinguished philosophers and historians have formed a link with liberal-minded people over a wide field of culture. The Society is naturally stronger in Great Britain and the United States than elsewhere, but it has members in most parts of the world except the Soviet Union and its satellite countries. A special effort is now being made to increase its membership on the Continent of Europe.

The propaganda against pure science and against freedom in science was, we claim, brought to Britain from Russia, and it is essentially based on the Marxist doctrine that science is, and always has been, determined solely by economic pressure. Now, however, there has been a surprising change of front. Two distinguished Soviet physicists, Academicians P. L. Kapitza and A. Joffe, have been permitted to write articles expressing views that bear a striking resemblance to those held by the Society for Freedom in Science. The reason for this change of policy, and the degree to which it is actually affecting scientific life in the U.S.S.R., are not known. Perhaps it has been found empirically that totalitarianism in science does not work. Vast sums are said to have been spent on Soviet scientific research, but no one not blinded by political enthusiasm would compare Soviet work and progress in fundamental science with that achieved in Western Europe and in America. In certain fields of research, such as genetics, Soviet standards and criteria are almost incredibly perverse. Hudson and Richens, in a remarkably careful and dispassionate review of Soviet genetics<sup>2</sup>, summarize their conclusions as follows:

"The school of genetics founded by Lysenko and Prezent in the Soviet Union, arose in 1935 and became dominant in Russia in 1940. It still flourishes, although perhaps less now than formerly. . . . Much of the scientific discourse of Lysenko's school is alogical, i.e. derives its conclusions not by logical argument from the facts, but by appeal to chosen authorities, by condemning views in opposition to these authorities, by analysing the presumed states of mind of its opponents, and by estimating the value of theories by their agronomic usefulness. . . . Lysenko's rejection of the data accumulated by Mendelian genetics during the past thirty years is obscurantist and reduces the value of his speculations."

It may be that the inevitably disastrous effect on practical results, in the long run, of such a travesty of sound scientific method is the cause of the change of policy apparent in the articles of Kapitza and Joffe. We are, however, ignorant of whether Soviet research workers are in fact now being given freedom to choose their own subjects or liberty to work in their own way. However that may be, communists in Britain have almost ceased to vilify the movement for freedom in science. Representatives of the Society were invited to address the British Association's Conference on Scientific Research and Industrial

Planning, held in London in December 1945, and their remarks on behalf of pure science and freedom in science were received with almost no opposition. The whole atmosphere of the meeting was in complete contrast to that of September 1941.

The change of front of the scientific materialists has been startling. They are beginning to speak of the internal logic of science and of its cultural value, ideas prominent in the thought of those whom they were recently attacking. Meanwhile, there is a certain lag in the application of the new orientation, and some of those who are accustomed to take their opinions, whether wittingly or not, from communist sources, are still making propaganda for the central planning of scientific research.

One aspect of scientific freedom that has to be maintained is the freedom to communicate the results of research to all and sundry—internationally as well as within the limits of individual States. The construction of the atom bomb, because of its immense destructive capacity, has introduced a complication into this claim.

It has long been argued that the scientific employee of an industrial firm should have the right to publish any discoveries in pure science he may make in the course of his work. It is, however, very naturally contended that technical discoveries and inventions directly concerned with the firm's business and therefore involving its financial interests are properly kept secret at the employer's discretion. It is not, however, always easy to draw a satisfactory line between the two spheres. Almost parallel considerations, though with far more serious and far-reaching implications, seem to apply to nuclear research and its technological developments. Fundamental investigation of the structure of the atom clearly belongs to the realm of pure science. The keeping secret of its results in any country would disrupt the progress of atomic physics throughout the world. On the other hand, the technical developments of this fundamental work, directed to the making of atomic bombs, obviously are and will be the concern of national governments, until, of course, a super-national authority with both the will and the power to control such activities comes into existence. Under present conditions it is widely held among men of science that national governments are fully justified in keeping strictly secret the processes developed for the making of the bombs, since the American proposal for world-wide control has not been unanimously accepted. Communistic men of science, however, and their supporters, for reasons which are not obscure when their political affiliation is remembered, now demand the freedom of open and world-wide communication of all such technological developments—a 'freedom' clearly of relative disadvantage under existing international conditions to non-communist States in possession of the secret processes.

As in the case of those laboratories of industrial firms in which fundamental, as well as technological, research is carried on, it is not always perfectly clear just where the line between the two spheres should be drawn. In an attempt to disentangle the threads of conflicting opinion in this matter, the Society for Freedom in Science is conducting a questionnaire among its members on the subject of secrecy in nuclear physics. The answers should show where, in the opinion of those who have shown their interest in scientific freedom by joining the Society, the line should be drawn between freedom in scientific

research on one hand and secrecy in technological matters of military importance on the other.

The violent attack on the old and well-established belief in the right to freedom in scientific research—an attack which, during the 'thirties, very nearly swept public opinion in Great Britain into a wholesale denial of that right—has turned attention to the psychological and philosophical foundations of that belief. A good deal of thought and study has been and is being devoted to the subject by members of the Society, and the results of some of it have been published. The field is wide, and much of it needs further clarification, for example, the relation of freedom in science to the concept of freedom at large. The present time, when the conflict between the opposite ideals of individualistic freedom and of the highly organised State with its tendency to totalitarian compulsion has reached a new degree of intensity, is particularly opportune for the active prosecution of these investigations.

<sup>1</sup> The whole set of Occasional Pamphlets may be obtained from the Secretary of the Society for Freedom in Science, University Museum, Oxford. 6s. 7d., including postage.

<sup>2</sup> Hudson, P. S., and Richens, R. H. "The New Genetics in the Soviet Union." Published by the School of Agriculture, Cambridge, 1946. 6s.

## OBITUARIES

### Sir Carruthers Beattie

SIR CARRUTHERS BEATTIE, vice-chancellor and principal of the University of Cape Town during 1918-37, died in Cape Town on September 10.

John Carruthers Beattie was born in Dumfriesshire on November 21, 1866, and was educated at Edinburgh, where he was an 1851 Science Research Scholar and Vans Dunlop Scholar in physics, and afterwards at Munich, Berlin, Vienna and Glasgow. In 1897 he went to South Africa as professor of physics at the South Africa College, Cape Town, being one of a group of Scottish professors at the College who played a great part in the development of education in South Africa and raised the status of the South African College so that in 1918 it was reconstituted as the University of Cape Town. Beattie had been appointed principal of the College in 1917, and became in 1918 the first vice-chancellor and principal of the University. Under his administration the fine buildings of the University on the slopes of Table Mountain above Groote Schuur—probably the most magnificent site of any university in the British Empire—were planned and erected.

At the South African College the teaching duties of the professors were heavy and left little time for research. The most important scientific work undertaken by Beattie was the first magnetic survey of South Africa, carried out in collaboration with Prof. J. T. Morrison, of Stellenbosch, between 1898 and 1906. Beattie was granted leave of absence for one year in 1903 to continue the observations; apart from this, the observations were made during the various college vacations. More than four hundred stations were occupied from Agulhas in the south to the Victoria Falls in the north, and from Saldanha Bay in the west to Beira in the east. About twenty repeat stations were selected, at which observations were made at frequent intervals during the course of the survey for the determination of diurnal and secular variations. The results were published by the Royal Society in 1909 as "Report of a Magnetic

Survey of South Africa" (235 pp.). Travelling in remote parts of South Africa at that time involved many discomforts, but in the course of it Beattie acquired an intimate knowledge of the country and its people.

Beattie was president of Section A of the South African Association for the Advancement of Science in 1910, in which year he was awarded the Medal of the Association. He became president of the Association in 1928. During 1905-6 he was president of the South African Philosophical Society and, after the formation of the Royal Society of South Africa, was for a time general secretary of the Society. He served on many Government committees and boards; he was a member of the Universities Statutes Commission, 1917; of the Scientific and Industrial Research Committee, 1907; of the Industries and Science Board, 1920; and of the Mining Industry Board, 1923. He was chairman of the Survey Commission in 1921. In 1920 he was created a knight bachelor.

The young University of Cape Town was fortunate in having Beattie as its principal for twenty years. Under his wise guidance a well-merited reputation, both in teaching and in research, was rapidly built up. He gained the respect and affection both of the students and of his colleagues. He was not an autocrat, but he could be firm when firmness was required. Patient, tactful, modest and approachable, he was an ideal principal.

In 1898 he married Elizabeth, third daughter of W. Paton, of Scarborough, and had a son, who was killed in the Second World War, and two daughters.

H. SPENCER JONES

### Prof. M. Camis

ALBERTO MARIO CAMIS, formerly professor of physiology in the Universities of Bari, Parma and Bologna, died on August 28, at the age of sixty-eight. For some years heart disease had seriously impaired his physical health, but his intellectual powers were unabated. His death will be mourned by a large circle of Italian and foreign friends. He paid several visits to physiological laboratories in Great Britain, beginning in 1908, when, as a young graduate from Pisa, he worked at Cambridge with Langley and Barcroft and at Liverpool with Sherrington. A year or two later he edited volume I of the English translation of Luciani's "Human Physiology".

Camis' scientific work covered a wide field, with original contributions on metabolism, respiration, oxygen carriage, the pharmacology of muscle, physiological psychology, the labyrinth, autonomic reflexes, the spinal cord, and the cerebellum. A cultured writer, with a great sense of style and arrangement, he also wrote some admirable monographs. "Il meccanismo delle emozioni" (1919) and "La fisiologia dell'apparato vestibolare" (1928) are particularly noteworthy. His interests in other branches of science, especially physics, in philosophy, in history, in literature, and in art gave him a breadth of view which, combined with modesty, kindness, tact and generosity, made him a delightful companion. His short, stocky figure, black beard, vivacious manner and twinkling eyes will be remembered by all who met him. Well versed in the physiological literature of five languages, he was a frequent attendant and contributor at the International Physiological Congresses,



including the last at Zurich in 1938. Possibly his most important work was as a teacher and an encourager of young physiologists. He was an interesting and lucid lecturer who could interpret modern science to a lay audience.

An ardent patriot with a passionate devotion to Italy, Camis' later years were saddened by the misfortunes that befell his country. During the Italian campaign against Ethiopia, he spent nine months as a volunteer (aged fifty-six) in Somaliland studying the metabolism and diet of both natives and European immigrants. The results, which contradicted much of the teaching then current, were published by the Reale Accademia d'Italia in a slim volume entitled "Metabolismo basale ed alimentazione in Somalia" (1936). Yet little more than two years after his return to be professor at Bologna, he was pensioned

by the Italian Government on account of a Semitic strain in his ancestry. Thereupon he followed an old inclination by becoming a Dominican monk, and in June 1939 was sent to Manila in the Philippines to join the staff of the Dominican University of St. Thomas there. But his health would not stand a tropical climate and he returned after six months to the House of his Order at Bologna where, until 1943, he taught psychology in its seminary. For the remainder of the War he found a refuge from the Nazi domination of Italy in the Dominican University at Rome. After the liberation he was at once restored to his professorship, but ill-health prevented him from taking up the duties. He spent the last year of his life at the Convent of St. Dominic in Bologna, where he died. He was childless and a widower.

R. S. CREED

## NEWS and VIEWS

Prof. E. D. Merrill

ON October 14, Dr. Elmer Drew Merrill, the well-known American botanist, was seventy years of age. To mark the occasion, special numbers of the *Journal of the Arnold Arboretum* (Harvard University) and of *Chronica Botanica*—in the latter case comprising a selection from Dr. Merrill's principal general writings, with a biography and bibliography, entitled "Merilliana"—have been issued. After holding posts in his *alma mater*, the University of Maine, and in the U.S. Department of Agriculture in Washington, Merrill lived and worked from 1902 until 1923 in the Philippines, first as botanist to the Bureau of Agriculture and later also to the Bureau of Forestry at Manila and eventually to the Philippine Bureau of Science. For several years, while holding the latter post, he was also head of the Department of Botany of the University of the Philippines, and in 1919 he became director of the Bureau of Science. During this period he wrote the "Flora of Manila" (1912), "An Interpretation of Rumphius's Herbarium Amboinense" (1917), "Species Blancoanae" (1918), "A Bibliographic Enumeration of Bornean Plants" (1921), and the "Enumeration of Philippine Flowering Plants" (4 vols., 1923-26).

In 1924, Merrill left the Philippines to become dean of the College of Agriculture, and director of the Agricultural Experiment Station, of the University of California, being also director of the California Botanic Garden during 1927-29. The University of Maine conferred on him the honorary degree of D.Sc. in 1926. While in California he wrote "Plantæ Elmerianæ Borneenses", which appeared in 1929. In 1930 he became director-in-chief of the New York Botanic Garden. His important "Commentary on Loureiro's 'Flora Cochinchinensis'" was published in 1935. Since that date Dr. Merrill has held the post of professor of botany and administrator of botanical collections at Harvard University.

Philip Hill Chair of Biochemistry: Dr. Frank Dickens, F.R.S.

DR. F. DICKENS has been elected to the Philip Hill chair of experimental biochemistry tenable in the Courtauld Institute, London. This chair is an independent research post endowed by Mrs. Philip Hill

in memory of her husband. Dr. Dickens took the Natural Sciences Tripos at Cambridge, and then spent two years in research work on pure organic chemistry under the late Sir Jocelyn Thorpe. In 1923 he became an assistant in the Biochemical Department (later the Courtauld Institute) of the Middlesex Hospital, and collaborated in the important work done there on insulin and sex hormones under the direction of Prof. E. C. Dodds. In 1927 he began his interesting work on tissue metabolism. In collaboration with the late Dr. Simer, he devised a method, which has been widely adopted, for the measurement of the true respiratory quotient of isolated animal tissues. This method has the advantage of being applicable in the presence of bicarbonate and carbon dioxide mixtures. By the use of this method he was able to show that there is a distinct difference in the metabolism of cancerous and most normal tissues. Dr. Dickens has also conducted research on tissue enzymes and the inhibitory effect on them of such substances as fluoride and iodoacetic acid. He has also obtained a certain amount of evidence to show that different paths of fermentation and oxidation may be available in cells and cell extracts from that usually followed, and which is known as the Embden-Meyerhof cycle. Dr. Dickens has also shown that tumours and embryonic tissues have an unusually high content of citric acid. A study of the distribution of citric acid in the body showed that about 1 per cent is contained in the hard substance of bone, and that this is very easily influenced by dietary and hormonal conditions, and may play an important part in calcium metabolism and bone formation. During 1943-44, at the request of the Medical Research Council, Dr. Dickens undertook special research on the toxic effects of oxygen on brain metabolism. Dr. Dickens has recently published four papers on the factors which control the carcinogenic action of certain hydrocarbons.

Zoology at University College, Hull:

Prof. P. G. 'Espinasse

MR. P. G. 'ESPINASSE has become professor of zoology at University College, Hull. The College opened in October 1928, and the following year Mr. 'Espinasse, who had just graduated in the final honour school of zoology at Oxford, was appointed

assistant lecturer in Prof. A. C. Hardy's new department there. Two years later, the department was enlarged to one of Zoology and Oceanography, and Mr. 'Espinasse then became lecturer with enlarged responsibilities on the zoological side. In 1942, when Prof. Hardy was appointed to the regius chair of natural history at Aberdeen, the Department was split into two: one of zoology with Mr. 'Espinasse as head (several departments in the College have non-professorial heads), and one of oceanography under Dr. C. E. Lucas. Zoology now again has a chair.

Prof. 'Espinasse is a versatile zoologist. While he is keenly interested in genetical theory and has written several papers on it, his researches have been mainly in the fields of micro-anatomy, embryology and the more physiological side of zoology. He worked out the development of the hypophysial portal system in man, has done much work on the action of the hormone œstrone and made important contributions to our knowledge of feather growth. While his skill as a microtome has enriched his Department with beautiful series of histological and embryological preparations, he brings to his teaching something even more valuable: a love of discussion and a deep interest in the philosophy lying behind biological theory.

### Centenary of Anæsthesia

ON October 16, 1846, W. T. G. Morton, a dentist of Boston, Massachusetts, successfully administered ether to a printer named Gilbert Abbot during an operation, performed by J. C. Warren, for removal of a tumour from the neck; and this date has just been celebrated as the anniversary of the first practical application of anæsthesia for the purpose of abolishing pain during a surgical operation. An editorial article in the *British Medical Journal* (p. 546, Oct. 12, 1946), and six other articles in this issue, mark this centenary and give an epitome of our knowledge of anæsthetics. Dr. J. H. Burn and H. G. Epstein discuss theories of anæsthetic action, Dr. C. Langton Hewer discusses the remarkable recent advances in anæsthetic practice, A. C. King contributes an illustrated article on the history of anæsthetic apparatus, and Dr. E. Ashworth Underwood, director of the Wellcome Historical Medical Museum, discusses, in another illustrated article, the history of man's knowledge of the use of substances for the purpose of abolishing pain. This latter article, which is a valuable contribution to the history of medicine, begins with a reference to the neolithic age, when unknown substances may have been used for the purpose of abolishing pain during the operation of trephining the skull, which appears to have been performed quite often in those times. The controversies which raged around the work of Clarke, Wells, Morton, and the others, and their experiences with nitrous oxide and ether, are here discussed. Chloroform, first used by James Young Simpson in Edinburgh, came a year or so later. Thereafter, the stage was set for the remarkable subsequent development of what Sir William Osler has called "medicine's greatest single gift". These developments are the subject of an exhibition at the Wellcome Historical Museum, which was opened by Lord Moran on October 16.

In two of the articles in the *British Medical Journal* we are reminded of the close relationships which have always existed between medicine and literature. It was Oliver Wendell Holmes who sug-

gested the terms 'anæsthesia' and 'anæsthetic'; and, when W. E. Henley, who had already lost one foot, had to have the other one amputated, he sought the aid of Lister and was under his care in the Edinburgh Old Infirmary during the years 1873-75. There, with the aid of what he has described as "the thick, sweet mystery of chloroform", he lost his other foot. In his "Hospital Verses", which are extensively quoted in this issue of the *British Medical Journal* in an article by Gunilla Liddle, he gives us a vivid picture, not only of Lister himself, but also of life in the wards of those days and of his own experiences in them. The centenary of the first practical use of anæsthetic substances has also been celebrated by a meeting, held on October 16, of the Royal Society of Medicine, and the *British Medical Bulletin* has a special issue devoted to anæsthetics which has the thoroughness and comprehensive scope characteristic of that journal.

### Research in Chronic Rheumatism

As a result of investigations begun so long ago as 1922, the Medical Advisory Committee to the Ministry of Health recommended in 1945 that a number of diagnostic and research centres should be established for the study of chronic rheumatism and for the improvement of existing facilities for diagnosis and treatment; and it was proposed that the special centres should be located in university medical schools and teaching hospitals, where resources are available for a combined attack on the disease in all its forms. A rheumatism centre of the kind envisaged by the Ministry is to be established at the University of Manchester, with the assistance of a grant from the Nuffield Foundation of £100,000 spread over ten years. In broad outline it is proposed to establish a diagnostic and research centre at the teaching hospital, the Manchester Royal Infirmary, to deal with short-stay in-patients and out-patients. For long-stay in-patients there will also be a clinic at a base hospital near the centre, provided by the Manchester Public Health Committee, and a second base hospital, the Devonshire Royal Hospital at Buxton. At the base hospitals lengthy investigations will be carried out, and problems of rehabilitation and resettlement will be studied. At the centre the work will cover two main fields: the clinical, sociological and industrial aspects of the disease, and the fundamental study of the disease process by pathological, bacteriological and biochemical methods. The clinical work will be under the direction of a physician who will have the full co-operation of the Departments of Orthopædics and Physiotherapy of the Manchester Royal Infirmary as well as of the University Dental School. The social aspects of the disease, and its industrial implications, will be studied in co-operation with the University Department of Industrial Health. Fundamental research into the causes of diseases of the bones and joints will be under the direction of a whole-time pathologist who is an expert in this field.

### National Laboratories in India

ACCORDING to *The Statesman* (Calcutta and Delhi) of October 14, plans for four more national laboratories in India have been approved recently by the Governing Body of the Council of Scientific and Industrial Research.

Dr. Rajendra Prasad, Minister for Food and Agriculture, will lay the foundation stone of the Fuel Research Institute at Digwadih, near Dhanbad, on

November 17. The capital cost of the Institute is estimated at Rs. 14 lakhs. Mr. C. Rajagopalachari, Minister for Industries and Supplies and President of the Council of Scientific and Industrial Research, will lay the foundation stone of the National Metallurgical Laboratory at Jamshedpur on November 19. The initial capital expenditure on this Laboratory will be about Rs. 43 lakhs. The foundation stone of the National Physical Laboratory in Delhi will be laid by Pandit Jawaharlal Nehru, vice-president, new Central Government, on January 4, 1947, during the Indian Science Congress session. The estimated cost of this Laboratory is about Rs. 40 lakhs. Mr. B. G. Kher, Premier of Bombay, will lay the foundation stone of the National Chemical Laboratory at Poona some time towards the end of January 1947. The Bombay Government recently agreed to the location of this Laboratory in Poona and the transference to the Council of the land required for this purpose. This Laboratory is expected to cost Rs. 35 lakhs.

### Manchester Federation of Scientific Societies

A FEDERATION of Scientific Societies has been formed in Manchester to enable the member societies to work together in matters of common interest. Pure and applied science are both strongly represented in the Federation, which will provide a meeting ground for workers in both academic and technological fields on the widest possible basis. The new body will not in any way seek to take over any of those activities which are the functions of the participating societies. It will, however, assist the executives of these societies in arranging their meetings and discussions to the greatest advantage of the members, many of whom belong to several societies. A calendar will be issued twice a year giving a list and dates of all meetings to be held by the societies in the Manchester district. The wider activities of the Federation are yet to be planned in detail. It is already interesting itself in the provision of post-graduate and refresher courses in science, and in this matter will seek the collaboration of the University of Manchester and the technical colleges. It will also pay attention to the problem of bringing scientific matters to public attention in popular form.

A need long felt by the Manchester scientific workers, and, indeed, by those of other big centres, including London, is for a scientific centre of their own. The home of the Manchester Literary and Philosophical Society in George Street, which frequently gave hospitality to other societies, was destroyed by enemy action in 1940. The scientific societies of Manchester need a building with a lecture theatre, meeting and committee rooms, and some provision for bodily refreshment, and it is hoped, by working together, that they may be able to satisfy this need. The principal scientific and professional societies are supporting the Federation, of which Dr. C. J. T. Cronshaw, a director of Imperial Chemical Industries, Ltd., has accepted an invitation to be the first president. Mr. J. T. Marsh, of Tootal Broadhurst Lee Co., Ltd., is the present chairman of the committee, and Dr. E. H. Rodd, of Imperial Chemical Industries, Ltd. (Dyestuffs Division), Blackley, is the honorary secretary.

### Document Copying on Microfilm

The photographic copying of documents and of published matter had attracted serious study in the United States for some years before war risks directed

attention in Great Britain to its value. Recent conferences, such as that organised by the Association of Special Libraries and Information Bureaux (*Nature*, 156, 24; 1945), have established clearly that photographic methods of reproduction will have many future parts to play in the publication and duplication of documents of all types, whether for business purposes or as part of the scientific information services (see *Nature*, 157, 745; 1946, 158, 353; 1946). 'Microfilm', that is, 35-mm. film coated with a fine-grained photographic emulsion and adapted to carry a series of images usually 24 mm. × 16 mm. or 24 mm. × 32 mm., is one of the media most commonly used for this purpose; but its application has undoubtedly been hindered by the limited supply of suitable apparatus for copying the original documents or for reading the film record. Potential users of microfilm will therefore be interested in the announcement of a new document-recording camera and (No. 3) microfilm reader and printer, made by Messrs. W. Watson and Sons, Ltd., of 313 High Holborn, London, W.C.1. The camera is a general-purpose machine which makes special provision for originals in book form and can tackle single documents up to 27 in. × 18 in.; it has a magazine holding 200 ft. of film and is designed for speedy operation, with interlocked controls. In the reader, the projected image is viewed by transmission through a diffusing screen 12 in. × 12 in. The activities of the British Standards Institution in this field should do much to stimulate the production and use of such equipment in Britain.

### Science To-day

A WEEKLY science news-letter entitled *Science To-day*, edited by A. W. Haslett from 104 Clifton Hill, London, N.W.8, and offered for subscription at 30s. for 12 months (50 issues), is intended to provide brief but accurate notes on the main trends in contemporary science for both the scientific and non-scientific reader. It is intended to include also book reviews and notes on books. The first issue, dated October 10, consists of eight octavo pages and touches on fish migration, radar and surveying, the giant man of old Java (*Meganthropus paleojavanicus*), the international organisation of science, and lines of nuclear research on the atom. The latter article occupies three of the eight pages and is entitled "Atom Perspective"; it outlines in very general terms the structure of the atom, pointing out that we still know very little about the nucleus itself, which is the object of much current research.

### Security in the Pacific Area

A REPORT by a Chatham House Study Group and issued by the Royal Institute of International Affairs, under the title "The Pattern of Pacific Security", points out that the region is not in itself an area which possesses natural defining boundaries by which the political cartographer can almost automatically draw regional frontiers on the map of security. While there are certain interests and problems which are mainly Pacific in character, most of the Powers concerned in the region are also Powers with substantial interests elsewhere. Accordingly, the Pacific Ocean must be treated as an area which cannot be considered apart from others, and the whole argument of the report reinforces the view that a system of security in the Pacific can be established only on the wider basis of world organisation, the mainstays for which are the United States, the British Common-

wealth, the U.S.S.R. and China. The thirty-four specific conclusions of this study are set forth in its final chapter, following chapters in which the Pacific area is considered as a region, the main features of a design of security are outlined, and the position of each of the four major Powers is examined under the sub-title "A Speculative Appreciation of Certain Power Factors in the Pacific". British interests in the Pacific are discussed in a separate chapter, leading to the conclusion that Great Britain is a Power with so substantial a concern in the region that, in partnership with the Pacific Dominions of the British Commonwealth, she is bound to play a large part in the future history of that Ocean.

### Sky Fantasia

ROBERT R. COLES, Hayden Planetarium, has an article with this title in *Sky and Telescope* of June, and among a number of celestial phenomena that present interesting and sometimes puzzling features is included the apparently greater diameter of the rising moon compared with the diameter when it has attained a higher altitude. Some text-books still repeat the old explanation, discarded many years ago, that the horizon moon is so situated that its size can be easily compared with terrestrial objects, but at higher altitudes we are deprived of these for comparison. Anyone can disprove this theory if he observes the moon near the horizon at sea, where no terrestrial objects are available for comparison. Yet the moon looks as large when rising or setting over the sea as it does when viewed on the land. Some years ago, Drs. E. G. Boring and A. H. Holway, two Harvard psychologists, after a series of experiments, concluded that the illusion is due to a physiological cause. It has been found that objects viewed straight ahead appear larger than do those of the same size in positions where the eye must be raised to see them. Although this theory is almost certainly the correct one, the basic causes are still somewhat of a mystery. The illusion can be observed in the constellations also, such as the Plough, which appears very much larger when low on the horizon than when high in the sky. Other groups of stars, like the Great Square of Pegasus, the Northern Cross, etc., exhibit the same phenomenon. An experiment which can be performed by anyone on some of these groups of stars, or preferably on the moon, will show that the old theory is incorrect. When the moon is near the horizon, gauge it between the thumb and forefinger and notice it shrinking; as the finger and thumb are separated it appears to swell again. This experiment is referred to elsewhere in the same issue of *Sky and Telescope*, and shows that the illusion is due to a physiological or psychological cause.

### Surface-Active Agents

THE eight papers, together with the introductory address by M. L. Anson, presented at the two-day conference on 'Surface-Active Agents' held by the Physics and Chemistry Section of the New York Academy of Sciences in January 1945, have now been published (*Ann. New York Acad. Sci.*, 46, 347; 1946). Almost all the surface-active agents referred to were water-soluble substances which, even in small concentrations, lower the surface tension of water considerably. The properties of surface-active agents, how they are measured and how they are related to structure, were the topics discussed on the first day of the conference. Papers on these subjects were

contributed by A. W. Ralston, E. K. Fischer and D. M. Gans, D. Price, and L. Shedlovsky. On the second day, the applications of surface-active agents to biology, medicine and industry were dealt with, E. I. Valko and R. D. Hotchkiss lecturing on the biological and medical applications; M. H. Hassialis and R. R. Ackley on the industrial applications. In the introduction, it is pointed out that although surface-active agents have been known for some time as chemical substances, it is only relatively recently that they have become available as cheap commercial compounds. Many such agents have been prepared and many industrial applications discovered, mostly in industrial laboratories, but basic scientific work on pure substances has been very greatly neglected. Indeed, it was lack of sufficient knowledge of the properties of pure surface-active agents that prevented any useful theoretical discussion of the relation between structure and properties. The object of the conference was to stimulate interest and to put the understanding of surface-active agents and their applications on a better scientific basis; the publication of the proceedings of this conference on surface-active agents should be of considerable value in guiding workers in this field as to the choice of suitable research problems.

### War-time Activity of the Leicester Museum and Art Gallery

THAT it is possible for a regional museum under active administration to fulfil and even increase its interests under the difficulties of war-time conditions has been amply proved by the Leicester City Museum and Art Gallery. The fortieth annual report (April 1, 1943-March 31, 1944; recently received) to the City Council shows, for example, that in that year the Geological Department, besides giving technical assistance in connexion with war-time industrial developments, provided special courses of instruction for members of the Forces; that the Department of Botany arranged topical exhibits in relation to war-time gardening, food values, medicinal herbs, etc., and that the Schools Service was extended to units of H.M. Forces stationed in the Leicester area, and to the development of children's clubs in art, science and drama. In addition, several special exhibitions of wide public interest were a prominent feature of the period. The R.A.F. "Wings for Victory" Exhibition drew 36,306 visitors, and the "City Planning" Exhibition, which was arranged in collaboration with various other Corporation Departments of Leicester City, drew 17,574 visitors. It is of interest to note that the general policy of the year was one directed at the "maintenance of public good spirits and morale". Towards this end, several other exhibitions of topical, art and domestic interest were arranged, while lectures and the weekly lunch-time concerts continued to be regular features. The bold and exploratory activity shown by the Leicester Museum throughout the war years has probably been watched with interest by other museum administrators. Many new methods of direct public appeal have been tried out and, judging from the attendance figures shown on p.15 of the present report, these have met with considerable success.

### British Bryological Society

A MEETING of the British Bryological Society was held in London during September 27-28. After the meeting there was a dinner to celebrate the jubilee

of the Society (founded in 1896 as the Moss Exchange Club), at which Sir Clive Forster-Cooper and Dr. John Ramsbottom were guests of honour. During the afternoon of September 27 the meeting was held (by kind permission of the director) in the Board Room of the Natural History Museum. Prof. T. M. Harris, of the University of Reading, read a paper on the fossil liverwort *Naiadita*, and Miss Grace Wigglesworth, formerly of the University of Manchester, on reproduction in *Polytrichum commune*. Among the exhibits was part of the herbarium of the late Mr. H. N. Dixon, a former president of the Society. On September 28 there was an excursion to Eridge and Harrison's Rocks, near Tunbridge Wells, and the rich and interesting bryophyte flora of the sandstone was seen at its best; *Pallavicinia Lyellii*, *Odontschisma denuatum*, *Orthodontium gracile* and *Dicranum Scottianum* were among the interesting species found. In a stubble field near Eridge a rich flora of ephemeral bryophytes was seen, for which the wet season was doubtless responsible.

### University of Leeds

At a meeting of the Council held on October 16, it was announced that Imperial Chemical Industries, Ltd., have given £2,000 to establish a research school in the Department of Biomolecular Structure, and the Rockefeller Foundation has given 10,000 dollars for research under the direction of Prof. W. T. Astbury for the current academic year. The Yorkshire Copper Works have given £300 for 1946 and 1947 for award of a scholarship to students of pure and applied science, preferably metallurgy.

Dr. F. C. Happold, reader in biochemistry, has been appointed professor of biochemistry as from August 1. The title of emeritus professor has been conferred upon Prof. J. H. Jones, professor of economics, and Prof. W. P. Milne, professor of mathematics, on their retirement.

Lord Halifax will give the fifth Montague Burton Lecture on International Relations on February 20, 1947.

### Earthquakes during August

On August 2 the earthquake near Copiapo in northern Chile had its epicentre near lat. 27° S., long. 70° W. The destructive Dominican Republic earthquake at 17h. 51m. 07s. G.M.T. on August 4 had its epicentre near lat. 19.3° N., long. 69° W., which is nine miles east of the Samana Peninsula. Strong aftershocks from this epicentre took place at 13h. 28m. 24s. G.M.T. on August 8 and 19h. 17.6m. G.M.T. on August 21. The earthquake of August 11 at 1h. 54.3m. G.M.T. had its epicentre in the Solomon Islands near lat. 8° S., long. 155° E., whereas that of August 15 at 15h. 23.9m. G.M.T. had its epicentre near lat. 22° S., long. 170° E. All the above epicentres were determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association. The earthquakes of August 2, 8, 11 and 21, together with nine others, were registered by Mr. E. W. Pollard at Binstead, Isle of Wight.

### Agricultural Research Council: Post-graduate Scholarship Awards

THE Agricultural Research Council announces the following awards of post-graduate scholarships in agricultural science and in animal health, to take effect from the beginning of the academic

year 1946. Such scholarships were last awarded in 1941, after which, as a war-time measure, they were discontinued. On this occasion the potential needs for specialist advisers in the National Agricultural Advisory Service were taken into account, as well as those of the research service. J. M. Barry, University of Oxford, a three-year research scholarship in animal biochemistry; J. R. S. Fincham, University of Cambridge, a three-year research scholarship in plant genetics; A. Ibbotson, University of Birmingham, a three-year research scholarship in entomology; D. J. R. Laurence, University of Cambridge, a three-year research scholarship in animal genetics; B. C. Loughman, University College of Wales, Aberystwyth, a three-year research scholarship in biochemistry; Miss M. T. Morton, University of Edinburgh, a one-year research scholarship in plant pathology; Miss U. Parsons, University of Cambridge, a three-year research scholarship in animal physiology; Miss J. N. Winfield, University of Leeds, a one-year research scholarship in plant physiology.

### The Night Sky in November

Full moon occurs on Nov. 9d. 07h. 10m., U.T., and new moon on Nov. 23d. 17h. 24m. The following conjunctions with the moon take place: Nov. 14d. 20h., Saturn 4° S.; Nov. 22d. 03h., Jupiter 2° S.; Nov. 24d. 18h., Mars 0.5° S. In addition to these conjunctions with the moon, the following conjunctions take place: Nov. 1d. 00h., Mercury in conjunction with Venus, Mercury 3.2° N.; Nov. 6d. 08h., Venus in conjunction with Mars, Venus 5.2° S.; Nov. 15d. 01h., Mercury in conjunction with Mars, Mercury 1.0° S. The following occultations of stars brighter than magnitude 6 take place, the latitude of Greenwich being assumed: Nov. 2d. 18h. 27.6m., 33 Capr. (D); Nov. 5d. 22h. 11.0m., 30 Pisc. (D); Nov. 6d. 00h. 22.4m., 33 Pisc. (D); Nov. 7d. 19h. 32.1m.,  $\nu$  Pisc. (D); Nov. 16d. 05h. 03.4m.,  $\eta$  Leon. (D); Nov. 16d. 05h. 39.6m.,  $\eta$  Leon. (R); Nov. 18d. 04h. 06.6m.,  $\nu$  Virg. (D); Nov. 18d. 05h. 04.8m.,  $\nu$  Virg. (R). Mercury sets at 17h. 05m. on Nov. 1 and can be seen in the western sky after sunset. The planet is in inferior conjunction on Nov. 21. Venus is in inferior conjunction on Nov. 17 and can be seen towards the end of the month in the eastern sky, rising about 1h. 40m. before the sun. Mars and Jupiter are unfavourably placed for observation. Saturn rises at 22h. 25m. and 20h. 32m. at the beginning and end of the month respectively and is stationary on Nov. 21. The stellar magnitude of the planet is 0.4 throughout the month. There will be a partial eclipse of the sun on Nov. 23, invisible at Greenwich but visible over parts of Canada and America.

### Announcements

DR. FRANK HARTLEY, secretary of the Therapeutic Research Corporation of Great Britain, Ltd., has been appointed manager of the Scientific Services Department of British Drug Houses, Ltd.

A SERIES of discussion meetings on Wednesdays at 7.30 p.m. under the general title "The Outlook in . . ." has been arranged by the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1. The first meeting (chairman, Dr. C. F. A. Pantin) will deal with biology (October 30), and the second (chairman, Prof. N. F. Mott) with physics (November 20).

## LETTERS TO THE EDITORS

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

## Colour of Heavy Lead Silicate Glass

It has been generally accepted in the optical industry that heavy lead flint glasses are yellow in colour. The Schott catalogue<sup>1</sup> on Jena optical glasses marks most of the heavy flints they produce as being yellow, and it is further pointed out that noticeable yellow colour would result even by using chemically pure materials. The question whether the yellow colour is intrinsic to the composition or is due to the presence of colouring oxides as impurities has been the concern of many ceramists and glass technologists<sup>2,3</sup>. Based on the fact that for heavy lead glasses the colour of the glass becomes browner as the temperature is raised, it was considered probable that the yellow tinge at room temperature might be due to the residual effect of thermal broadening and shifting of the characteristic ultra-violet absorption band towards the longer wave-lengths of the spectrum. Thus it has been suggested by several workers as being due to the thermal dissociation of lead silicate into unbonded lead oxide<sup>4</sup>. W. Weyl<sup>3</sup> further suggested, on the modern view, that the deepening in colour might be due to the influence of the PbO bond in the glassy structure. On the other hand, it is also well known that colouring oxides such as iron, copper, etc., all produce more intense colours in heavy lead glasses than in ordinary lead-free glasses. In fact it is not impossible that the thermal deepening in colour is partly due to the presence of such oxides.

In relation to this problem, particular mention should be made of the work carried out by Sir Herbert Jackson<sup>4</sup> and his colleagues Smith and Cooke<sup>5</sup> of the British Scientific Instrument Research Association early in 1924, who not only stressed the heavy colouring effect of iron oxide in heavy lead glasses, but also, by using raw materials containing less than 0.00005 per cent iron oxide, succeeded in producing a glass of refractive index 1.83, density 5.05, completely free from colour. But for glasses melted in platinum, of densities varying from 6.06 to 7.05 (corresponding to indices of refraction from 1.924 to 2.09), the colour deepened progressively from faint yellow to orange, when viewed through 1 cm. thickness. They also mentioned that chromium oxide coloured the glass intensely.

Recently, we have reinvestigated the colouring effect of iron oxide, as well as chromium oxide and copper oxide, in heavy lead silicate glasses. For glass of refractive index 1.915, iron oxide contributed a yellow colour, copper oxide green, and chromium oxide yellow, when viewed through 2 cm. thickness at concentrations of 0.01, 0.005 and 0.0005 per cent respectively. Spectrophotometric measurements indicated that the colouring effect of each oxide was proportional to its concentration over the range studied. Comparatively, the colouring power for iron oxide, copper oxide and chromium oxide was approximately in the ratio 1:2:40 respectively. Chromium oxide thus appeared by far the most powerful agent which could render a noticeable tint at a concentration so low as 0.00002 per cent at 2 cm. thickness.

We were naturally interested in producing a glass as free from colour as possible. For raw materials pure lead nitrate was prepared by dissolving spectrum pure lead in nitric acid, and precipitated silica was obtained by distillation from sodium silicofluoride and sulphuric acid. By sintering the batch and melting in a pure thoria crucible, a glass was obtained free from any noticeable tint through 5 cm. thickness, the refractive index being 1.90. It thus appeared that up to the index 1.90, heavy lead silicate glass could still be colourless. We found also that by melting in platinum, the attack—though not detrimental to the crucible—contributed appreciable colour to the glass. Details of the present results are to be published elsewhere.

We wish to acknowledge the courtesy of the British Scientific Instrument Research Association in allowing us to mention the results quoted above. The experiments were carried out by the staff of these laboratories working as a team.

W. M. HAMPTON  
(Technical Director)

Chance Brothers Limited,  
Smethwick.  
Sept. 20.

"Jaener Glas für die Optik", No. 5858, p. 15, p. 4. Catalogue of Schott and Genossen, Jena.

<sup>2</sup> Möhl, H., and Lehmann, N., *Sprechsaal*, 62, 463 (1929).

<sup>3</sup> Weyl, W., *J. Soc. Glass Techn.*, 27, 289 (1943).

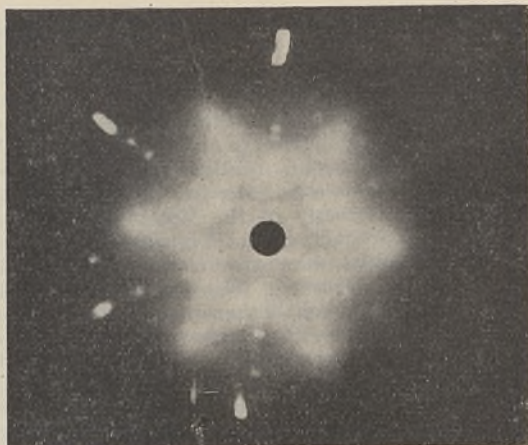
<sup>4</sup> Jackson, Sir Herbert, *Nature*, 120, 264 and 301 (1927).

<sup>5</sup> Report 27, British Scientific Instrument Research Association, 1924, Report to Members.

## Statistical Structure of Ice and of Ammonium Fluoride

Booth<sup>1</sup> has pointed out that if a strong diffuse streak of X-ray scattering connects two regions in the reciprocal lattice of a centro-symmetrical crystal, then the structure factors corresponding to those two regions must have the same sign; and he has suggested that this may be helpful in overcoming the X-ray crystallographer's bugbear: determination of phase. This argument is quite sound, it seems to me, if the diffuse scattering is due to displacement or vibration of those atoms the diffraction of which is mainly responsible for the reinforcing scattered waves which give the Bragg reflexions; and in crystals where this is the case, the method should be very useful.

In ice, however, where the contribution of the centro-symmetrically arranged oxygen atoms certainly decides the phase of the scattered waves, strong diffuse streaks do connect regions where the structure factors are not of the same sign; moreover, the diffuse pattern is more symmetrical than could possibly be the case if Booth's rule were satisfied. The diffuse pattern is very strong near 0°C, but it has almost disappeared at -183°C, although it is still easily visible



LAUE PHOTOGRAPH OF ICE AT -2° C., SHOWING STRONG DIFFUSE PATTERN

on the Laue photograph (published by Barnes in 1929<sup>2</sup>) of ice at -78.5°C. It is, therefore, of thermal origin; but comparison with theory shows that it cannot, in the main, be due to acoustical vibrations, because no combination of any elastic constants whatever could give the star-shaped pattern found.

Since the diffuse streaks cannot be due to the oxygen atoms in ice, they must presumably be due to strong vibratory movements of the hydrogen nuclei, which may still, according to Bernal and Fowler<sup>3</sup>, retain about 0.5 electrons each.

Bernal and Fowler have also pointed out that if ice is molecular (and its Raman and infra-red spectra prove that it is) then the unit cell cannot be so small as that given by X-rays. It must be at least three times as large. But Pauling<sup>4</sup> has shown from the experimental value of the residual entropy that the water molecules in ice cannot have the definite orientations which would permit a unique crystalline configuration such as that suggested by Bernal and Fowler. In fact, there are (3/2)<sup>N</sup> permitted molecular configurations (N is Avogadro's number) of a mole of ice. The change from one configuration to another, Pauling suggests, would take place by group movements of hydrogen nuclei, each of which would move from the neighbourhood of one oxygen to that of its next oxygen neighbour (or possibly by a rotation of the water molecules).

The diffuse X-ray scattering indicates that this is so; in which case, the small unit cell found by X-ray structure analysis would indeed be the true statistical unit cell, although the instantaneous configuration would be more complex and might not even be strictly periodic. It might well be that even at very low temperatures indeed the apparent unit cell would still be small because different molecular configurations would be frozen in, in different parts of a single crystal. Such time- or space-averaged statistical structures are becoming increasingly familiar to X-ray crystallographers.

A similar star-shaped diffuse pattern is observed for ammonium fluoride (isomorphous with ordinary ice), in which, therefore, similar strong vibratory movements of the hydrogen atoms must be taking place. Although, undoubtedly, the H—F bond is much more ionic in character than the N—H bond, yet even in this case a resonance between the structures N:H:F<sup>-</sup>, N<sup>-</sup>H<sup>+</sup>F<sup>-</sup> and N<sup>-</sup>H:F seems probable.

I am indebted to Miss D. J. Smith and Mr. P. G. Owston for experimental assistance.

KATHLEEN LONSDALE

Royal Institution,  
Albemarle Street,  
London, W.1.  
Sept. 30.

<sup>1</sup> Booth, A. D., *Nature*, 158, 380 (1946).

<sup>2</sup> Barnes, W. H., *Proc. Roy. Soc., A*, 125, 670 (1929).

<sup>3</sup> Bernal, J. D., and Fowler, R. H., *J. Chem. Phys.*, 1, 515 (1933).

<sup>4</sup> Pauling, L., "The Nature of the Chemical Bond" (Cornell University Press, 1945) 302.

## Spiral Cracks in Glass Tubes\*

ANYONE dropping very hot glass tubing into cold water expects it to shatter. However, one does not expect it to shatter in a simple geometric pattern such as a spiral. I was surprised to observe such a fracture, and to find that the spiral pattern is a preferred one. (The experiments were limited to 'Pyrex' glass, since soda glass was not available.)

A method of making these spiral cracks in 'Pyrex' tubing is the following: one lays one end of a stick of thick-walled capillary tubing on a hot plate. (A tube 7 mm. in diameter with a 1.5 mm. hole is a suitable size. A suitable hot plate is one having 1 kW. rating and a flat metal top 8 in. in diameter. The temperature of the hot plate was probably between 500° and 600°C., which is well below the 'strain-point' of 'Pyrex'. Heating the glass essentially from one side seems to promote spiral fracture.) A rubber blow-tube is slipped over the cool end of the glass tube, and then, while blowing air through the glass tube to keep water out of the capillary, one plunges the hot glass endwise into a bucket of water. The spiral fracture shown in the photograph results.

It was noticed that quenching from a high temperature gives rise

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HERZBERG, GERHARD. *Infrared and Raman Spectra of Polyatomic Molecules*. (Molecular Spectra and Molecular Structure, Vol. 2.) Med. 8vo. Pp. xiii+632. (New York: D. Van Nostrand Co., Inc., 1945.) 9.50 dollars.\*

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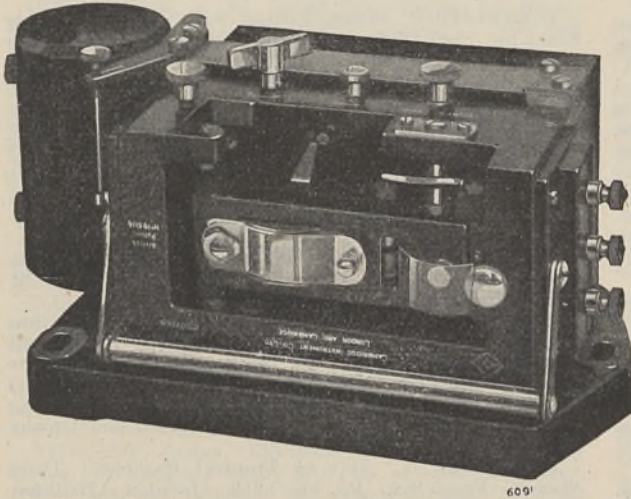
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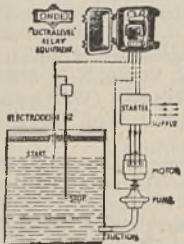
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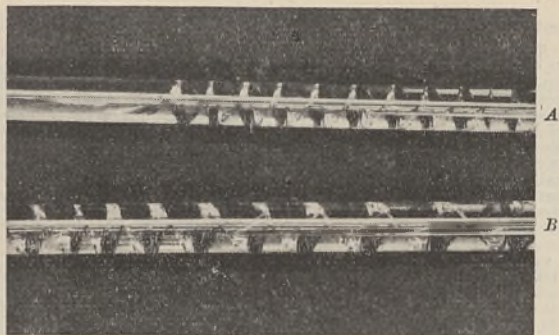


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to a close spiral (Fig. A), and from a lower temperature a coarser spiral. A temperature gradient along the tube, made by touching one end of the tube to the hot plate and raising the other end slightly, results in a tapered spiral (Fig. B). Too low temperature of heating before quenching gives a straight line or a wavy line fracture, while a too high temperature may cause short segments of the tube to be broken off. Left- and right-handed spirals are equally prevalent, even in sections of the same tube.

As a result of this heating and quenching, one may qualitatively describe the cracking of the glass as follows. Well-annealed glass is strain-free when uniformly heated. When such hot glass is suddenly plunged for a moment into water, the outside of the glass in contact with the water is chilled and undergoes tensional stress while the hot interior is compressed. Under the tensional stress, any minute fissure in the surface of the glass (usually at the end) may open and start a crack which travels over the surface of the glass and relieves the tensional strain. Prolonged cooling deepens the crack and causes a secondary crack to form which is continuous with the first and completes the spiral rupture. The spiral pattern is apparently the one that gives most strain release in the circumstances.

The simplicity of this form of fracture would indicate that the related mathematical problem in heat transfer and stress-strain relations might have a relatively simple solution.

JOHN J. HOPFIELD

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Sept. 22.

\* Contribution No. 4 from the Applied Physics Laboratory of The Johns Hopkins University; the work described here was done in connexion with Contract NOrd 7386 with the U.S. Naval Bureau of Ordnance.

### Electron Accelerator of Synchrotron Type

While accelerators of the cyclotron type have facilitated the production of energetic particles, they are, as yet, beyond the financial means of a great many laboratories. Moreover, the attainment of energies nearing the range of a thousand million electron-volts is associated with considerable difficulty and expense if attempted by current methods. It is suggested that, by using the synchrotron principle<sup>1</sup> together with a magnet of unusual design, these objections might be overcome.

It can be shown that the energy and radius of an equilibrium orbit in the synchrotron are determined by

$$E = \sqrt{(Bcer)^2 + E_0^2}, \quad (1)$$

$$r = \sqrt{(c/\omega)^2 - (E_0/Bce)^2}, \quad (2)$$

where  $E$  is equilibrium energy (total);  $E_0$  is rest mass energy;  $r$  is radius of equilibrium orbit;  $B$  is magnetic flux density at orbit;  $\omega$  is angular velocity of 'dee' voltage;  $e$  is charge on particle;  $c$  is velocity of light.

Equation (1) shows that the equilibrium energy may be increased by increasing  $B$ —as observed by McMillan. Equation (2) indicates that the equilibrium radius may be maintained constant by causing a suitable increase in  $\omega$  as the value of  $B$  is raised.

Rendering the equilibrium radius constant in this way allows the use of a magnet of simplified design. The most convenient form of magnet is a laminated steel bobbin, the depth and width of which are small compared with its diameter. The vacuum chamber and energizing coil lie between the cheeks of the bobbin, the coil having the smaller diameter. Ring-shaped pole pieces are fastened to the cheeks in the region of the vacuum chamber so that the distribution of the field may be controlled. The usual magnet yoke is eliminated in this way and, since it is unnecessary to increase the depth and width of the bobbin in direct proportion to the diameter, the saving in material and the efficiency are greater for larger accelerators. The magnet of the small (13 Mev.) electron accelerator which is being built at this University weighs less than 200 lb.

While some difficulty is associated with the required change in  $\omega$ , no insuperable difficulty is anticipated. It is certainly possible to produce a change large enough to accelerate electrons to high energy from a reasonable injection energy. It is thought that, where the final velocity of an accelerated particle is several times the initial value, the difficulty of producing a correspondingly large frequency

change might be circumvented by the use of 'harmonic orbits'. The fact that a particle can be accelerated when its period is an integral multiple of the period of the 'dee' voltage suggests that a large change in velocity may be accommodated by repeatedly changing  $\omega$  over a 2:1 range. The frequency is increased slowly and decreased very rapidly, several such cycles occurring as the magnetic field increases to its maximum. We hope to verify this when our accelerator is placed in operation.

A. I. ARCHER

University of the Witwatersrand,  
Johannesburg.  
Sept. 10.

<sup>1</sup> McMillan, E. M., *Phys. Rev.*, **68**, 143 (1945).

### Reaction Velocity at Phase Limits and its Dependence on the Frequency of the Vibration of the Lattice

IN studying reactions between two solid phases, it is found that the reaction velocity in systems such as  $MgO/Ag_2SO_4$ ,  $MgO/Ag_3PO_4$ ,  $MgO/Mg_2P_2O_7$  and  $MgO/MgSiO_3$  is not determined by the diffusion process through the reaction products, but by reactions at one of the phase limits. The reaction velocity is independent of the thickness of the layer of reaction product and changes with temperature according to the exponential equation

$$dm/dt = C \exp(-q/RT).$$

The reaction velocity of the systems magnesium oxide/silver salt is at a certain temperature about a million times as great as in the system  $MgO/Mg_2P_2O_7$ , and in the latter is considerably greater than in the system  $MgO/MgSiO_3$ ; but this difference is dependent only on the great differences in energy of activation. On the other hand, the constant  $C$  for all the four systems is practically the same.

System	$q$ kcal.	$C$ gm.-mol. MgO cm. <sup>-2</sup> sec. <sup>-1</sup>
$MgO/Ag_2SO_4$	61	$2.0 \times 10^4$
$MgO/Ag_3PO_4$	61	$2.0 \times 10^4$
$MgO/Mg_2P_2O_7$	82	$2.1 \times 10^4$
$MgO/MgSiO_3$	112	$1.0 \times 10^4$

Since the specific gravity of magnesium oxide is about 3.2, the constant  $C$  corresponds to a yield of  $5 \times 10^{13}$ – $1.0 \times 10^{14}$  molecule layers per second: the linear reaction velocity in cm. sec.<sup>-1</sup> is in the systems investigated proportional to the product of atom frequency and lattice spacing of the oxide.<sup>4</sup>

When investigating the thermal decomposition of zinc oxide we have arrived at an analogous result<sup>5</sup>:

$$dx/dt = 1.2 \times 10^{12} \exp(-94,000/RT).$$

ROBERT JAGITSCH

Department of Chemical Technology,  
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Gothenburg.  
Sept. 2.

<sup>1</sup> Jagitsch, R., and Hedvall, J. A., *Ark. kemi., min. o. geol.* (Stockholm), **18**, No. 14 (1944).

<sup>2</sup> Jagitsch, R., and Perlström, G., *Ark. kemi., min. o. geol.* (Stockholm), **22**, No. 4 (1946).

<sup>3</sup> Unpublished results.

<sup>4</sup> cf. Polanyi, M., and Wigner, E., *Z. phys. Chem.*, **A**, **139**, 439 (1928).

<sup>5</sup> Bengtson, B., and Jagitsch, R., *Ark. kemi., min. o. geol.* (Stockholm), in the press.

### An Extension of the Lens-Mirror System of Maksutov

THE lens-mirror system described by D. D. Maksutov<sup>1</sup>, in which the aberrations of a spherical mirror are corrected by a single spherical-surfaced meniscus lens, while eminently suitable for telescope objectives of moderate relative aperture, combining the coma correction of the refractor with a virtual absence of secondary spectrum, suffers from two sets of limitations which restrict its possible application in other fields. In the first place, the higher order spherical aberration is too great to yield the highest resolving power at very great relative apertures (except at very small focal lengths). Secondly, since the system has only three variables apart from meniscus thickness, the oblique aberrations other than coma cannot be corrected simultaneously with spherical aberration and axial chromatism, thus restricting its use over large angular fields. The former limitation may be reduced by increased thickness of the meniscus, but this necessarily involves larger uncorrected oblique aberrations.

D. G. Hawkins and E. H. Linfoot<sup>2</sup> recently described in *Nature* a combination of a concentric Maksutov meniscus and a doublet Schmidt aspheric plate which overcomes these limitations. Similar results may be obtained without the use of non-spherical curves by the use of two spherical-surfaced meniscus lenses, one concave and one convex to the mirror. In such a system, conserving the secondary-spectrum correction of the Maksutov system, the higher order spherical aberration is very considerably reduced, the first order oblique aberrations may be completely corrected, and the meniscus thicknesses may be increased with further considerable gain in axial correction, without detriment to the oblique imagery. Moreover, the variables of the system being more than are required to fulfil the Seidel conditions, a form of lens may be chosen reducing the higher order oblique aberrations to negligible size: this is possible in these two-meniscus systems by adopting a form in which the effective stop lies between the centres of curvature of the two surfaces of each meniscus (which are close together), thus reducing the angles of incidence of a principal ray to very small values. This is not possible in the Maksutov systems, since in these coma correction requires that the stop should be relatively far removed from the meniscus centres of curvature.

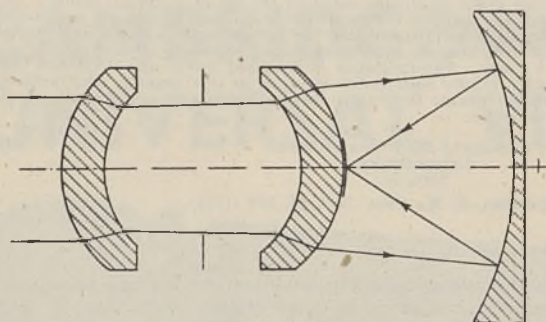


Fig. 1

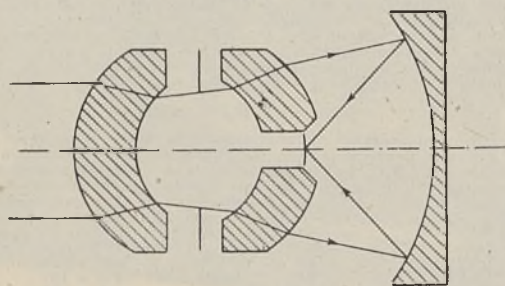


Fig. 2

In the  $F/1.0$  lens shown in Fig. 1, the oblique aberrations are thus reduced to a level where the unvignetted oblique imagery over  $24^\circ$  of field is identical with the axial to six-figure ray tracing accuracy, the axial spherical aberration producing a departure of the emergent wave-front from sphericity of a quarter of a wave-length per 25 mm. of focal length. The thicker meniscus form shown in Fig. 2, which has similar oblique corrections, reduces the axial aberration to half this value for an aperture of  $F/1.0$  and, for an aperture of  $F/0.7$ , the wave-front aberration is about one wave-length per 25 mm. of focal length.

It is hoped that a fuller report of the actual designs, and further modifications, will be published elsewhere.

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<sup>1</sup> Maksutov, D. D., *J. Opt. Soc. Amer.*, **34**, 270 (1944).

<sup>2</sup> Hawkins, D. G., and Linfoot, E. H., *Nature*, **157**, 445 (1946); *Mon. Not. Roy. Astro. Soc.*, **105**, 334 (1945).

### Effect of Pressure on Crystal Growth

I NOTE, in the account of Mr. F. R. Himsforth's paper before the Roads and Building Materials Group of the Society of Chemical Industry, a comment<sup>1</sup> that "there are theoretical difficulties in the assumption that growth of a crystal in a not completely confined space can exert a pressure, and more direct experimental proof of such a process is still required".

It is well known to crystallographers that when a crystal grows at rest on the bottom of a vessel, growth on the contact face is slowed but not totally inhibited—and growth on the contact face involves a force lifting the crystal against its own weight. Attention should also be directed to a paper by G. A. Russell<sup>2</sup> on crystal growth and solution under local stress, and to the preliminary quantitative measurements of A. Shubnikov<sup>3</sup>. Shubnikov found a growing crystal of alum exerted a force of  $0.89 \text{ gm./cm.}^2$ .

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<sup>1</sup> *Nature*, **158**, 13 (1946).

<sup>2</sup> *Amer. Min.*, **20**, 733 (1935).

<sup>3</sup> *Z. Krist.*, **88**, 466 (1934). *Trav. Inst. Lomonosoff Acad. Sci. URSS.*, No. 6 (Ser. cryst.), 17 (1935).

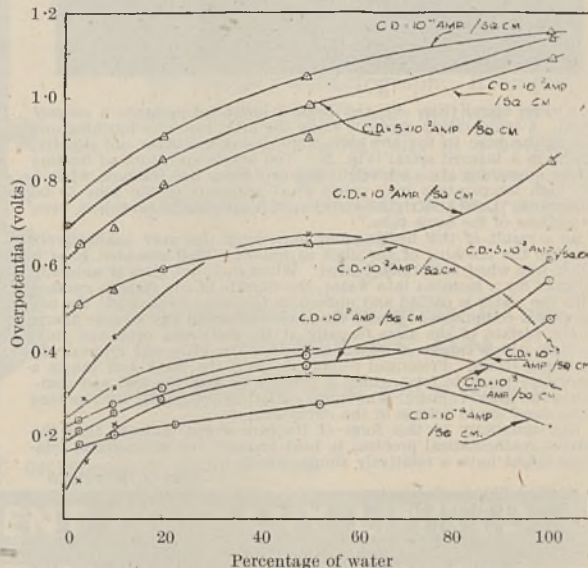
The comment to which Dr. Hey refers was intended to question if any appreciable pressure could be exerted by a growing crystal under the conditions cited. The forces quoted by Dr. Hey are small, though sufficient to raise a crystal against its own weight. The general problem of the effect of uni-directional stress on solubility has been discussed by various authors, and reference may be made in particular to the work of R. W. Goranson<sup>1</sup>. Under a compressive stress the solubility of the stressed face is increased more than that of the unstressed face, and continued growth of the stressed face must depend on some degree of supersaturation of the liquid. There does not appear to be any experimental proof of the exertion of appreciable pressures by growth of a crystal in a not completely confined space.

F. M. L.

<sup>1</sup> *J. Chem. Phys.*, **8**, (4), 323 (1940).

### Effect of the Solvent on Hydrogen Overpotential

THE recent work of Hickling and Salt<sup>1</sup> in proposing a new version of the atomic hydrogen theory of overpotential has served to increase interest in experiments which offer critical evidence differentiating between the theories concerning the various processes regarded as the slow stage in overpotential. Little work has been done on the influence of the solvent on overpotential<sup>2</sup>, and knowledge of this latter aspect would seem of use in the connexion mentioned above. Thus, alteration of the solvent medium at once affects the entities discharged at the cathode, the interfacial tensions at the metal-solution and solution-gas interfaces and adsorption on the cathode. Each of these factors has been regarded as having considerable importance in hydrogen overpotential theory<sup>3</sup>.



HYDROGEN OVERPOTENTIAL IN ACETIC ACID - WATER MIXTURES: VARIATION WITH COMPOSITION OF SOLUTION.  $\Delta$ , LEAD CATHODE;  $\circ$ , COPPER CATHODE;  $\times$ , NICKEL CATHODE

Measurements of hydrogen overpotential have been made, mostly at high current densities ( $10^{-3}$  -  $10^{-1}$  amp./sq. cm.) on lead, copper and nickel cathodes in a number of normal solutions of hydrogen chloride in methyl and ethyl alcohols and glycol, formic and acetic acids, diethyl ether and dioxane, and, where practicable, in the corresponding aqueous - non-aqueous mixtures containing these solvents. Typical results are shown in the accompanying figure. The solvent effect was found to be marked in some systems, amounting to a decrease of 0.5 volt for overpotential on lead in 100 per cent ethyl alcoholic solution. The overpotential on lead is generally less in non-aqueous than in aqueous solutions, and sometimes has a tendency to pass through well-defined maxima and minima at intermediate compositions.

On nickel cathodes there is usually a less marked solvent effect of a different type, and more complex variations tend to occur. The behaviour of copper cathodes resembles that of lead.

Gurney's expression<sup>4</sup> for the interface potential  $V_c$  at a working cathode contains a solvation energy term, but it would seem that the theory indicates an independence of the overpotential on the solvation energy, and therefore the influence of the solvent, because this term is eliminated when the expression for the reversible hydrogen electrode potential is subtracted from  $V_c$ . Eyring, Glasstone and Laidler's theory<sup>5</sup> accords with the lowering observed in some solvent - water mixtures, but is in disagreement with experiment when compared with the increased value of the overpotential on lead observed in some methyl and ethyl alcohol - water mixtures, and it is difficult to understand upon its basis why the solvent effect is a function of cathode material. (This latter objection appears to apply also to all versions of the slow discharge theories.) It seems that a treatment of the solvent effect on overpotential from an atomic hydrogen viewpoint, in which account is taken of the influence of the properties of the cathode upon its power for adsorption of the solvent, might prove to be a possible basis of the interpretation of the results. A detailed report of this work will be published elsewhere.

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<sup>1</sup> Hickling and Salt, *Trans. Faraday Soc.*, **38**, 474 (1942).

<sup>2</sup> Lewina and Silberfarb, *Acta Physicochim. U.R.S.S.*, **4**, 275 (1936). Novoselski, *J. Phys. Chim. (Russ.)*, **11**, 369 (1938). Hickling and Salt, *Trans. Faraday Soc.*, **37**, 224 (1941).

<sup>3</sup> Bowden and Agar, Annual Reports of the Chemical Society, 60 (1938). Wirtz, *Z. Elektrochem.*, **44**, 303 (1938).

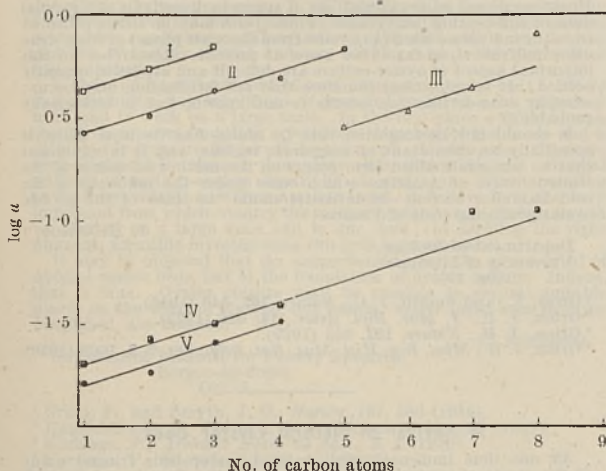
<sup>4</sup> Gurney, *Proc. Roy. Soc., A*, **134**, 137 (1931).

<sup>5</sup> Eyring, Glasstone and Laidler, *J. Chem. Phys.*, **7**, 1053 (1939).

## Biological Activity of Compounds in Homologous Series

WHEN a biological action may be attributed to a physical mechanism, the equi-effective (equi-toxic, equi-anarcotic, etc.) concentrations of compounds in homologous series decrease very rapidly as the number of carbon atoms increases: the molar concentration required to produce a given effect is approximately one third that of the preceding member; that is, the logarithm of the equi-effective concentration is a linear function of the number of carbon atoms. This generalization holds fairly well over a wide range of biological actions and homologous series, and it has been used to predict the activity of higher members of a series from results obtained with the lower homologues. The decrease in equi-effective concentration does not, however, proceed indefinitely. As the homologous series is ascended, a member is reached which has the maximum activity, and the higher members are either entirely inactive or have very greatly reduced activity. The position of this 'cut-off' depends on the homologous series, on the nature of the biological action being investigated, and even on the relative resistance of different strains of the same organism. It is the purpose of this communication to suggest that the position of this 'cut-off' can be approximately predicted from the results obtained with lower homologues.

Ferguson<sup>2</sup> has suggested the (thermodynamic) activity as defined by G. N. Lewis<sup>3</sup>, instead of concentration, as a more useful index of biological activity. He has shown that, as a homologous series is ascended, the equi-effective thermodynamic activity changes much more slowly than does the corresponding equi-effective concentration. Moreover, while the concentration decreases, the thermodynamic activity, in general, slowly increases (see Tables 2, 3 and 4 of ref. 3). This means that, although a rapidly diminishing concentration suffices to produce a given biological effect, a slowly increasing thermodynamic activity is needed. Since by definition the thermodynamic activity cannot exceed unity (which occurs when the solution becomes saturated), the member of the homologous series for which the thermodynamic activity approaches unity possesses the maximum biological activity. After that member the 'cut-off' occurs, for a more than saturated solution would be needed to produce a given effect.



RELATIONSHIP BETWEEN THE LOGARITHM OF THE THERMODYNAMIC ACTIVITY REQUIRED FOR EQUI-EFFECTIVE BIOLOGICAL ACTION, AND THE LENGTH OF CARBON CHAIN

- I. Alkyl acetates: hæmolysis of ox blood.
- II. Alcohols: bactericidal action, *Staphylococcus aureus*.
- III. Paraffin hydrocarbons: narcosis of mice.
- IV. Alcohols: inhibition of development of sea-urchin eggs.
- V. Alcohols: tadpole narcosis.

It can be seen from the accompanying graph that for every additional  $\text{CH}_2$  group in any homologous series there is an approximately constant increase in the logarithm of the critical thermodynamic activity which just suffices to produce a given effect. This increase is followed fairly closely in the eight series calculated by Ferguson<sup>2</sup>, and in four additional ones which I have calculated from published biological results<sup>4-6</sup>. The average increase in  $\log a$  for every additional  $\text{CH}_2$  group is 0.10. The divergencies do not appear to be greater than the probable error, although the lower alcohols are sometimes, but not always, more active than could be predicted from the higher homologues. If, therefore, the logarithm of this critical thermodynamic activity can be calculated from the biological results obtained with the lower members, a straight line, drawn through these points at the average slope, will, when produced, give the member for which  $\log a$  approaches zero. In other words, this will give the member which will exert the same biological action as the lower members at a thermodynamic activity approaching unity. From Curve I, one can predict that, whereas butyl acetate will probably be active in about one third the molar concentration required in the case of propyl acetate, amyl acetate will probably be inactive under the same conditions. In fact, butyl acetate is active at about the required concentration<sup>7</sup>, but no results were reported for amyl acetate. From Curve II one can expect heptyl alcohol to be inactive against *Staphylococcus aureus*, and hexyl alcohol probably active. Tilley and Schaffer<sup>8</sup> found the 'cut-off' to occur with hexyl alcohol. Against less resistant organisms (*B. typhosus*) the 'cut-off' does not occur until later in the series. There are few

biological results available with homologous series extending past octyl. Clark's results on the depression of the frog's heart are too approximate for accurate prediction, for all the molar concentrations above  $\text{C}_8$  are given to one significant figure only. However, using the results of the three lower members, one can predict that the 'cut-off' should appear with hexadecyl alcohol. Clark found it to occur with tetradecyl alcohol.

It is a pleasure to thank Dr. J. C. Speakman for advice and criticism.

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<sup>1</sup> Kamm, O., *Science*, **54**, 55 (1921).

<sup>2</sup> Schaffer, J. M., and Tilley, F. W., *J. Bact.*, **14**, 259 (1927).

<sup>3</sup> Ferguson, J., *Proc. Roy. Soc., B*, **127**, 387 (1939).

<sup>4</sup> Lewis and Randall, "Thermodynamics", chap. 2 (McGraw-Hill, 1923).

<sup>5</sup> Tilley, F. W., and Schaffer, J. M., *J. Bact.*, **12**, 303 (1926).

<sup>6</sup> Welch, H., and Slocum, G. G., *J. Lab. Clin. Med.*, **28**, 1440 (1943).

<sup>7</sup> Vernon, H. M., *J. Physiol.*, **43**, 325 (1911). Fühner, H., *Biochem. Z.*, **120**, 143 (1921).

<sup>8</sup> Fühner, H., and Neubauer, E., *Arch. exp. Path. Pharm.*, **56**, 333 (1907).

<sup>9</sup> Clark, A. J., *Arch. Int. Pharmacodyn.*, **33**, 101 (1930).

## Effect of Electrolytes on Cation-active Detergents

It is well known that the addition of divalent metallic ions greatly enhances the surface-active properties of anion-active detergents, and it was suggested by Robinson<sup>1</sup> that a similar effect should occur on adding divalent anions to cation-active substances. This was confirmed by Powney and Addison<sup>2</sup> for the addition of sulphate ions to dodecyl pyridinium chloride.

We have recently investigated the effect of the addition of sodium sulphate to several such compounds, including cetyl trimethyl ammonium bromide. It was found that in 0.01 *N* sodium sulphate, a concentration of 0.0025 per cent of this substance produced the maximum lowering of surface tension, whereas in the absence of added electrolyte a concentration of 0.015 per cent was necessary in order to produce the same effect.

Since cetyl trimethyl ammonium bromide is used as an antiseptic, tests were carried out to determine whether the bactericidal and penetrating properties of very dilute solutions would be improved by the addition of sodium sulphate. The test organism used was a pyogenic strain of *Staphylococcus aureus* supplied by the National Collection of Type Cultures, and it was found that by the addition of extremely small quantities of sodium sulphate the concentration of cetyl trimethyl ammonium bromide required to produce a given effect could be halved.

We would like to thank the Director of Research for his advice and criticism in this work, and the Council of the British Launderers' Research Association for permission to publish this note.

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<sup>1</sup> *Nature*, **139**, 626 (1937).

<sup>2</sup> *Trans. Farad. Soc.*, **33**, 1253 (1937).

## Reduction by Dissolving Metals

IN order to draw general conclusions as to the mechanism of reduction by dissolving metals from the data obtained in the course of a number of reductions by sodium and alcohol in liquid ammonia<sup>1,2,3</sup>, it is necessary to determine more precisely the role of the solvent. That its use is not essential for the hydrogenation of benzene derivatives to *o*-*d*-hydro-compounds is shown by the fact that anisole, dimethylaniline or *m*-tolyl methyl ether when treated in boiling light petroleum (b.p. 100–120°) with potassium and the equivalent amount of ethyl, or better, isopropyl alcohol, gave the dihydro-derivatives already obtained<sup>1,2</sup>. This was shown by conversion to the 2:4-dinitrophenylhydrazones of  $\Delta^2$ -cyclohexenone, m.p. 133–134°, convertible by acid to the derivative of  $\Delta^2$ -cyclohexenone, m.p. 167°, and in the last case by preparation of the 2:4-dinitrophenylhydrazone of 3-methyl- $\Delta^2$ -cyclohexenone, m.p. 174°. The method has little practical value because of the small yields, except perhaps with compounds insoluble in ammonia; but it demonstrates that the solvent does not affect the nature of the products.

The favourable influence of ammonia is probably due partly to its ability to dissolve alkali metals, but more to its ability to stabilize the divalent anions formed as intermediates<sup>4</sup> (compare its use for the preparation of alkali salts of very weak acids such as unsaturated hydrocarbons<sup>5</sup>). Also, in contrast to reduction in pure alcohols, both these methods employ much lower proportions of alcohol to substrate, thus increasing the efficiency of the metal by decreasing the tendency to form hydrogen gas.

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<sup>1</sup> Birch, *J. Chem. Soc.*, 430 (1944).

<sup>2</sup> Birch, *J. Chem. Soc.*, 809 (1945).

<sup>3</sup> Birch, *J. Chem. Soc.*, 593 (1946).

<sup>4</sup> Levy and Cope, *J. Amer. Chem. Soc.*, **66**, 1684 (1944). Birch, unpublished work.

## The Perfect Buffer

CONSIDER a solution containing (a) equivalents of a weak acid, H.A. and (b) equivalents of a strong base. For this to be a perfect buffer it may presumably be stated that the rate of change of pH with added acid or base must be a minimum; that is,  $\frac{dpH}{db} = 0$ . For a weak acid:  $\frac{CH}{CA}/\frac{CHA}{CA} = k$ . Since the salt will be practically 100 per cent ionized and the acid negligibly so, it follows that  $CA = b$ , and  $CHA = (a - b)$ .  $\therefore CH = b(a - b) = k(1)$ . By taking natural logarithms and differentiating twice with respect to  $b$  it is easily shown that  $b = \frac{1}{2}a$  (2), and by substitution from (1) that  $CH = k$ . The perfect buffer solution should thus consist of two equivalents of a strong base together with one equivalent of a weak acid having a dissociation constant equal to the hydrogen-ion concentration required. This has long been known as an empirical relation, but we believe the above derivation to be original.

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## Reactions of Organic Halides in Solution

IN a recent note<sup>1</sup>, I discussed those reactions of organic halides in solution which involve substitution by a nucleophilic reagent at a saturated carbon atom. In reply to the letter by Profs. Hughes and Ingold<sup>2</sup> on this subject, I wish to make the following points.

In my note<sup>1</sup> I stated that the decrease in the bimolecular  $S_N2$  reaction-rate of the halide  $R-X$  as  $R$  varies along the series methyl, ethyl, *sec*-propyl, *tert*-butyl, is attributed by Hughes and Ingold to the increase in electron accession to the reaction centre. In disagreeing with this statement, Profs. Hughes and Ingold say that they regard the polar and steric effects as both contributing to the structural influence on rate<sup>2</sup>. At the time of publication of my note, however, Hughes had estimated the steric compressions involved in the  $S_N2$  reactions of  $R-X$  for the methyl, ethyl, *n*-propyl, *iso*-butyl, *neopentyl* series only. For the reaction of these halides with sodium ethoxide, Hughes had concluded (as mentioned in my communication<sup>1</sup>) that "The rate relationships for the first four members are fairly normal for the bimolecular mechanism, the rate of which is decreased by electron-accession to the reaction centre, but the introduction of the last  $\beta$ -methyl substituent has obviously introduced an effect which is far larger than that to be expected on the basis of its capacity for the release of electrons. . . . This effect is believed to be of steric origin."<sup>3</sup> This indicates that steric hindrance was considered to be unimportant in the bimolecular  $S_N2$  reactions of  $R-X$  when  $R$  is methyl and ethyl. The part played by steric hindrance in these reactions when  $R$  is *sec*-propyl and *tert*-butyl had not been specifically considered by Hughes and Ingold at this time. (Calculations of the steric compressions involved in the methyl to *tert*-butyl series had been made, however, by A. G. Evans and M. Polanyi<sup>4</sup>.)

With regard to the fact that an electron-attracting group often accelerates bimolecular nucleophilic substitutions in spite of steric hindrance, I did not state that the polar effect is "absent in general from bimolecular nucleophilic substitutions"; I stated that there is strong evidence that the decrease in rate of the bimolecular substitution reactions of  $R-X$  with nucleophilic reagents for the series methyl, ethyl, *sec*-propyl, *tert*-butyl, and ethyl, *n*-propyl, *iso*-butyl, *neopentyl*, can be interpreted in terms of steric hindrance, but not in terms of electron accession to the reaction centre.

As regards the ambiguity of the polar effect in bimolecular reactions, I compared the behaviour of allyl chloride and its  $\alpha$ - and  $\gamma$ -methyl derivatives, because I believe that this is an example in which ambiguity concerning the polar effect of the methyl group can be eliminated, and that the importance of the steric effect in bimolecular substitution reactions can thus be demonstrated for  $\alpha$ -methyl groups and hence for the series methyl, ethyl, *sec*-propyl, *tert*-butyl.

Finally, the activation energy for the ionization of  $R-X$  is determined not only by (a) the ionization potential of  $R$ , but also by (b) the bond strength of  $R-X$ , and (c) the heat of solution of  $R^+$ . For the methyl, ethyl, *sec*-propyl, *tert*-butyl series, changes in factors (b) and (c) are approximately equal in magnitude and have opposite effects upon the activation energy of the ionization reaction. Thus, along this series it is the great decrease in factor (a), the ionization potential of  $R$ , which is responsible for the marked increase in the rate of ionization (this point is discussed in detail in a forthcoming publication). For some other series, on the other hand, it may well be that the sequence of ionization rates is mainly determined by changes in factor (b), the bond strength of  $R-X$ , or in factor (c), the heat of solution of  $R^+$ .

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<sup>1</sup> Evans, A. G., *Nature*, 157, 438 (1946).

<sup>2</sup> Hughes and Ingold, *Nature*, 158, 94 (1946).

<sup>3</sup> Hughes, *Trans. Farad. Soc.*, 37, 621 (1941).

<sup>4</sup> Evans, A. G., and Polanyi, *Nature*, 149, 608 (1942).

## Survival of Oyster and Other Littoral Populations

THE problem of the maintenance of marine littoral populations and especially that of the European oyster (*O. edulis*) in Great Britain as discussed by Gross and Smyth in *Nature*<sup>1</sup> is one of great interest. In all species it is reasonable to assume that the properties of each particular organism give a measure of its attunement to the environment in its recent past, if not to the present. The supreme criterion and one hard fact of the sum of its relationships to life conditions is the number of young (larvæ) produced during the life of the individual. This provision of young has ensured survival of the species

in the past against predators, parasites, competitors and normal and abnormal deviations in the total of chemico-physical conditions over the range of the environment. In a given locality, however, it is reasonable to infer that extinction may occur or tend to occur if the full span of life is not attained by the normal adult population. If, therefore, the normal span of life is reduced in any locality, fewer young will be produced over that period of time which has ensured survival in the species as a whole, and a combination of local unfavourable conditions—or indeed any single one of a significant nature—will reduce the chance of survival and may result in local extinction.

As there is a tendency on oyster beds for all the larger oysters to be removed, it is fairly certain that the span of life in many localities has been reduced in the last few centuries; this factor must therefore be added to those given by Gross and Smyth as inimical to survival. The provision of a central spawning stock of large oysters has been advocated<sup>2</sup> and would be generally valuable in all producing areas.

Another important factor of biological significance is the great reduction in the number of holders of scattered small plots. An oyster bed is only assured of survival when the larvæ set free are returned in oscillations of the estuarine water<sup>3</sup> to that bed. Where there is only one part of a locality used as an oyster bed, the chance of larvæ returning to that particular spot has a low degree of probability; if there are twenty places in the same locality, the chance of larvæ returning to one or other of the twenty suitable places has a relatively high degree of probability, and survival in that locality is enhanced.

With regard to the suggestion of mass hybridization, this has virtually had a chance of operating in the Thames Estuary, where oysters have been imported by the oyster merchants themselves at one time or another from Brittany and other parts of France, Scheidte, Norway, Falmouth, Poole, Swansea and other parts of England and the west coast of Ireland. But the assumption that cross-fertilization occurs is not entirely warranted. "Fertilisation almost always occurs in the oviduct as Hoek deduced long ago (1883); but it is still a matter of conjecture to what extent cross-fertilisation occurs. Since females on English beds nearly always carry some sperm-morula amongst the eggs, self-fertilisation will nearly always be possible. On the other hand [functionally] pure males undoubtedly exist and spawn, and Hoek has described accumulations of sperm in diverticula of the renal duct of egg-bearing individuals. Thus sperm may be either collected from the individual itself [as a relic from the male phase] or from some other individual, so far as we know at present. Researches on this important aspect of oyster-culture are difficult and are [still] urgently needed. It is quite clear therefore that self-fertilisation may occur; whether cross-fertilisation occurs is not known, but is biologically probable."<sup>4</sup>

It should not be forgotten that *O. edulis*, like its near allies, is essentially an inhabitant of temperate regions, and it is significant that no temperate allied form occurs on the north-west shores of the United States of America—which come under the influence of the cold Labrador current—at latitudes similar to those of the prolific oyster-producing beds of France.

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<sup>1</sup> Gross, F., and Smyth, J. C., *Nature*, 157, 540 (1946).

<sup>2</sup> Orton, J. H., *J. Mar. Biol. Assoc.*, 14, 626 (1927).

<sup>3</sup> Orton, J. H., *Nature*, 123, 453 (1929).

<sup>4</sup> Orton, J. H., *Mem. Roy. Hist. Mus. Nat. Belg.*, Ser. 2, 3, 1003 (1936).

## A Revival of Natural Oyster Beds?

AT one time immensely rich natural oyster beds fringed many of the coasts of western Europe. Those of the French and Scottish coasts yielded tens of millions of oysters annually, but the banks along the English, Dutch, German and Danish coasts were by no means negligible. These oyster beds disappeared, no doubt through overfishing, and a few poor remnants, scattered along our coasts, economically of little or no importance, remind us of the once important fishery on the natural oyster beds. Only in France and Holland were new methods adopted in time, and an intensive oyster culture, spreading prosperity in the regions concerned, took the place of the old free fishery on the natural beds.

Recently, both British and German men of science<sup>1,2</sup> have tried to contrive a plan to restore the wealth of the natural oyster beds. Both recognize fully that overfishing was the cause of the decline, but they cannot understand why the natural oyster beds failed to recover after the termination of the fishery and even after re-laying reasonable quantities of French and Dutch oysters. Both ascribe recent failures of efforts to raise the population of remnants of natural oyster beds to inadequate properties of the mother-oysters used, and suggest the selection of certain strains of oysters, or even mass-hybridization; and both hope that a general revival of the once prolific oyster beds will start from the moment that a limited stock of mother-oysters of the desired qualities occupies the banks.

I feel fairly sure, however, that both plans are doomed to failure, as in both the same mistake is made: the reproductive power of the oyster, *Ostrea edulis* L., has been over-rated. Repopulation of natural oyster banks is possible as soon as natural reproduction surpasses natural mortality. Mortality in oyster populations is far from negligible, and the possibilities for natural reproduction are generally highly over-rated. 500,000–1,000,000 larvæ in one incubating mother oyster is indeed an enormous and promising number. But my data<sup>3</sup> collected in the Oosterschelde show that about 10 per cent of the planktonic larvæ are destroyed by plankton-eating animals during each tidal cycle, and 4 per cent are swept away by currents to areas unfavourable for fixation in the course of one tidal cycle; the latter figure will certainly be much higher in estuaries less enclosed than the basin of the Oosterschelde. Water-temperature influences the rate of development of the larvæ, low temperatures slowing it up. In the Oosterschelde, about 5 per cent of the larvæ produced reach the 'mature' stage, ready for fixation, at 20° C.; about 2½ per cent at

18° C. Though oyster farmers place millions of limed tiles and thousands of cubic metres of mussel-shells at the most favourable time in the water of the Oosterschelde, only about 1 per cent of the 'mature' larvae succeeds in finding a collector and in accomplishing fixation; the other 99 per cent perishes. Many of the newly settled spat perish in the first weeks of sedentary life, and in spite of all the care of the oyster-farmers, it is considered normal if 10 per cent of the spat survives until October, not to mention the losses by severe frost in the following winter, and those by sifting sand or silt or by predators and diseases before the age is reached at which they participate in reproduction. It may be concluded that the 'useful effect' is not very great in the propagation of *Ostrea edulis*, even when the oyster farmer intervenes, the most perilous period being that during which it is urgent to find a collector.

How are 'mature' oyster larvae to find any cultch on the natural oyster beds if it is not provided by the oyster farmer? Practically the only hard and clean objects available there are the new shell-edges of the growing oysters themselves<sup>4</sup>. This is the reason why oysters are so often found in clusters on the natural beds instead of singly. When the beds had a rich population, many larvae were produced and the oysters themselves provided the cultch in the form of their clean new shell-edges. Natural banks could thrive even on less-favourable spots thanks to the great number of oysters present in the community. Then man interfered. He overfished the beds and the phenomenon described above contributed to a rapid decline, for large oysters were fished away, diminishing both the number of mother oysters and the quantity of natural cultch; and at the same time innumerable young oysters, attached to the shells of the larger ones, were destroyed. This depletion process is accelerated as soon as oysters become so scarce on the natural banks that fertilization possibilities diminish and only part of the maternal eggs are in a position to produce larvae. That means the end of a natural oyster bed.

What can we do to stop the decline? When the population is poor, and no cultch is planted, spatfall prospects are negligible. The provision of cultch is only profitable if enough spat is collected to pay the charges, and that will not be the case when too few larvae reach the mature stage. In the favourable conditions of the Oosterschelde, we need at least 10,000,000 mother-oysters if enough spat is to be produced in an average summer. It will be clear from the foregoing why I do not believe the British and German plans to restore the natural oyster beds can be successful, as both want to start with a very limited number of mother-oysters and say nothing about the planting of cultch material.

Is there no hope for revival of once prosperous oyster beds? There is a possibility, but only if one is prepared to invest a lot of money in it, and to work on a large scale. In the first place a suitable area should be selected, ensuring a restricted dispersal of the larvae and a suitable temperature for larval development. A wide area of bottom surface should be cleaned thoroughly with oyster dredges. Several millions of mother-oysters should be planted there, more according as hydrographical conditions are less ideal. I believe it is not very important from which country the mother-oysters come. Cultch should be planted on a large scale and in due time; in deciding the right moment, scientific investigations can help a great deal.

It may be objected that my suggestions do not aim at a revival of natural oyster beds, but at the foundation of oyster culture. Indeed, that is true. Oyster culture may be possible in several suitable places on the coast of Europe, but natural oyster beds, once severely overfished, are doomed.

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Oct. 2.

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<sup>1</sup> Gross, F., and Smyth, J. C., *Nature*, 157, 540 (1946).

<sup>2</sup> Hagmeier, A., *Z. Fischerei u. d. Hilfswiss.*, 39, 105 (1941).

<sup>3</sup> Korringa, P., *Archives Neerl. de Zool.*, 5, 1 (1940).

<sup>4</sup> Korringa, P., *Basteria*, 10, No. 3/4 (1946).

#### Occurrence of Foot Louse of Sheep in the British Isles

WE wish to record the first known occurrence in the British Isles of *Linognathus pedalis* (Oshorn), the foot louse of sheep. In June 1946 a heavy infestation of this parasite was reported by Mr. C. T. Murphy on the legs of a flock of a hundred cross-bred Suffolk sheep, near Colchester, Essex. The lice were identified in this laboratory as *L. pedalis*, and a part of the material has been placed in the collections at the British Museum (Natural History).

*Linognathus pedalis* is a sucking louse which previously had only been recorded from sheep in the United States, South America, New Zealand, Australia and South Africa. Heavy infestations of this louse cause considerable irritation and loss of condition of the host, and its introduction into Great Britain is to be regretted. Control of this parasite, with modern insecticides, should not, however, be difficult.

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#### Control of Wireworm

Thomas and Jameson<sup>1</sup> state that as a result of the application of 'Gammexane' in field trials reductions in wireworm populations of up to 65 per cent have been obtained. Numerous similar trials were laid down by the Cambridge Advisory Centre in the spring of 1946, in conjunction with Imperial Chemical Industries, Ltd. 'Gammexane' was applied in powder form at various strengths, to test its efficiency in the control of wireworms on arable crops. In the majority of these trials, which included wheat, oats, barley, sugar beet and reseeded grassland, the plant establishment in treated plots was satisfactory

or normal compared with plots receiving no treatment, where it was poor or failed entirely.

Five centres, where the crop differences were very striking, were selected for intensive sampling and investigation, to find if 'Gammexane' treatment caused any marked reductions in the wireworm population. Each centre consisted of five 'Gammexane' treatments and a control untreated in twelve replicated plots. Twenty standard 4-in. diameter cores were taken from each plot, in the growing crop in May and June, in all 240 samples per centre. Each core was split in two, the top three inches being bulked separately from the bottom three inches. This was to find if there was any downward migration of wireworms as a result of the treatment. The samples were examined by the wet or flotation extraction method<sup>2</sup>.

At four of the five centres examined, the populations were found to be similar to the initial populations, as first estimated before treatment. Only at one centre was there an apparent reduction in population. The results were examined statistically, and only at one centre was the difference between treatments and controls significant. No downward migration of wireworms was demonstrated.

As these findings did not offer any explanation of the striking crop differences obtained, a simple test was devised to discover if 'Gammexane' had any inactivating effect on the wireworms. R. C. Amsden had previously demonstrated that wireworms could be extracted by placing soil in trays in a water bath, until the surface temperature of the soil reached 40° C. This treatment by heat causes large numbers of active wireworms to come to the surface, from which they can be picked off. Twenty cores were again taken from each plot at three of the above-mentioned centres, and treated by this method. The soil was afterwards examined by the wet method to recover the wireworms still remaining in the soil. At two of the centres a higher proportion of wireworms came to the surface in the samples from untreated plots than from treated plots. A statistical analysis of these results showed that the difference was highly significant. The figures at the third centre, however, showed no difference between treated and untreated plots.

All centres are being sampled again on the completion of harvesting. The results so far show that the wireworm populations in the untreated plots are only slightly lower than the first estimation, whereas the populations in the treated plots are now considerably reduced, in some cases to the extent of 60-70 per cent.

These findings seem to suggest that the application of 'Gammexane' quickly renders the wireworm incapable of attacking the crop, but any killing action appears to be considerably delayed.

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<sup>1</sup> Thomas, F. J. D., Jameson, H. R., *Nature*, 157, 555 (1946).

<sup>2</sup> Cockbill, G. F., Henderson, V. E., Ross, D. M., and Stapley, J. H., *Ann. Appl. Biol.*, 32, 148 (1945).

#### Polyploidy and Parthenogenesis in the Genus *Saga*

THE large wingless Tettigoniid grasshopper *Saga pedo* (*serrata*) is an inhabitant of southern Europe, its distribution ranging from Spain to the Ural Mountains. Among the northern outposts of its range are some localities in the Moravian mountains and Voronij, Saratov and Ufa in Russia. It is remarkable that this species, which occurs farther north than any other representative of the genus, appears to reproduce normally by parthenogenesis. The biology and cytology of *Saga pedo* was studied by Matthey<sup>1</sup> in material from the Swiss canton Valais. He found that the chromosome number of the parthenogenetic females generally amounted to 68, made up of six pairs of metacentric and twenty-eight pairs of acrocentric elements. This high number is unique among the Tettigoniidae, the idiograms of which range from 22 to 36 in all other species investigated. Matthey suggested, therefore, that *S. pedo* must in reality be a tetraploid.



SPERMATOGONIAL PLATE OF *S. ephippigera*: BOUIN, SECTION 14  $\mu$   
THICK, GENTIAN VIOLET.  $\times 1850$

*Saga ephippigera* and *Saga gracilipes* had originally been chosen as objects of a cytological study because they represent an instance of two species inhabiting the same area. They are sporadically distributed almost throughout Palestine, both species frequently occurring in closely neighbouring localities. *S. ephippigera* is noteworthy for its giant size (total length of larger females including ovipositor, 125-135 mm.), which is nearly equalled by the largest specimens of *S. gracilipes* (total length of larger females including ovipositor, 107-120 mm.). Both species are bisexual. The examination of their idiograms has furnished a full confirmation of Matthey's assumption.

In a number of males of each of these species, the diploid chromosome number in the spermatogonia was found to be 31. There is a certain discrepancy between this number ( $2n = 30 + X$ ) and that of the female *S. pedo* ( $4n = 64 + 4X$ ). However, one male of *S. ephippigera* possessed a supernumerary pair of chromosomes, thus showing 33 elements in the spermatogonia, and sixteen tetrads and one dyad in all first spermatocytes throughout the testis. This exceptional number ( $n = 16 + X$ ) makes a perfect fit with the tetraploid number of *S. pedo*. It seems plausible that the establishment of a super-

numery pair of chromosomes may have occurred in *S. pedo* previous to the doubling of the chromosome number.

As regards the structure of the chromosomes, both *S. gracilipes* and *S. ephippigera* agree in having a 1-shaped X and a graded series of acrocentric autosomes. (The arms of the X are nearly equal in *S. ephippigera*, whereas the X of *S. gracilipes* has markedly unequal arms.) The four pairs of V-shaped elements present in *S. pedo* in addition to the two pairs of X's would appear to have evolved by intrachromosomal rearrangements in originally acrocentric chromosomes rather than by centric fusion<sup>2</sup>.

It may be concluded that in the case of *Saga pedo*, as in the well-known instances of *Artemia*, *Trichoniscus* and *Solenobia*, polyploidy occurs in conjunction with parthenogenesis. In *Saga*, as in the two latter genera, the parthenogenetic polyploid has a wider geographical distribution and reaches farther north than its diploid bisexual relatives.

It is of some interest that the largest tetraploid females of the Swiss race of *S. pedo* which formed the material of Matthey's investigation were considerably smaller (99 mm. total length including ovipositor) than good-sized females of either of the diploid species in Palestine.

Details of the cytology of the bisexual species will be published elsewhere.

Thanks are due to Dr. G. Haas, who kindly provided some of the cytological material and who participated in the earlier phases of this study.

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<sup>1</sup> Matthey, R., *Rev. Suisse de Zool.*, 48 (1941). White, M. J. D., "Animal Cytology and Evolution" (Cambridge, 1945).

### Diatoms Without Siliceous Frustules

DIATOM material freshly gathered during February 1946 from Chichester Harbour was identified as *Navicula ramosissima* (Agardh) Cleve. The organism was arranged in files within a filamentous muco-gelatinous sheath forming frondose colonies up to 10 cm. in length. When the filaments were placed in diluted sea-water, differences in osmotic pressure caused the diatom cells to be extruded from the envelope. These cells were taken up with a sterilized pipette and allowed to fall upon the following nutrient agar medium (Medium 1): disodium phosphate 0.02 gm., sodium nitrate 0.10 gm., soil extract 50 c.c., agar 10 gm., sea-water 1,000 c.c. The colonies were at first very slow to develop, but after several days cell division proceeded fairly regularly for about a week, after which the colonies became quiescent and showed signs of falling.

Subcultures were made on another medium (Medium 2) containing disodium phosphate 0.1 gm., sodium nitrate 0.2 gm., soil extract 50 c.c., copper sulphate, trace, agar 10 gm., sea-water 1,000 c.c. Great activity was noted after 48 hours, and reproduction continued for several days. After a week, however, the cultures appeared to be waning, and examination under the microscope showed that the siliceous frustules were being burst open and the cell contents extruded, enclosed within an intact perizonium, an extremely tenuous membrane which would often break by pressure from a cover-glass when preparing a mount.

Fresh sub-cultures of these naked protoplasmic bodies were made upon the second medium. The naked cells retained the characteristic healthy brown colour of the normal cells, but bore no trace of the markings characteristic of the species. The division of the chromatophores and other cytoplasmic elements appeared to be in every way normal, and division took place along the longitudinal axis in what would have been the valvar plane. The chromatophores consisted of two flattened bodies oblong-lanceolate in shape, often folded longitudinally, measuring approximately 22  $\mu$  long by 5  $\mu$  wide when first liberated. After being cultured for three months, the protoplasmic masses lost a good deal of their rectangularity, became globular and underwent a reduction in size. The cells, devoid of the rigid siliceous frustule, had now lost all normal powers of locomotion and spread themselves slowly over the surface of the agar, forming dense irregularly shaped colonies. After culturing for seven months on Medium 2 all the protoplasmic masses had adopted, more or less, the same globular shape and had a diameter of 8-10  $\mu$ , and exhibited a hyaline marginal area about 2  $\mu$  wide between the chromatophores and the perizonium.

Smears of the agar culture were prepared upon glass slides and placed in diatom-free static nutrient sea-water (in 100 c.c. beakers) and in a specially designed dripping apparatus through which the nutrient sea-water (Medium 1) flowed at a rate of about 10 litres in 24 hours. After ten days it was noticed that rich colonies of diatoms had grown over the slide and on the bottom of the beakers and throughout the dripping apparatus. Upon microscopic examination, it was found that the form of the protoplasmic bodies was returning to the navicloid, although irregularities persisted. Quite a number had regained the power of movement and had formed chains of ten or twelve cells. The new or re-established cells varied from 13.5 to 17  $\mu$  in length and from 4 to 5  $\mu$  wide. Quantities of culture media kept as controls showed no diatom development.

Very little is known concerning the factors governing the secretion of silica by the diatom cell. Bachrach and Lefèvre<sup>1</sup> found that under some unknown cultural conditions certain small marine diatoms failed to produce siliceous frustules, and such forms showed no signs of decreased virility. A form of *Nitzschia closterium*, first isolated by Allan and Nelson<sup>2</sup> has been kept in culture for more than thirty years, and Wilson<sup>3</sup> describes triradiate and oval cells as well as normal ones, but there is no suggestion that the oval cell was produced by the liberation of the protoplasmic mass from the siliceous frustule. Geitler<sup>4</sup> observed the liberation of protoplasts from frustules of marine diatoms in culture and suggested that the phenomenon was pathological. It is difficult to suggest why the frustules of *Navicula ramosissima* ejected their protoplasmic masses, as it was not the result of a planned experiment. It seems that it was due to variation in the internal

pressure of the cell brought about by the relative concentration of the culture medium. It is unlikely that the failure to produce siliceous frustules while in agar culture was due to exhaustion of the natural silica content of the medium. The re-establishment of the normal navicloid shape is probably controlled by the flowing of the aqueous medium, for the most active and perfectly re-formed cells were found on the inside of the outlet tube from the dripping apparatus, that is, where the rate of flow was greatest.

Acknowledgment is made to Board of Admiralty for permission to publish the foregoing work, which forms part of a general investigation on the antifouling problem relating to ships, in progress in this Laboratory.

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<sup>1</sup> Bachrach, E., and Lefèvre, M., *J. Physiol. et Path.-gen.*, 27, 241 (1929).

<sup>2</sup> Bachrach, E., and Lefèvre, M., *Trav. Cryptogram.*, 281 (1931).

<sup>3</sup> Allan, E. J., and Nelson, E. W., *J. Mar. Biol. Assoc.*, 8, 421 (1910).

<sup>4</sup> Wilson, D. P., *J. Mar. Biol. Assoc.*, 26, 235 (1946).

<sup>5</sup> Geitler, L., *Archiv. f. Protist.*, 78, 1 (1932).

### Protein of Fruits

IN continuation of the work on apple-fruit protein, it has been found that if, after the initial treatment of the frozen and ground tissue with alkaline buffers<sup>1</sup>, extraction with this buffer is prolonged for several hours at 1° C. and the tissue is then washed with a small quantity of the buffer, the combined extract and washings may contain as much as 85 per cent of the original protein. A much larger proportion of non-nitrogenous material is also dispersed into the solution, with the result that when precipitation of the protein-complex is caused by adjustment of the pH to 6, the nitrogen content of the precipitate is only 5 per cent. At pH less than 4 or, if precipitation is brought about by treatment with ammonium sulphate (to half-saturation), the nitrogen content falls as low as 4 per cent. Of great interest is the fact that the ammonium sulphate precipitates are partially soluble in water or phosphate buffer of pH 8; and the resultant solutions, after dialysis at 1° C., show a positive oxidase action, a strong peroxidase action and a small but definite amylase action (greatly reduced, no doubt, by the presence of tannin). Acid precipitates, however, even after precipitation at low temperatures, are practically insoluble in water and exhibit none of the above enzyme activity.

The nitrogen content of the ammonium sulphate precipitates cannot be raised above 5 per cent by repeated reprecipitations, and the enzyme activity is much reduced during this process, even when care is taken to keep the temperature as low as possible.

A fairly stable complex appears to be involved, and new methods are being tried to split this complex and liberate for study the enzymes it undoubtedly contains.

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<sup>1</sup> Hulme, *Nature*, 158, 58 (1946).

### Glycogen Phosphorylysis in Alloxan-diabetic Rats

IN a previous communication<sup>1</sup> we reported that the rate of glucose resorption from the small intestine of alloxan-diabetic animals is increased with the degree of diabetes, and that administration of insulin brings this rate down again to its normal value. Starting from the now proved fact that the rate of glucose resorption is dependent on the rate of phosphorylation, we examined whether alloxan-diabetic rats show an increase of the rate of phosphorylation. We found that the rate of glycogen phosphorylysis in muscles of alloxan-diabetic rats was increased by 63 per cent after 15 minutes and by 69 per cent after 30 minutes incubation time. By adding insulin *in vitro*, the rate of glycogen phosphorylation is diminished. We were able to confirm the results of Schumann<sup>2</sup> and those of Verzář and Montigel<sup>3</sup> that glycogen phosphorylysis in muscle of adrenalectomized rats is lowered.

On measuring the fractions of phosphoric acid in blood by Lohmann's<sup>4</sup> method of hydrolysis, we found an increase of 55 per cent of pyrophosphate, of 58 per cent of hexose phosphoric acid and of 33 per cent of the amount of total acid soluble phosphorus, as shown in the accompanying table.

	FRACTIONS OF PHOSPHORIC ACID IN BLOOD (MG. PER CENT AVERAGE)			
	Inorg. P	7-min. hydrolysis	180-min. hydrolysis	Total acid-soluble P
Normal	3.81	1.81	2.57	25.1
Diabetic	4.29	2.81	4.05	33.0

Determinations of phosphatase in blood plasma gave the following average results: 26 units in normal animals; 43.4 units in alloxan-diabetic animals; and 14 units in adrenalectomized ones.

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<sup>1</sup> Laszt, L., *Nature*, 157, 551 (1946).

<sup>2</sup> Schumann, H., *Pflüger's Arch.*, 243, 695 (1940).

<sup>3</sup> Verzář, F., and Montigel, L., *Helv. Chim. Acta*, 25, 9 (1942).

<sup>4</sup> Lohmann, K., *Biochem. Z.*, 194, 206 (1928).



Alloxan Diabetes and Kidney Function

It is a well-known fact that the intravenous injection of high diabetogenic doses of alloxan (80-100 mgm. per kgm.) in the dog produces a very severe diabetic-uramic syndrome. With such doses the death of the animals follows as a rule within one week, the cause of the death being probably due to the disturbance of the renal function<sup>1,2,3</sup>. In the course of our experiments on alloxan diabetes in the dog, we have been faced with this fact, which prevented us from keeping the animals with severe diabetes for further study. It was thought that clamping of the renal vessels previous to the alloxan injection, maintained a few minutes after the end of the injection, would avoid the kidney damage, since we have been able to demonstrate the rapid inactivation of the alloxan in contact with the blood and body tissues<sup>4</sup>. Our former experience shows, in fact that after ten minutes of contact with blood at 37° C. *in vitro* a diabetogenic dose of 100 mgm. alloxan per kgm. does not evoke its diabetogenic effect.

In order to test our theory the following experiments were performed: a group of five normal dogs were injected with alloxan during clamping of the renal vessels. Two of the dogs received 80 mgm. of the drug per kgm., and the other three 100 mgm. per kgm. Just before the alloxan injection in the saphenous vein, the abdomen was opened under local anaesthesia (with procaine solution, without adrenaline), and the usual aseptic care. After dissection of the renal pedicles, one clamp was placed in each side, suppressing the blood flow in both kidneys. The alloxan was then injected, and the clamps removed ten minutes after the end of the injection. The abdomen was closed with suture, and the animal, which behaves as a normal one, is replaced in the cage. Venous blood samples are taken for glucose and urea estimations, just before the injection of alloxan, and afterwards every hour for eight or ten hours, and on the following days.

Other five dogs have been treated in the same way (including procaine, opening of the abdomen, suture, etc.) but no clamps were placed on the kidney vessels.

TABLE 1. EFFECT OF INTRAVENOUS INJECTION OF ALLOXAN IN THE DOG

(a) Dogs with clamped kidney vessels.

Dog number	Alloxan mgm./kgm.	Blood sugar (mgm. per 100 c.c.)										
		Before alloxan	After alloxan (hours)									
248	90	80	—	73	67	40	23	23	20	23	117	117
249	90	87	90	127	103	87	70	50	47	27	77	60
250	100	80	90	153	132	80	43	50	43	50	153	103
251	100	97	173	160	137	101	17	33	27	37	180	103
252	100	93	170	163	107	93	87	80	60	50	93	88

(b) Dogs with non-clamped kidney vessels

240	80	77	143	177	197	207	143	83	43	33	320	1060
253	100	73	170	167	143	110	77	37	70	27	70	1000
254	100	90	140	—	—	—	—	—	—	—	237	347
262	100	77	147	200	—	—	—	—	—	—	280	—
263	100	87	163	190	—	—	—	—	—	—	197	657

TABLE 2. BLOOD UREA IN DOGS AFTER ALLOXAN INJECTION. DOGS FROM TABLE 1. UREA IN MG. PER 100 C.C.

Dog number	Before alloxan	Clamped kidney vessels Hours after alloxan		Dog number	Before alloxan	Unclamped kidney vessels Hours after alloxan	
		24	48			24	48
248	42	80	42	240	56	480	688
249	32	32	52	253	28	112	360
250	52	64	66	284	—	240	544
251	40	38	60	262	40	152	—
252	36	44	62	263	40	140	512

As seen in Table 1, both groups of dogs show the known glycaemic response to the alloxan, but, surprisingly, the dogs with clamped kidney vessels do not have hyperglycaemia forty-eight hours after the injection. These dogs are neither diabetic nor uramic, and in contrast with the non-clamped ones they live without hyperglycaemia, glycosuria or elevation of blood urea, and with a normal aspect, two months after the administration of alloxan. The unclamped dogs died between two and seven days after the injection with hyperglycaemia and very high uraemia (Table 2).

It seems, therefore, that avoiding the contact between the kidneys and the blood carrying alloxan, during the time necessary for the inactivation of the drug, not only prevents the kidney damage and the uraemia, but also the diabetic disturbance. These results indicate that the kidney plays some hitherto unknown part in the development of alloxan diabetes; the contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect.

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<sup>2</sup> Grande-Covian, F., and De Oya, J. C., *Rev. Clin. Esp.*, 15, 262 (1944).  
<sup>3</sup> De Oya, J. C., and Grande-Covian, F., *Rev. Clin. Esp.*, 16, 412 (1945).  
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An 'Incomplete' Form of  $\alpha$  Agglutinin

In the *Rh* system of blood groups two forms of antibody have been described, an agglutinin and an 'incomplete', 'blocking' or 'conglutinating' antibody<sup>1,2</sup>. The iso-agglutinin can be detected by the ordinary iso-agglutinin technique<sup>3</sup>, which, however, fails to detect the incomplete antibody. The presence of the latter in a serum can, however, be demonstrated by the blocking test<sup>4</sup>, the Coombs test<sup>5</sup>, the Diamond slide test<sup>6</sup>, the conglutination test<sup>7</sup>, and the albumen test<sup>8</sup>.

Attempts to demonstrate an incomplete antibody in the *ABO* system have heretofore proved unsuccessful. However, the fact that with certain anti-*A* sera better agglutination with group *A*<sub>1</sub> red cells was obtained at a dilution of 1:16 or 1:32 than with undiluted serum<sup>9</sup> seemed to us to indicate the possible presence of an 'incomplete' or 'blocking' antibody. Two such sera, therefore, were chosen and tested.

These were very potent immune anti-*A* sera from persons of group *O* (Taylor-Sparks) produced as a result of injection with *A* group specific substance isolated from pseudomonas cyst<sup>10</sup>. It was thus first necessary to inactivate the iso-agglutinin, which was readily detectable at all dilutions up to a titre of 16,000 and 8,000 respectively. It has been shown<sup>11</sup> that while the anti-*Rh* agglutinin is rendered inactive by heating at 70° C. for 5-10 minutes, the incomplete antibody is still active. However, as the anti-*A* agglutinin seems to be more heat-stable than the anti-*Rh*, the sera containing immune anti-*A* agglutinins were heated for 20 minutes at approximately 75° C., after which they were tested against *A*<sub>1</sub> cells at room temperature and were found to give no agglutination. With *A*<sub>2</sub> cells there was slight agglutination ((+)); with *B* cells the agglutination was slightly stronger.

The heated sera were then tested for the possible presence of an incomplete form of anti-*A* antibody by the blocking test<sup>4</sup>. One volume of serum and one volume of a 2 per cent suspension of *A*<sub>1</sub> red cells were mixed in a small tube and allowed to stand at room temperature for one hour. The supernatant fluid was then withdrawn from the tube and a unit volume of a strongly agglutinating anti-*A* grouping serum (titre 512) was added. A control tube, containing the same *A*<sub>1</sub> red cells, which, however, had not been exposed to the test sera (Taylor-Sparks), and a volume of the anti-*A* grouping serum, was included in the experiment. After two hours at room temperature, the *A*<sub>1</sub> red cells which had first been treated with the heated test sera (Taylor and Sparks) gave no agglutination with the anti-*A* serum, whereas in the control tube the red cells were completely agglutinated. This experiment clearly demonstrated that the expected agglutination between the *A* cells and the anti-*A* serum had been blocked by a factor contained in the sera (Taylor and Sparks), whereas the red cells which were not first exposed to the Taylor and Sparks sera were agglutinated normally. To show that the blocking was specific for the *A* cells, blocking tests were also carried out using group *B* cells. In these there was no blocking of the anti-*B* agglutination.

It was next decided to attempt to demonstrate the presence of the blocking antibody in the sera (Taylor and Sparks) by the Coombs test. One volume of each of the heated sera was mixed with a 2 per cent suspension of *A*<sub>1</sub> red cells and allowed to stand for 1 hour at room temperature as for the blocking test. The *A*<sub>1</sub> red cells were then carefully washed and an anti-human serum rabbit serum added to them. Almost immediately the cells were strongly clumped, showing that they had become sensitized by an antibody. Group *O* cells subjected to the same treatment were not clumped.

The blocking or incomplete antibody in Taylor and Sparks heated sera was also demonstrated well by the Diamond slide test, and rather less conclusively by the Diamond albumen test.

It may be significant that in both the instances the incomplete *A* antibody was found in an immune serum (it is possible that it does not occur naturally and is only produced as a result of stimulation by the homologous antigen). We are planning further work to elucidate this point, but our experiments to date have shown that incomplete *A* antibodies occur and, furthermore, that a positive Coombs reaction can be obtained in the *ABO* system.

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B. E. DODD

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Sept. 17.

<sup>1</sup> Race, R. R., *Nature*, 153, 771 (1944).  
<sup>2</sup> Wiener, A. S., *Proc. Soc. Exp. Biol. and Med.*, 58, 173 (1944).  
<sup>3</sup> Boorman, K. E., Dodd, B. E., and Mollison, P. L., *Brit. Med. J.*, 535 and 569 (1942).  
<sup>4</sup> Coombs, R. R. A., Mourant, A. E., and Race, R. R., *Brit. J. Exp. Path.*, 26, 255 (1945).  
<sup>5</sup> Diamond, L. K., and Abelson, M. N., *J. Lab. and Clin. Med.*, 30, 204 (1945).  
<sup>6</sup> Wiener, A. S., *J. Lab. and Clin. Med.*, 30, 662 (1945).  
<sup>7</sup> Diamond, L. K., and Denton, R. L., *J. Lab. and Clin. Med.*, 30, 821 (1945).  
<sup>8</sup> Barnes, D. W. H., and Loutit, J. F., in the press.  
<sup>9</sup> Loutit, J. F., and Morgan, W. T. J., to be published.  
<sup>10</sup> Coombs, R. R. A., and Race, R. R., *Nature*, 158, 233 (1945).

Enhancement of Immune Antibodies by Human Serum

It has been observed that the use of human serum, instead of saline, as a diluent in titration of immune agglutinins (*A*, *B*, *Rh*) enhances the action of these antibodies, and higher titres are therefore obtained<sup>1</sup>. Similarly, the 'conglutination-test' for the detection of *Rh* sensitization is also based on the use of human serum, instead of saline, for dilution in titration<sup>2</sup>. In describing the 'conglutination-reaction', Wiener suggested that this is due to a serum factor, a protein, which is not fully developed in the foetus and is formed only shortly after delivery<sup>3,4</sup>. The post-natal formation of sufficient quantities of this protein would presumably account for the development of erythroblastosis foetalis after delivery, and not during pregnancy.

We have tried to determine whether the property of serum to enhance the action of immune antibodies is present in sera of new-

borns or infants up to eighteen months of age. The sera studied were taken from umbilical blood, infants up to the age of eighteen months, and adults in the pregnant and non-pregnant state, as controls. These sera were used as diluents for titration of two immune anti-Rh sera (titres 1:256, 1:64), and anti-A serum (titre 1:250,000) and an anti-B serum (titre 1:2,048).

The results of titration with these various sera are tabulated below. A serum was considered to be 'enhancing' when in titration it reacted like mature serum. By the term 'non-enhancing' sera, we refer to sera which reacted in a manner similar to saline as diluent.

Age	Number of sera examined	Number of 'non-enhancing' sera	Number of 'enhancing' sera
Umbilical blood	40	37	3
1-6 months	11	11	
6-18 months	4		4
17-40 years	13		13
Pregnant women	12		12

In one case the serum of a child aged three months gave higher titres than those obtained with saline as diluent, but much lower than the titre obtained with mature serum. In the beginning of this study, three sera from umbilical blood gave titres similar to those of mature sera.

The results reported above indicate that human serum at birth and during the first six months of life lacks that serum factor which confers upon it the ability to enhance the action of immune antibodies. Unless the human placenta, in certain conditions, is permeable to this serum factor from the mother's blood, it does not seem likely that the development of erythroblastosis foetalis after delivery is due to the neo-natal formation of this serum factor.

Our findings confirm the observations made by Boorman, Dodd and Morgan<sup>1</sup> insofar as the ability of mature sera to enhance the action of immune antibodies is concerned. The identical enhancement of human sera in respect of immune anti-Rh, as well as anti-A and anti-B, would seem to be in disagreement with the view that the 'conglutination-test' is due to a special antibody (glutinin)<sup>2,3</sup>.

A detailed account of the work reported here will be published elsewhere.

We are indebted to Prof. B. Zondek for his interest and to our colleagues of the Pediatric Department for their kind supply of blood specimens.

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<sup>1</sup> Boorman, K. E., Dodd, B. E., and Morgan, W. I. J., *Nature*, 156, 663 (1945).

<sup>2</sup> Wiener, A. S., *J. Lab. and Clin. Med.*, 30, 662 (1945).

<sup>3</sup> Wiener, A. S., *Amer. J. Diseases Child.*, 71, 14 (1946).

### The Thyroid and Tuberculosis

BARRY'S recent communication<sup>1</sup> on the resemblance of the chemical constitution of thyroxine to that of diploicin which was isolated by Nolan<sup>2</sup> from the lichen *Buella canescens*, and which, according to Burger and associates<sup>3</sup>, possesses tuberculostatic activity *in vitro*, has induced us to give the following summary concerning the influence exerted by thyroxine and hypothyroidism on the course of experimental tuberculosis in the guinea pig.

Thyroidectomized guinea pigs are more susceptible to tuberculous infection than are the controls, while those injected with 30 micrograms of thyroxine, twice a week, are more resistant against tuberculosis.

In the course of the same month in which tuberculous inoculation took place, deaths occurred in 30 per cent thyroidectomized, 5 per cent controls, and in none of those which had received thyroxine injections. During the third month, mortality was as high as 75 per cent in thyroidless animals, 60 per cent in the controls, and only 15 per cent of the hyperthyroid animals. During the seventh month, the only survivors were 15 per cent of the animals treated with thyroxine, while all thyroidectomized and control animals had succumbed.

Resistance against tuberculous infection was greater in the animals in which thyroxine treatment had been instituted one month before their inoculation with bacilli.

The thyroidectomized animals were given calcium and parathyroid hormone in order to prevent the disturbances due to thyroid deficiency.

Pathological anatomical studies of the organs revealed lesions the characteristics of which depended on the time of survival. The animals with longer survival periods had developed caseous lesions to a larger extent than had those which had died early, the lesions being of a congestive type.

The greater resistance toward tuberculous infection of the animals injected with thyroxine appears to be due either to tuberculostatic activity, or to greater immunity, for example, increase of alexines as observed by Fassin<sup>4</sup>, of opsonic index and of micro- and macrophagocytary activities as demonstrated by Marbe<sup>5</sup> and Asher<sup>6</sup>.

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Buenos Aires.  
Sept. 12.

<sup>1</sup> Barry, V. C., *Nature*, 158, 131 (1946).

<sup>2</sup> Nolan, *Sci. Proc. Roy. Dub. Soc.*, 21, 67 (1935).

<sup>3</sup> Burger, A., Brindley, C. O., Wilton, E. L., and Bernheim, F., *J. Amer. Chem. Soc.*, 67, 1416 (1945).

<sup>4</sup> Fassin, L., *C.R. Soc. Biol.*, 62, 388 (1907).

<sup>5</sup> Marbe, S., *C.R. Soc. Biol.*, 64, 1113 (1908).

<sup>6</sup> Asher, L., *Klin. Wchschr.*, 3, 308 (1924).

### Uranium in Urine

DURING some work in this Research Department on compounds of uranium, as a safety precaution, we commenced to analyse the urine of personnel concerned, using a fluorimetric method. In the preparation of fluorimetric standards, known amounts of uranyl nitrate were added to samples of urine from persons not engaged on the work with uranium. To our surprise we found uranium to be present in some of the 'blank' urine samples. It was found that analysts who had recently been engaged in the determination of sodium as sodium uranyl magnesium acetate<sup>1</sup> voided traces of uranium in their urine, the element being detected for some weeks after the analyst ceased to be using 'sodium reagent'. Out of 14 analysts examined between January 28, 1944 and February 1, 1944, six (Nos. 1-6 below) who had been in contact with magnesium uranyl acetate solution during the past two months had urine containing 2-10  $\mu\text{gm}$ . per litre of uranium, eight (Nos. 7-14) who had not been in such recent contact with uranium salts varied from 'not detected' to 4  $\mu\text{gm}$ . per litre. The table gives the experimental figures, expressed as  $\mu\text{gm}$ . uranium per litre.

Analyst	January 28	January 29	January 31	February 1
1			4	10
2		10	4	4
3	6			6
4	6			6
5			10	6
6			10	6
7	<2			
8	2			
9			2	4
10			2	
11			2	4
12			2	
13		2		
14	<2			

The fluorescence was compared visually, against standards equivalent to 2.6 or 10  $\mu\text{gm}$ . per litre, 2  $\mu\text{gm}$ . per litre being the limit of detection by the method used.

Careful examination by the works medical officer failed to detect any deviation from normal health in analysts 1-6, but we think it should be made known how readily this element may be absorbed. In the case under discussion, the reagents used by the analysts were an aqueous solution containing 43 gm. uranyl acetate per litre in addition to magnesium acetate and acetic acid, and also an alcoholic solution, made by saturating alcohol with (almost insoluble) sodium magnesium uranyl acetate. We are inclined to think that it may be the second of these solutions which is more likely to penetrate the skin.

H. M. WILSON  
A. A. SMALES

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Billingham Division,  
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Sept. 17.

<sup>1</sup> Cf. Caley, E. R., and Foulk, C. W., *J. Amer. Chem. Soc.*, 51, 1664 (1929).

### "Conditions of Survival"

In common, I imagine, with many readers of *Nature*, I was extremely disturbed by the editorials of September 28 and October 5 on "Conditions of Survival". We have long been accustomed to have in these editorials of *Nature*, sober and constructive examination of the social implications of science. It is all the more surprising to find ill-considered intrusions into political topics, the effect of which—whatever the intention—is to increase the divisions in a world where unity is the essential condition for survival.

I do not wish to dwell on the main topics—the control of atomic energy and U.N.R.R.A.—because events in the intervening period have already falsified the worst fears that were raised in the editorial. Since it was written, the Scientific Committee of the Atomic Energy Commission—of which the Soviet Union is a member—has issued a unanimous report declaring that the control of atomic energy is possible. The question at issue now is not the refusal by the Soviet Union to surrender national sovereignty but that of the United States to accept the prohibition of the atomic bomb and its insistence on attaching to the Lillenthal report the political condition of the abolition of the veto. As Prof. Blackett has ably pointed out<sup>1</sup>, the veto is the only guarantee that a security organisation can function without producing the war which it is its object to prevent.

At the same time, in other spheres, the picture is far from being as black as it was painted. There are increasing signs of greater international co-operation as witnessed by the Stalin interview, the proceedings at the Peace Conference and the setting up at Copenhagen of the World Food Board under the presidency of Sir John Orr.

In this atmosphere it is all the more regrettable that *Nature* editorials should contain statements which are not only unfounded but highly injurious to the cause of peace. The editorial of September 28 states that "in deference to the U.S.S.R., Great Britain and America have abandoned the principles involved in the Atlantic Charter". Now in the first place the principles have not been abandoned: the difficulties in realizing them in practice are being slowly but surely overcome. These difficulties can no more be attributed to the U.S.S.R. than to the other allies: they are inherent in the situation at the end of the War. Wide divergencies of policy about the best means of effectively preventing the resurgence of fascism and of aiding the reconstruction of the devastated countries are bound to exist and will need the utmost good will and good faith to overcome.

These divergencies, however, are quite distinct from the moral antagonism stressed throughout both editorials. It is not a fact that "the aims and values of Soviet Russia are not those of Western

Europe". The very form of this statement shows how far many well-intentioned people have fallen into the trap prepared for them by Dr. Goebbels. The concept of a Christian Western Europe containing all the virtues as a bulwark against the evils of bolshevism was one of his favourite ways of justifying Nazi Germany and is being echoed even to-day by his tolerated disciple General Franco. To fall for this 'holier than thou' attitude is a particular weakness of Anglo-American culture: it is apt to appear to other countries as nauseating hypocrisy. Men of science in Great Britain should be more wary of accepting this flattering ascription to themselves of the monopoly of moral values. Quite apart from the fact that the Soviet Union has as good a claim as a Christian country and as heir to the same classical culture as ourselves, the cultures of Islam, India and China have contributed their share to the common heritage. "Respect for human personality, freedom of worship, freedom of investigation" are far from being an exclusive mark of Christian ethics: they are concessions won from Christian churches in a long struggle in which science played a notable part. Communism has never denied these principles; in fact the Soviet Union has asserted and upheld them fighting with us against those who openly rejected them. In so far as we admit and propagate this concept of a radical moral division of the world, we increase the tensions that may ultimately lead to war.

The opportunity for new international unity which we all earnestly desire is to be found rather in the discovery of common grounds between ourselves and the Soviet Union than in pointing out superficial, and often fictitious, differences. The resolutions of the International Council of Scientific Unions do effectively speak for science, and the Soviet Union is represented on many of these councils. The same appeal for understanding and unity has in recent days been made by Henry Wallace and General Eisenhower. We, as men of science no less than citizens, should know that it is in this direction that our contribution to world welfare can be made.

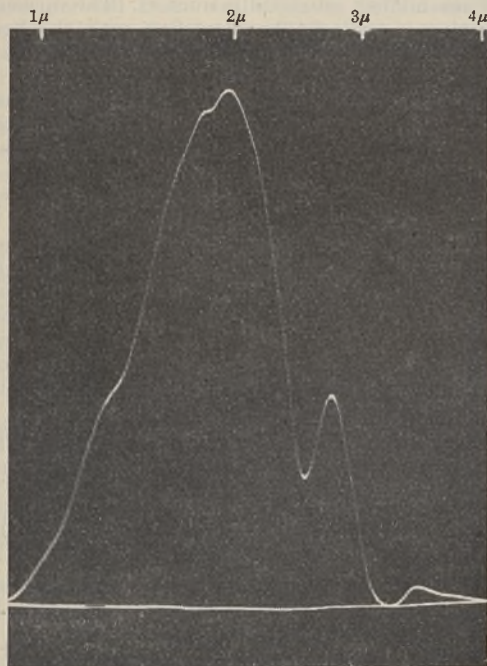
J. D. BERNAL

Birkbeck College,  
London, E.C.4.  
Oct. 7.

<sup>1</sup>"The Atom and the Charter", published jointly by the Fabian Society and the Association of Scientific Workers (Sept. 1946).

### Infra-Red Recording with the Cathode Ray Oscilloscope

IN *Nature* of August 10, p. 196, King, Temple and Thompson have described under the above title an infra-red spectrometer in which the spectrum is displayed on a cathode ray oscilloscope. This spectrometer is virtually identical with the one which we described in *Nature* earlier this year (April 27, p. 547), except that the trace is smoothed after rectification. The impression conveyed by their communication is that theirs was a parallel piece of work, which was concluded shortly after ours and was done quite independently. No mention is made of the fact that our spectrometer was demonstrated to Dr. Thompson on February 28, when full details were given of our procedure, and that it was only after this information had been given that work was started at Oxford on this project. Furthermore, the modification mentioned, and claimed as an advance, was introduced by us some



INFRA-RED EMISSION SPECTRUM FROM A NERNST FILAMENT BETWEEN  $1\mu$  AND  $4\mu$ , SHOWING SUPERIMPOSED ABSORPTION BANDS AT  $1.4\mu$ ,  $1.9\mu$ ,  $2.8\mu$  (DUE TO  $H_2O$  AND  $CO_2$  IN THE ATMOSPHERE), AND  $3.3\mu$  (DUE TO A THIN FILM OF HYDROCARBON MATERIAL)

three months ago, and Dr. Thompson was informed of this several weeks before the date of his communication to *Nature*.

Once an advance of the kind we described has been made, it is obvious that many modifications and improvements can be made in the method of presentation. The accompanying photograph shows that the modifications which we have introduced since the date of our original communication make our apparatus considerably superior to the Oxford one in suppression of noise, indication of base line and detection of weak absorption bands. Our spectrum is strictly comparable with that shown in Fig. 2 of the communication from the Oxford workers.

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MY colleagues and I are not conscious of any act of impropriety in this matter, but the comments above give a misrepresentation of the position, to which I must reply briefly. It was shown more than two years ago by the work of Baker and Robb that a cathode ray tube could be used to record an infra-red spectrum, and the spectroscopic panel of the Hydrocarbon Research Group of the Institute of Petroleum decided to explore the problem as one of its several projects. By mutual agreement between Dr. Sutherland and myself, this particular project was begun by him at Cambridge, since at that time duplication of the necessary apparatus would have been difficult, if not impossible. In company with others, several of my colleagues and I saw the instrument of Daly and Sutherland in operation on February 28, but received no information about its construction other than that contained in their communication in *Nature*, to which acknowledgment was made in our own communication. At that time, my colleagues raised with the Cambridge workers the possibility of using a smoothed trace, since we were hoping to use this method when the necessary bolometer could be obtained; but we were given to understand that Daly and Sutherland preferred their own form of record. After obtaining a Bell Telephone thermistor in May last, we were able to complete our instrument and to demonstrate it to many visitors during June. I was eventually informed indirectly, and later directly by Dr. Sutherland, that he had now gone over to the form of recording which we had used. At no time yet have my colleagues and I ever seen any of the technical drawings or circuits used by the Cambridge workers, or had any details of the experimental arrangements not mentioned in their published note. So far as we can tell, our form of chopped wave, the amplifiers, and other electrical equipment, differ in some important features from those used by them, and the whole instrument differs from theirs much as two different types of spectrometer differ. As stated in our note, we also have already made, or are in process of making, several marked improvements since the original photographs shown in our note were taken.

H. W. THOMPSON

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Oxford.

WE note that Dr. Thompson and his colleagues do not consider there is anything improper in failing to acknowledge information given to them considerably before the date of publication.

Dr. Thompson's statement that no information (other than that contained in our original communication) was obtained by seeing our apparatus in action, and incidentally having every question answered on that occasion, is not justifiable. To take only one instance: the method of scanning by means of a carefully designed cam, coupled by potentiometer to the X plates of the cathode ray tube, and described by the Oxford workers in their note, but not in ours, was of course seen by them and explained to them and others present on that occasion. In this connexion, moreover, the third last sentence of Dr. Thompson's note makes puzzling reading.

The implication in Dr. Thompson's note that we followed the Oxford group in introducing smoothing is also incorrect. We have never been informed what the Oxford workers were doing, and on two occasions when we visited Oxford, while their apparatus was under construction, we were not invited to see it. It is certainly true that we gave them no circuit diagrams, and this may well account for their obvious lack of success in eliminating 'noise' from their spectra.

Dr. Thompson refers to the work of Baker and Robb. This was indeed the first attempt to present an infra-red spectrum on a cathode ray screen, and we gladly acknowledge the stimulus which their work provided to us in this direction. However, the Baker and Robb apparatus was never completed, as they themselves state in their paper. Our attack on the problem differed fundamentally from that of Baker and Robb, and for the first time gave a simple practicable instrument which could be easily duplicated by anyone interested.

The statement that "the spectroscopic panel of the Hydrocarbon Research Group of the Institute of Petroleum decided to explore the problem . . . and by mutual agreement this project was begun at Cambridge" is misleading. Dr. Thompson and one of us (G.B.B.M.S.) were asked to submit *independently* to the Panel our proposals for future research. The problem of cathode ray presentation never appeared in Dr. Thompson's programme at any time, so there was no question of allocating it to Cambridge in any division of work; the really essential piece of this apparatus, namely, the thermistor bolometer, would have been just as accessible to Dr. Thompson as it was to us.

So far as we are concerned, we do not wish your columns to be burdened by any further communications on this affair.

E. F. DALY  
G. B. B. M. SUTHERLAND

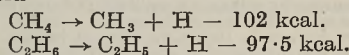
MY colleagues and I feel that to deal with points made by Daly and Sutherland would only lead to fruitless correspondence; and therefore, while repudiating the new charges brought against us, we will refrain from further comment.

H. W. THOMPSON

## BOND-ENERGIES AND ISOMERIZATION

DURING the past three years, the Universities of Manchester and Leeds have held a number of meetings to discuss subjects of joint interest to industrial and academic research workers. These meetings—which began on a small scale—have gradually increased in popularity and scope, as instanced by the attendance of some hundred and seventy chemists from industry and the universities at the conference on "Friedel-Crafts Catalysts and Polymerisation" held in the University of Manchester in September last year<sup>1</sup>, and more recently by an attendance of two hundred at a conference on "Bond-Energies and Isomerisation" held in the Chemistry Department of the University of Manchester on August 31. In welcoming the guests to this conference, Prof. M. Polanyi expressed his appreciation of the enthusiastic response made by industrial firms in these experiments designed to attain a closer co-operation between the universities and industry in problems of wide general interest to both.

The first paper in the morning session on the "Calorimetry of Carbon Bonds" was read by Dr. H. A. Skinner. The speaker discussed the value of modern calorimetric methods (as developed by Rossini and Kistiakowsky in the United States) in providing entirely reliable heats of reaction. Heats of formation, accurate to within 0.1 kcal. mole<sup>-1</sup>, have been measured for the first five or six members of the homologous series of *n*-paraffins, mono-olefines, and monohydric alcohols. The data prove that there are small, but unquestionably real, variations in the C—C and C—H bond-energies as we pass from one compound to another. Direct evidence of a difference in the C—H bond-breaking energies in CH<sub>4</sub> and C<sub>2</sub>H<sub>6</sub> was obtained recently by Stevenson and Hipple from electron impact studies, and independently by Kistiakowsky from kinetic studies of rates of bromination: the mean values from these investigations yield



If accurate measurements of the heats of formation of compounds of the general class CH<sub>3</sub>X, C<sub>2</sub>H<sub>5</sub>X (where X is a univalent atom or radical) can be made, the energy of disruption of the C—X bonds can be deduced from the equations:

$$\begin{aligned} Q_a(\text{CH}_3\text{X}) - Q_a(\text{CH}_3) &= E(\text{C—X}) \text{ in CH}_3\text{X} \\ Q_a(\text{C}_2\text{H}_5\text{X}) - Q_a(\text{C}_2\text{H}_5) &= E(\text{C—X}) \text{ in C}_2\text{H}_5\text{X}, \end{aligned}$$

where the  $Q_a$  values are the heats of formation from atoms. The values of  $Q_a(\text{CH}_3)$  and  $Q_a(\text{C}_2\text{H}_5)$  are given by:

$$\begin{aligned} Q_a(\text{CH}_3) &= Q_a(\text{CH}_4) - 102 = (124.1 + L) \text{ kcal.} \\ Q_a(\text{C}_2\text{H}_5) &= Q_a(\text{C}_2\text{H}_6) - 97.5 = (235 + 2L) \text{ kcal.} \end{aligned}$$

$L$  is the heat of sublimation of carbon: but since it appears also in the quantities  $Q_a(\text{CH}_3\text{X})$  or  $Q_a(\text{C}_2\text{H}_5\text{X})$ , the  $L$  terms cancel out in deriving  $E(\text{C—X})$ . Values of  $E(\text{C—X})$  so obtained are therefore independent of any assumptions regarding the value of  $L$ .

Applying these equations to some specific examples for which reliable heats of formation are known, one can derive:

- (i)  $E(\text{C—C}) = 84.3$  kcal., for the C—C bond in CH<sub>3</sub>CH<sub>3</sub>;
- (ii)  $E(\text{C—C}) = 80.2$  kcal., for the C—C bond in CH<sub>3</sub>CH<sub>2</sub>—CH<sub>2</sub>CH<sub>3</sub>;

$$\text{(iii) } E(\text{C—O}) = 90.2 \text{ kcal., for the C—O bond in CH}_3\text{—OH};$$

$$\text{(iv) } E(\text{C—O}) = 91.5 \text{ kcal., for the C—O bond in CH}_3\text{CH}_2\text{—OH.}$$

The fall in  $E(\text{C—C})$  from ethane to butane has been attributed to the radical resonance energy in the —C<sub>2</sub>H<sub>5</sub> radical: the absence of a similar fall in the C—O bond-breaking energy passing from methyl to ethyl alcohol can be satisfactorily explained in terms of the increased ionicity of the C—O bond in ethyl alcohol relative to C—O in methyl alcohol.

The existing heat of combustion data on the methyl and ethyl halides are insufficiently accurate to allow reliable estimates to be made from the thermochemical data of the carbon-halogen bond-breaking energies. Studies by both kinetic and thermochemical methods are proceeding at Manchester to derive these latter quantities with some precision.

The determination of bond-energies from kinetic studies of simple decomposition reactions was the subject in the second paper, on the "Determination of Bond-Energies by Pyrolysis", given by Dr. C. Horrex (University of Sheffield). Dr. Horrex described the attempts which have been made to derive bond-energies by measuring the temperature variation in the equilibrium constants of decompositions of the type  $AB \rightarrow A + B$ . The method has been successfully used in a number of cases (for example,  $\text{I}_2 \rightleftharpoons 2\text{I}$ ,  $\text{C}_2\text{N}_2 \rightleftharpoons 2\text{CN}$ ,  $\text{OH} \rightleftharpoons \text{O} + \text{H}$ ,  $\text{C}_6\text{Ph}_6 \rightleftharpoons 2\text{CPh}_3$ ), but has limitations and is a difficult technique to apply.

The pyrolysis method was introduced by Rice and Johnson in 1934, who measured the temperature coefficients of the rates of decomposition of several organic compounds, and calculated the corresponding activation energies. The compounds were passed rapidly at low pressures through a tube heated to different measured temperatures, and the extent of decomposition into free radicals was determined by the Paneth effect on metallic mirrors. The measured activation energy can be identified with the bond-breaking energy of the primary process  $RX \rightarrow R + X$ , if secondary reactions between the radicals and the undecomposed  $RX$  do not occur, or can be prevented. Butler and Polanyi employed the pyrolysis method for study of the decomposition of organic iodides,  $RI \rightarrow R + \text{I}$ , measuring the rate of reaction by the amount of iodine formed. These investigators found marked variations in the C—I bond-energy as the radical  $R$  is changed. There is a steady drop in bond-energy in passing from MeI, EtI, *n*PrI, to *iso*PrI and *t*-BuI. The technique used by Butler and Polanyi was not entirely satisfactory, and reproducible results could not be guaranteed. The activation-energies were calculated by assuming a temperature-independent factor of  $10^{13}$ , and not from the temperature coefficients of the rates of decomposition.

The study of the pyrolysis of the organic iodides using a modified and much improved technique has now been started by Dr. Horrex and Dr. Szwarc. The results are very reproducible, and the activation-energies derived from the slopes of the graphs  $\ln k$  against  $1/T$  are independent of contact times and changes in the carrier gas. Experiments using EtI and C<sub>6</sub>H<sub>5</sub>.CH<sub>2</sub>I have been extensively studied, and yield the following results:

$$\begin{aligned} \text{EtI: Activation-energy} &= 54 \pm 1 \text{ kcal.} \\ \text{Temp.-independent factor} &= 12 \times 10^{13}. \end{aligned}$$

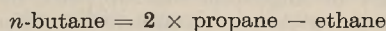
$$\begin{aligned} \text{C}_6\text{H}_5\text{.CH}_2\text{I: Activation-energy} &= 29.5 \pm 1 \text{ kcal.} \\ \text{Temp.-independent factor} &= 10^9\text{--}10^{10}. \end{aligned}$$

The result using ethyl iodide agrees with the earlier determination by Butler and Polanyi, but the earlier estimation of the benzyl iodide bond-energy placed it at too high a figure. The lower value (29½ kcal.) is in much better agreement with the value to be expected from the study of the reaction of benzyl chloride and sodium vapour, and points to a high resonance energy and marked stability in the benzyl free radical.

Dr. J. G. M. Bremner (I.C.I. (Billingham)) delivered a paper (prepared jointly with Mr. G. D. Thomas) on "The Extension of Thermodynamic Values from the Aliphatic to the Aromatic Series". The speaker showed that the free energy of formation of the aliphatic hydrocarbons can be expressed as a sum of contributions from individual groups, in somewhat similar manner to that in which the heats of formation can be expressed with reasonable accuracy as a sum of individual bond-energies. The free-energy values (over a range of temperature) for

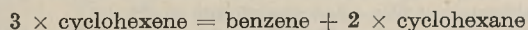
the groups  $\text{CH}_3$ ,  $>\text{CH}_2$ ,  $\text{>CH}$ , and  $\begin{array}{c} | \\ -\text{C}- \\ | \end{array}$  have been

tabulated, and when added together give results for the normal paraffins agreeing closely with Rossini's values. Equations of the type



can be set up, and good agreement of estimated and observed free energies obtained when the equations show an identity of groups on each side.

In deriving the resonance energy of aromatic compounds, the Pauling method employs bond-energy values for C—C and C=C which are characteristic of aliphatic compounds. A similar extension cannot be made to calculate the resonance free energy of an aromatic compound. The referring of bond or group values derived from the aliphatic to the aromatic series involves a reaction in which there is an increase in the entropy of translation. This can be estimated, and the entropy decrease then remaining can be attributed to the increase in symmetry and the decrease in the number of internal rotations. When these factors are allowed for in a reaction yielding benzene, for example,



there remains an *additional* small entropy decrease, which may be referred to as the resonance entropy of benzene. The estimated value of this resonance entropy is about 4 cal./degree.

The afternoon session, during which Prof. M. G. Evans acted as chairman, opened with a paper by Dr. A. G. Evans on "Ionization Energies of Carbon-halogen Bonds, and Proton Affinities of Olefines". The speaker began by describing the reactions of organic halides in solution, which involve substitution at a saturated carbon atom. Two possible mechanisms have been established by Ingold and co-workers—a unimolecular  $S_N^1$  mechanism and a bimolecular or  $S_N^2$  mechanism.

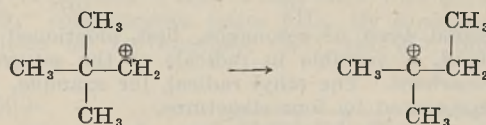
It has been found experimentally that the unimolecular  $S_N^1$  reaction-rate of  $R-X$  increases along the series of  $R=\text{Me, Et, sec-Pr, } t\text{-Bu}$ , whereas the bimolecular  $S_N^2$  reaction-rate decreases along the same series.

An explanation of these facts can be given in terms of the activation-energies associated with both mechanisms, as derived from potential-energy curves.

The prime factor favouring  $S_N^1$ , in passing from  $\text{Me} \rightarrow t\text{-Bu}$ , is the great increase in the ease of ionization of the  $R-X$  bond, due to the marked fall in the ionization potential of the radical  $R$ . The decrease in the  $S_N^2$  rates, from  $\text{Me} \rightarrow t\text{-Bu}$ , can be accounted for satisfactorily in terms of the carbon-halogen bond-strengths and steric hindrance.

Dr. Evans showed how the values of the ionization potentials of hydrocarbon radicals, coupled with bond-breaking energies derived from substitution heats, can be combined to estimate the proton affinities of olefines. The calculated affinities show that carbonium ions are markedly more stable when the positive charge is located on a tertiary, or on a secondary, carbon atom than when it is on a primary carbon atom. The energy differences are sufficiently large to allow isomerization to take place.

This effect is illustrated in the neopentyl derivatives, in which all reactions of the carbonium-ion type yield exclusively rearranged products which are all accounted for if the ion rearranges thus:



Other examples of such isomerization frequently occur in the Friedel-Crafts reaction. The 'peroxide effect' for hydrogen bromide addition to double bonds, which constitutes an exception to the Markownikov rule, was discussed in terms of bond-energies.

The determination of bond-energies by spectroscopic methods was outlined in the next contribution, by Dr. H. D. Springall, on the "Spectroscopic Evidence on Bond-Energies". Dr. Springall pointed out that the estimation of the heat of formation from atoms ( $Q_a$ ) of an organic compound requires a prior knowledge of the energies of dissociation ( $D$ ) of a number of common diatomic molecules—particularly  $\text{H}_2$ ,  $\text{O}_2$ ,  $\text{N}_2$ , and  $\text{CO}$ . The latter is important in determining the value of the latent heat of sublimation of carbon,  $L$ .

To evaluate  $D$  for a diatomic gas, it is necessary to examine the vibrational energy-levels of the ground-state, and to evaluate the energy difference between the lowest state ( $V=0$ ) and the onset of the dissociation continuum ( $V=V_c$ ). From an analysis of a suitable vibrational spectrum, it is usually possible to trace the vibrational-levels in the ground-state from  $V=0$  to  $V=c. 20$ . It is not, however, normally possible to observe up to  $V=V_c$  directly. Owing to the anharmonic nature of the vibrational motion, the energy difference  $\Delta E_v$  between successive levels is, to a first approximation, a linear function of  $V$ , so that  $V_c$  may be evaluated by the Birge-Sponer method of plotting  $\Delta E_v$  against  $V$  for the observed range, and extrapolating to  $\Delta E_v \rightarrow 0$ , when  $D$  is given by the area under the curve.  $D$  may also be estimated by plotting  $E_v - E_0$  against  $\Delta E_v$ , and extrapolating to  $\Delta E_v \rightarrow 0$ .

At the present time, the  $D$  values for  $\text{H}_2$  and  $\text{O}_2$  are known with certainty ( $\text{H}_2$ , 4.46 eV.;  $\text{O}_2$ , 5.08 eV.), but values for  $\text{N}_2$  and  $\text{CO}$  are still ambiguous. In both these cases, two alternatives exist:  $\text{CO}$ , 9.14 or 11.11 eV.;  $\text{N}_2$ , 7.38 or 9.76 eV. The most recent analysis based on the application of the Hund non-crossing rule, by Gaydon and Penney, favours the higher values in each case. The corresponding heats of atomization ( $\Delta H_{298}$ ) are

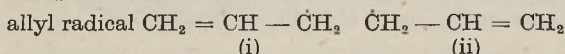
C graphite	= 126.2 or 171.6 kcal.
$\frac{1}{2}$ H <sub>2</sub>	= 51.8 kcal.
$\frac{1}{2}$ O <sub>2</sub>	= 59.1 kcal.
$\frac{1}{2}$ N <sub>2</sub>	= 85.5 or 113.0 kcal.

Dr. E. Warhurst concluded the afternoon session with a paper on the "Quantum Mechanical Theory of Bond-Energies". The gradations in the bond-energies in a series of compounds  $R-X$  have been explained qualitatively by the concept of resonance, in a theoretical treatment given by Baughan, Evans and Polanyi. The main factors influencing the  $C-X$  bond-strength in a series of  $R-X$  compounds are:

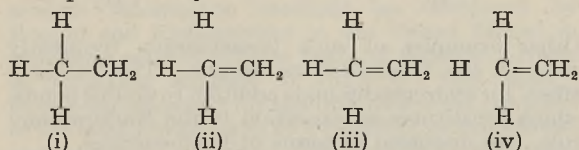
- (i) the resonance-energy of the radical  $R$ ;
- (ii) the ionic-covalent resonance energy from the

interaction of the structures  $R-X$  and  $\overset{\pm}{R}\overset{\mp}{X}$ .

One type of resonance of the free radical is well known, namely, that in an unsaturated or conjugated group; for example,



A second type of resonance, first mentioned by Wheland, is possible in radicals of the saturated hydrocarbons. The ethyl radical, for example, can be represented by four structures,



between which resonance can occur. The number of canonical states increases with the complexity of the radical: there are seven for *sec*-propyl, and ten for *t*-butyl.

If there were no interaction with the ionic state  $\overset{\pm}{R}\overset{\mp}{X}$ , then the changes in the bond-strength  $C-X$  in a series  $R-X$  would be equal to the changes in the radical resonance energy  $R_r$  of the radical. In the case of  $C-H$  bonds, where the ionic contributions are relatively small, there is a close parallelism between the  $C-H$  bond-breaking energies and the calculated  $R_r$  values, the bond-energies falling as the  $R_r$  values increase.

In most cases there is an appreciable resonance energy  $R_{ih}$  between the ionic and covalent states, and this factor operates in the direction of strengthening the  $R-X$  bond. The net strength of the  $R-X$  bond is accordingly determined by the balance between the weakening effect of radical resonance energy and the strengthening effect of the ionic resonance term. In the  $C-I$  bonds, the fall in bond-energy from  $\text{Me}-I$  to  $t\text{-Bu}-I$  is less than the fall in the  $C-H$  bond energies from  $\text{Me}-H$  to  $t\text{-Bu}-H$ , which agrees with our experience of the greater ionic character of  $C-I$  relative to  $C-H$  bonds. The strengths of the  $C-O$  bonds, from  $\text{Me}-OH$  to  $t\text{-Bu}-OH$ , show very little, if any, fall down the series. Here the ionic character of the  $C-O$  bonds is increasing sufficiently from  $\text{MeOH}$  to  $t\text{-BuOH}$  completely to offset the weakening effect of the radical resonance.

Periods of approximately thirty minutes were given to discussion of each paper, during which several valuable points illustrating the application of the general theory in reactions of industrial importance were made.

H. A. SKINNER

<sup>1</sup> See *Nature*, 156, 638 (November 24, 1945).

## CARBON SOURCES IN THE PHOTOSYNTHESIS OF AQUATIC PLANTS

By PROF. E. STEEMANN NIELSEN

Botanical Department, Danish Pharmaceutical Highschool

WHEREAS the carbon dioxide of the air as the carbon source in the photosynthesis of terrestrial plants has been known since the end of the eighteenth century, matters are quite different as regards the carbon supply of aquatic plants.

It was assumed by Nathansohn<sup>1</sup> that aquatic plants are able to utilize half of the carbon dioxide of bicarbonate in the surrounding water, while at the same time carbonate develops. He was of opinion that only carbon dioxide was directly assimilated, carbon dioxide being constantly released anew from the bicarbonate when the former was removed by the plants.

Another view, however, was advanced by Angelstein<sup>2</sup>, according to which aquatic plants were not only able to utilize the carbon dioxide in true solution, but also were able to use the bicarbonate directly in photosynthesis.

The view of Angelstein was supported by experimental work by Arens<sup>3</sup> on directed transfer of ions through the leaves of water plants.  $\text{Ca}(\text{HCO}_3)_2$  is consumed on the lower surface of the leaf, while an equivalent quantity of  $\text{Ca}(\text{OH})_2$  ions emerges at the upper surface. By means of a series of growth experiments, I showed<sup>4</sup> that bicarbonate may be an absolutely decisive direct carbon source in the photosynthesis of aquatic plants.

On the other hand, James<sup>5</sup> showed that the aquatic moss *Fontinalis* is unable to utilize bicarbonate directly. This is in accordance with experiments made on the same plant in the present investigation. As will be shown, *Fontinalis*, however, holds a special position.

In his admirable and important book on photosynthesis, Rabinowitch<sup>6</sup>, if anything, supports the view that bicarbonate is not used directly by aquatic plants. He does not feel quite sure of the reliability of Arens' experiments. But owing to the War, Rabinowitch was unaware of my work.

Experiments described herewith throw light on the qualitative and quantitative importance of carbon sources in the photosynthesis of aquatic plants. A full account will appear later in *Dansk Botanisk Arkiv*.

In Fig. 1 curves for the photosynthesis of *Myriophyllum spicatum* in optimal light (37,000 lux, 20° C.) partly with carbon dioxide in true solution (upper curve), partly with  $\text{HCO}_3^-$  as carbon source (lower curve, full line) are drawn together, the total carbon dioxide in  $10^{-3}$  mol/l. being marked along the abscissa. In the experiments with free carbon dioxide as the carbon source the amount of  $\text{HCO}_3^-$  present was without any importance whatever,  $pH$  being 4.6, at which hydrogen ion concentration only about one per cent of the total carbon dioxide occurs as  $\text{HCO}_3^-$  ions. As these have, as will appear, a much smaller effect on the photosynthesis even than free carbon dioxide, we may completely disregard the presence of  $\text{HCO}_3^-$ .

The bicarbonate curve ( $pH$  8.3) is corrected for the effect of the carbon dioxide in true solution present (see dotted curve), the intensity of photo-

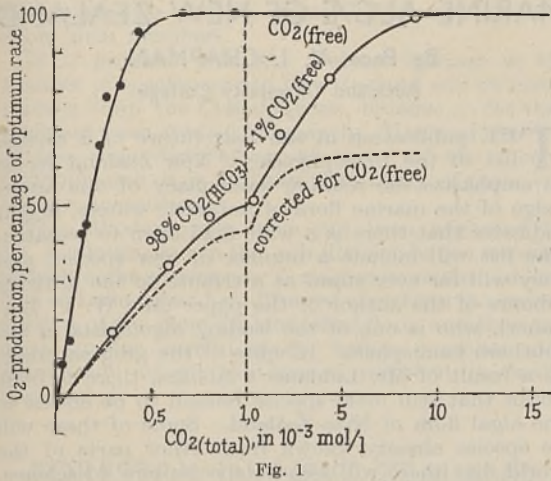


Fig. 1

synthesis that would have been obtained from the carbon dioxide in true solution corresponding to the amount of bicarbonate (at pH 8.3, 1 per cent carbon dioxide free) being subtracted from the original curve. At 10<sup>-3</sup> mol/l. the scale of the abscissæ is changed.

Fig. 1 shows that both free carbon dioxide and HCO<sub>3</sub><sup>-</sup> ions can be directly assimilated by *Myriophyllum*. As will be shown below, photosynthesis in this species is independent of the hydrogen ion concentration in the pH range 4-10. At low concentrations of carbon dioxide (total) the effect of free carbon dioxide is about four times as great as the effect of CO<sub>2</sub>HCO<sub>3</sub><sup>-</sup>.

Fig. 2 shows the results of similar experiments with *Fontinalis antipyretica* (15,000 lux, 22° C.). In this species there is practically no effect of HCO<sub>3</sub><sup>-</sup> ions on photosynthesis.

The *Fontinalis* originated from a locality with a considerable content of free carbon dioxide (order of magnitude 0.3 x 10<sup>-3</sup> mol/l.). From Fig. 2 it appears that it is possible for the plant to maintain considerable photosynthesis at this concentration of carbon dioxide.

The *Myriophyllum spicatum*, on the other hand, originated from a locality with practically no content of free carbon dioxide (order of magnitude 10<sup>-6</sup> mol/l.). The pH in summer is 9-10. The content of HCO<sub>3</sub><sup>-</sup> is 2 x 10<sup>-3</sup> equivalents/l. From Fig. 1 it

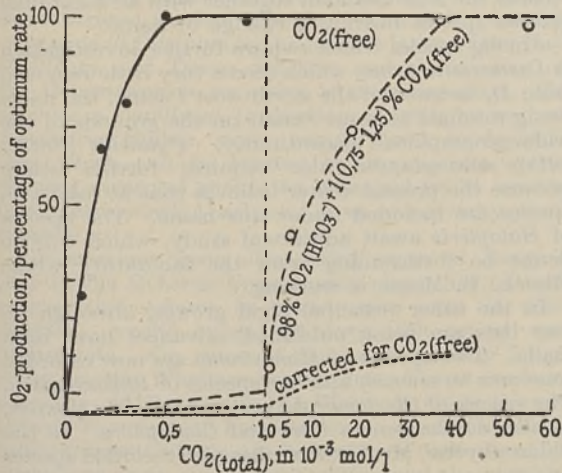


Fig. 2

appears that it is possible for the plant to maintain considerable photosynthesis at this HCO<sub>3</sub><sup>-</sup> concentration.

With free carbon dioxide as carbon source, the intensity of photosynthesis is independent of the ion composition of the water (see accompanying table).

RELATIVE PHOTOSYNTHESIS IN *Myriophyllum* AT 2 x 10<sup>-4</sup> MOL. CO<sub>2</sub>/l. 37,000 LUX, 20° C., pH 4.1.

Cations	Anions	Relative intensity of photosynthesis
H <sup>+</sup>	Cl <sup>-</sup>	102 ± 2
H <sup>+</sup> , K <sup>+</sup>	Cl <sup>-</sup> , SO <sub>4</sub> <sup>---</sup>	101 ± 2
H <sup>+</sup> , K <sup>+</sup> , Na <sup>+</sup> , Ca <sup>++</sup>	Cl <sup>-</sup> , SO <sub>4</sub> <sup>---</sup>	100 ± 2

The intensity of photosynthesis in *Myriophyllum* with HCO<sub>3</sub><sup>-</sup> as carbon source, on the other hand, is very dependent on the ion composition, both cations and anions asserting themselves (see Fig. 3). The best result at a certain HCO<sub>3</sub><sup>-</sup> concentration is obtained in lake water from the habitat of the species. In a pure KHCO<sub>3</sub> solution (10<sup>-3</sup> mol/l.) the photosynthesis is only 42 per cent of that in lake water with the same HCO<sub>3</sub><sup>-</sup> concentration (same pH). By simultaneous addition of, for example, Ca<sup>++</sup> and K<sup>+</sup> ions an

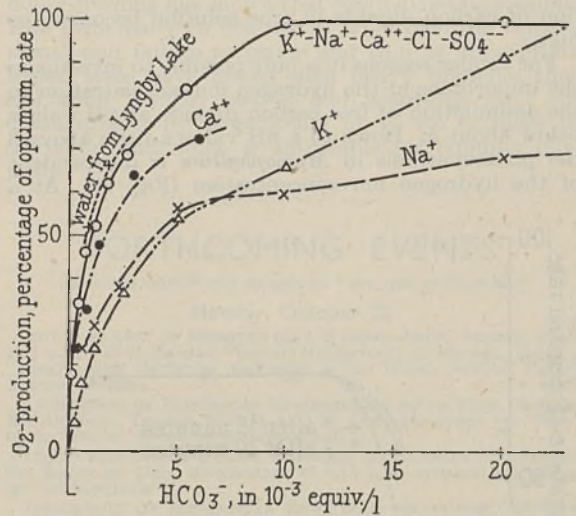


Fig. 3

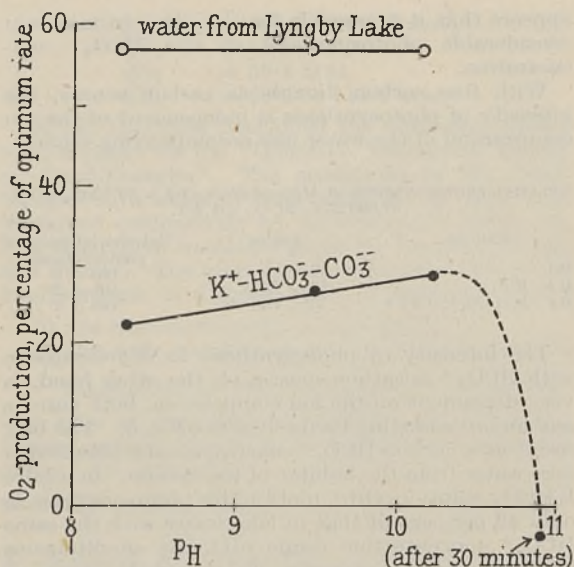
intensity of photosynthesis of 79 per cent of that in the lake water is obtained. The quantitative importance of the cations and anions was also investigated. It is the absolute amounts of the various ions which are of importance, not the proportions between the various ions. A further addition of a definite ion is of no importance when the optimum effect of this ion is reached.

In the pH range 8 to somewhat above 10 the assimilation of HCO<sub>3</sub><sup>-</sup> in *Myriophyllum* is independent of the hydrogen ion concentration in natural lake water (Fig. 4, upper curve). In the pure KHCO<sub>3</sub> (K<sub>2</sub>CO<sub>3</sub>) solution there is some increase of the photosynthesis with a rise of pH at lower concentrations of HCO<sub>3</sub><sup>-</sup> (Fig. 4, lower curve), whereas at high HCO<sub>3</sub><sup>-</sup> concentrations there is instead a very considerable reduction of the intensity of assimilation, the factor of time, however, asserting itself highly. Below pH 8 it is impossible to undertake investigations of the dependence of the assimilation of HCO<sub>3</sub><sup>-</sup> on the hydrogen ion concentration, as the concentra-

## MARINE ALGÆ OF NEW ZEALAND

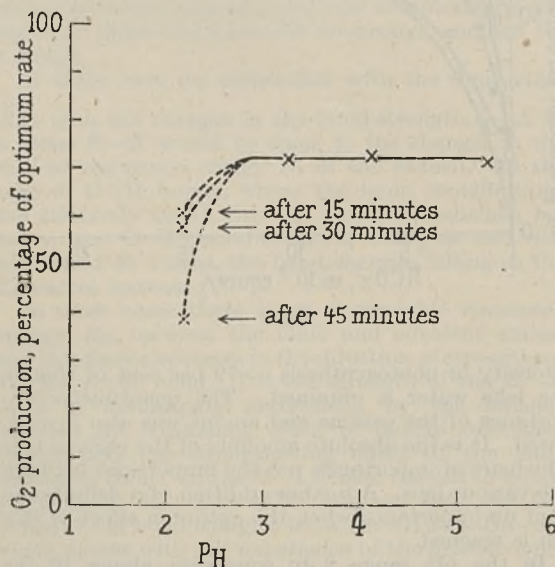
By PROF. V. J. CHAPMAN

Auckland University College

FIG. 4. CONCENTRATION OF  $\text{HCO}_3^-$   $10^{-3}$  EQUIVALENTS/L.

tion of carbon dioxide in true solution becomes too high.

For similar reasons it is only possible to investigate the importance of the hydrogen ion concentration to the assimilation of free carbon dioxide at pH values below about 5. Down to a pH value a little above 3 the photosynthesis in *Myriophyllum* is independent of the hydrogen ion concentration (Fig. 5). At a

FIG. 5. CONCENTRATION OF FREE CARBON DIOXIDE  $3.2 \times 10^{-4}$  MOL/L.

still lower pH value the hydrogen ions have a detrimental effect on the assimilation of carbon dioxide. This poison effect increases with time.

<sup>1</sup> Nathansohn, A., *Ber. sächs. Ges. d. Wiss.*, 59, 211 (1907).

<sup>2</sup> Angelstein, W., *Beitr. Biol. d. Pfl.*, 10, 87 (1910).

<sup>3</sup> Arens, K., *Jahrb. f. wissenschaft. Bot.*, 83, 513 (1936).

<sup>4</sup> Steemann Nielsen, E., *Dansk. Bot. Ark.*, 11, No. 8 (1944).

<sup>5</sup> James, W. O., *Proc. Roy. Soc.*, B (1928).

<sup>6</sup> Rabinowitch, E. J., "Photosynthesis and Related Processes", Vol. 1 (New York, 1945).

THE publication in the near future of a revised list of the Phaeophyceae of New Zealand serves to emphasize the relative inadequacy of our knowledge of the marine flora of antarctic waters, and it indicates that there is a wide field open to research. The list will include a number of new species, and they will for ever stand as a tribute to the untiring labours of the author of the paper (Mr. W. V. Lindauer), who is one of the leading algologists in the southern hemisphere. In spite of the progress made as a result of Mr. Lindauer's labours, there is little doubt that still more species remain to be added to the algal flora of New Zealand. Some of these will be species already known from other parts of the world, but there will also be species new to science. The publication of this list should serve, among other things, to stimulate work in New Zealand on the validity of some of the species recorded, especially those characteristic of the northern hemisphere, for example, *Cutleria multifida*. Although this species is at present retained in the list, there is some doubt as to whether the *Cutleria* found in New Zealand is really this species or whether it is not an entirely different one. However, plants are not very common and appear to be variable, so that until further collections are available a decision cannot yet be made.

Among the new plants listed by Mr. Lindauer are unnamed (for the moment) new species in each of the genera *Hecatonema*, *Mikrosyphar*, *Herponema*, *Spatoglossum* and *Tinocladia*, together with the following species new to science: *Leathesia nova-zelandica*, *Nemacystis nova-zelandica*\*, *Papenfussiella lutea*\*, *Myriogloia lindaueri*\*, and *Dictyota papenfussii*.

When compared with the earlier lists published by Laing, it will be noticed that a number of species of doubtful occurrence have disappeared and certain changes in nomenclature have been made. In the latter category the most important change is that of *Cystophora* for *Blossevillea*, because so many workers are used to the former name. It seems evident, however, that according to the rules of priority this change must be made. Altogether, the list contains seven species new to science and twenty-seven new records for New Zealand, together with an additional sixteen species bearing a change of name.

Among species which require further investigation is *Desmerestia firma*, which seems very little removed from *D. herbacea* of the north-west Pacific, the name being retained to some extent on the grounds of the wide geographical discontinuity. *Pylaiella* (*Bachelotia*) *nova-zelandica* also requires further study because the present writer believes that at least two species are included under this name. The species of *Halopteris* await additional study, which will no doubt be forthcoming from the laboratory where Miss L. B. Moore is working.

In the other principal algal groups, although no new lists are being published, advances have been made. Two species of *Monostroma* are now recorded (one new to science) and one species of *Rhizoclonium*. The species of *Chaetomorpha* still present some puzzles, as also do the genera *Ulva* and *Cladophora*. In the Chlorophyceae, Mr. Lindauer has also recorded species

\* Published by Kylin from material supplied by Mr. Lindauer.



new to science, and the genus *Codium* now contains three such members.

It is probable that the greatest increase in the number of species new to New Zealand will be forthcoming from the Cyanophyceæ, because so far they have not been studied intensively. However, in view of the wide distribution of many of the marine Cyanophyceæ it is unlikely that many of these will be new to science.

The Rhodophyceæ have not been neglected by Mr. Lindauer, and in this sub-division he has recorded at least eight species new to science since the publication of Laing's last list. The red algæ form the largest portion of the New Zealand algal flora, and they will need further careful study before complete discrimination of all the species recorded is finally achieved.

## FORESTRY IN NEW ZEALAND

IN the annual report of the New Zealand State Forest Service to March 31, 1945 (E. V. Paul, Govt. Printer, Wellington, 1945), a detailed statement of post-war forest policy is given, evidencing the importance attached to this branch of the national economy. The chief problems are connected with the indigenous forests, the large areas of exotic plantations, and fire protection and soil conservation, the latter of a gravity now becoming recognized in many other parts of the world.

The evolution of a silvicultural system for rimu is still the outstanding problem in the management of the indigenous forests of New Zealand. Although it was believed that its silviculture should be simple, this is not so; it does not 'seed' freely, and seedlings are intolerant of light and drought. It is hoped to undertake special investigations on these subjects.

Assessment surveys and sample plot investigations have been actively pursued as a basis of working plans for all the State exotic forests, which are regarded as essential to the development of a sound national forest policy. The total annual growth in the exotic forests seems to be very much less than commonly believed, and it will be necessary to limit sawn-timber production in the immediate future to safeguard requirements in high-grade timber.

The results both of assessment surveys and of trials in the sawing, drying and utilization of young *Insignis* pine timber for house building have clearly demonstrated the bad effect of 8 ft. × 8 ft. planting on stands of this pine in the pumice lands of the Bay of Plenty and Taupo districts, and the wisdom of the Department in reverting to closer spacings. To produce a significant proportion of heart as well as defect-free timber, every compartment of *Insignis* pine which can be treated by appropriate silvicultural measures should be managed on at least a forty years rotation and some even on a seventy years rotation.

Observations upon clear-felled areas of *Insignis* pine in the Rotorua Conservancy show that natural regeneration cannot be relied upon even in that district; results appear to vary with aspect, exposure, etc. On some of the more recently felled areas on the Whakarewarewa State Forest, and on even the oldest areas in the Waitapu State Forest, natural regeneration has been so unsatisfactory that further investigations are necessary of light burning operations as an aid to regeneration and the possible reversion to planting operations for re-establishment.

In land acquisition the Forest Service has continued its long-established policy of avoiding the enclosure of extensive areas of good farming land; but it requires small areas of good-quality soil for exotic hardwoods, the more extensive planting of which is to be undertaken as a post-war project.

For twenty-five years the Forest Service has successfully protected against fire some 15,000,000 acres of State forest, Crown lands, native lands, national parks, etc. This is claimed to be the greatest single contribution by any one national body to the conservation not merely of New Zealand's forest wealth alone, but also of the great soil and water resources of the Dominion. This policy is being continued, and is being supported by numerous Catchment Boards set up during the year under the Soil Conservation and Rivers Control Act, 1941. Co-operation by Maori interests, by forestation and sawmilling companies, and by local bodies is being continually sought and obtained.

It was hoped that the whole of the expansion in timber production required for the post-war period could be met by the exotic forests. An exhaustive series of trials in the logging, milling, drying, grading and utilization of young *Insignis* pine timber for house-framing has shown that this will not be possible. Due principally to the use of wide planting spacings and failure to prune and thin at appropriate times, trees have grown such heavy branches that the sawn timber, boards and scantling, etc., are characterized by large knots of 1½ in. or more in diameter, and much is unsuitable for building purposes.

## FORTHCOMING EVENTS

(Meetings marked with an asterisk \* are open to the public)

### Monday, October 28

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 3 p.m.—Field-Marshal Viscount Montgomery of Alamein, G.C.B.: "Morale—with Particular Reference to the British Soldier" (Lloyd Roberts Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Electricity" (to be opened by the President).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Manchester), at 6.15 p.m.—General discussion on "Anti-oxidants".

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. A. Rodgers: "The Pressurization of Aircraft Cabins".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the AGRICULTURE AND FOOD GROUPS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. G. L. Baker: "Agricultural Delaware and its Supporting Research"; Prof. J. A. Scott-Watson: "Agricultural Research and Farming Progress".

### Tuesday, October 29

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "Locomotor Mechanisms in Vertebrate Animals, 1. Aquatic Locomotion: Fins as Propellers; Brakes and Mechanisms of Directional Control".\*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. Redcliffe N. Salaman, F.R.S.: "The Potato as a Factor in Social Structure".

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Mr. F. H. Townsend, Mr. G. B. Goff and Mr. S. R. Kharbada: "An Improved Television Signal Generator and its Uses".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH and EAST OF SCOTLAND SECTIONS (joint meeting with the EDINBURGH UNIVERSITY CHEMICAL SOCIETY, in the Biochemical Lecture Theatre, The University, Teviot Place, Edinburgh), at 7 p.m.—Dr. D. J. Bell: "Some Observations on Biological Oxidation and Reduction".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester 3), at 7 p.m.—Mr. C. W. Bradley: "Some Applications of Photography to Textile Research".

### Wednesday, October 30

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Symposium on "Direction-Finding".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Prof. A. C. Fraser: "Adsorption and Digestion of Fat".

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. H. C. Stephenson: "Protection Against Industrial Poisons".

ROYAL INSTITUTE OF CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Prof. Alexander Findlay: "Students and the Royal Institute of Chemistry".

SHEFFIELD METALLURGICAL ASSOCIATION (in the Victoria Hall, Sheffield), at 7.30 p.m.—Dr. T. E. Allibone: "Atoms, Electrons and Engineers" (Faraday Lecture, by invitation of the Institution of Electrical Engineers).

SOCIETY OF VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in Biology" (to be opened by Prof. J. Z. Young, F.R.S., and Dr. D. Pontecorvo).

#### Thursday, October 31

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p.m.—Mr. C. B. Bisset: "Recent Progress in Geological Investigation and Mineral Developments in the Colonies, 5, The Work of the Geological Survey of Uganda".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. J. R. Partington: "History of Alchemy and Early Chemistry. 1".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. A. R. Collar: "Aeroclastic Problems at High Speed".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. Jaroslav Heyrovsky: "The Fundamental Laws of Polarography".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield 1), at 6.30 p.m.—Mr. J. Bradwell: "The Control of Coke Quality by the Shatter Test".

#### Friday, November 1

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF SWANSEA CHEMICAL SOCIETY, at University College, Swansea), at 6 p.m.—Prof. D. H. Hey: "Hamolytic Reactions".

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at University College, Gower Street, London, W.C.1), at 6.30 p.m.—Sir Philip R. Morris: "The Psychologist's Contribution to Educational Progress".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the College of Technology, Manchester), at 6.30 p.m.—Lecture by the Rt. Hon. Lord Piercy.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Percy Dunsheath: "New Problems in Electrical Engineering".

#### Saturday, November 2

BIOCHEMICAL SOCIETY (joint meeting with the SOCIETY FOR GENERAL MICROBIOLOGY, at the London School of Hygiene, Keppel Street, London, W.C.1), at 11.15 a.m.—Discussion on "Quantitative Biochemical Analysis by Microbiological Response".

GEOLOGISTS' ASSOCIATION (at the City Literary Institute, Stukeley Street, London, W.C.2), at 2.30 p.m.—Annual Reunion.

## APPOINTMENTS VACANT

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

FOUNDRY TECHNICAL OFFICERS to conduct research projects at Sheffield and other steel-making centres—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (November 1).

LECTURER IN CHEMISTRY in the Coventry Technical College—The Director of Education, Education Offices, Coventry (November 2).

ASSISTANT IN THE MECHANICAL ENGINEERING DEPARTMENT—The Principal and Secretary, Harris Institute, Preston (November 2).

LECTURER IN PHYSICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (November 4).

HEAD OF THE CHEMISTRY AND METALLURGY DEPARTMENT at Swansea Technical College—The Director of Education, The Guildhall, Swansea (November 5).

SENIOR ASSISTANTS IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (November 8).

EDUCATIONAL PSYCHOLOGIST for work in connexion with the Child Guidance Service—The Clerk of the County Council, Shire Hall, Dorchester (November 9).

LECTURER IN THE DEPARTMENT OF CHEMISTRY in the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (November 9).

SUPERINTENDING ENGINEER in the Radar Research and Development Establishment of the Ministry of Supply—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1656 (November 14).

LECTURER IN MATHEMATICS—The Secretary, Queen's University, Belfast (November 15).

PHYSICIST to take charge of a testing laboratory—The Wool Industries Research Association, Torridon, Headingley, Leeds 6 (November 16).

CHIEF OF THE DIVISION OF SOILS (headquarters at the Waite Agricultural Research Institute, Adelaide), Council for Scientific and Industrial Research—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting No. 932 (November 18).

OFFICER-IN-CHARGE of the Dairy Research Section, Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting No. 1009 (November 18).

RESEARCH OFFICER IN THEORETICAL PHYSICS, Division of Industrial Chemistry of the Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2, quoting No. 1004 (November 18).

PRINCIPAL OF THE KEIGHLEY TECHNICAL COLLEGE—The Acting Borough Education Officer, Keighley, Yorks. (November 18).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (December 21).

AGRICULTURAL ECONOMIST on the staff of the Senior Agricultural Economist in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Department of Agriculture and Lands, P.O. Box 387, Salisbury, Southern Rhodesia (December 31).

RESEARCH ASSISTANTS (2, temporary) for work on composts and organic fertilizers—The Registrar, The University, Reading.

GLASS-BLOWER AND STEWARD IN THE DEPARTMENT OF CHEMISTRY, University of Cape Town—The Secretary, Overseas Department (Ref. 18885), Ministry of Labour and National Service, Norfolk House, St. James's Square, London, S.W.1.

SCIENTIFIC ASSISTANT (Science graduate, Zoology), and a TECHNICAL ASSISTANT (Arts graduate), for bureau literary work—The Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture, New Haw, Weybridge, Surrey.

DEMONSTRATOR (part-time) IN BIOLOGY, and a LABORATORY ASSISTANT (Grade II) for the PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

AGRICULTURAL ADVISER on the staff of H.M. Special Commissioner, S.E. Asia, Singapore—The Personnel Department, Foreign Office, 8 Carlton House Terrace, London, S.W.1.

PROFESSOR OF GEOGRAPHY, a PROFESSOR OF PHYSICS, and a LECTURER IN CHEMISTRY, at the University of Rangoon, Burma—The Director, Appointments Department, The British Council, 3 Hanover Street, London, W.1, endorsed "Rangoon".

PRINCIPAL OF THE NEWTON RIGG FARM SCHOOL (graduate in Agriculture or appropriate sciences, with teaching experience and sound practical experience on farms)—The Director of Education for Cumberland and Secretary to the Farm School Governors, County Education Offices, Portland Square, Carlisle.

LECTURER (man or woman) IN PHARMACEUTICAL SUBJECTS in the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth.

LECTURER IN MINING—The Principal, County Mining and Technical School, Nuneaton, Warwickshire.

LECTURER IN PHYSICS to Final B.Sc. standard—The Organiser of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby.

## REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

### Other Countries

Proceedings of the United States National Museum. Vol. 96, No. 3196: Notes on Recently Mounted Reptile Fossil Skeletons in the United States National Museum. By Charles W. Gilmore. Pp. 195-204 + plates 12-19. (Washington, D.C.: Government Printing Office, 1946.) [154]

Indian Forest Bulletin. No. 90: The Efficiency of Enumerations. By Dr. A. L. Griffith. 10: Hill Sal (*Shorea robusta*) Forest in the United Provinces. Pp. ii + 12. 6 annas. No. 91: The Efficiency of Enumerations. By Dr. A. L. Griffith. 11: The Distribution of the Volume Figures (continued). Pp. ii + 5. 4 annas. (Dehra Dun: Forest Research Institute, 1946.) [164]

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 63: Preparation and Preservation of Fruit and Vegetable Products. By Dr. G. S. Siddappa and A. M. Mustafa. Pp. ii + 24. (Delhi: Manager of Publications, 1946.) 12 annas; 1s. [164]

Transactions of the American Philosophical Society. New Series, Vol. 35, Part 3: The Social Culture of the Nunivak Eskimo. By Margaret Lambis. Pp. 151-324. (Philadelphia: American Philosophical Society, 1946.) [164]

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 187: Alcohol, its Place in Organic Chemical Industry. By Dr. H. H. Hatt. Pp. 51. (Melbourne: Government Printer, 1945.) [174]

Indian Research Fund Association. Special Report No. 13: Report on Soya Bean. By the Soya Bean Sub-Committee of the Nutrition Advisory Committee. Pp. 35. 8 annas. Special Report No. 14: Diet Survey in College and School Hostels in Delhi. By Dr. K. L. Showire. Pp. 16. 1 rupee. (New Delhi: Indian Research Fund Association, 1946.) [174]

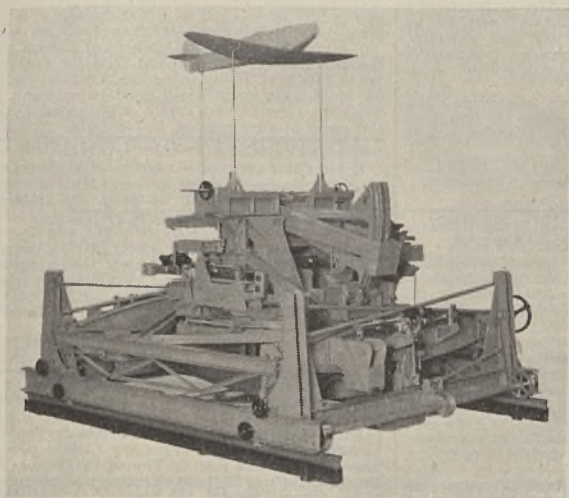
### Catalogues

Gowland Magnifiers. (List No. 137H.) Pp. 8. (Croydon: Gowlands, Ltd., 1946.)

Sofnol Non-hygroscopic Soda Lime. (Publication SO.646.) Pp. 4. (London: Sofnol, Ltd., Westcombe Hill, S.E.10, 1946.)

General Catalogue. (Binocular and Monocular Microscopes B.L.M. Series 3 and 4; Optical Accessories for the Microscope; Optical Instruments for Dissecting; Instruments for Measurement and Inspection; Photo-micrographic Apparatus and Microscope Lamps; Projection Apparatus.) Pp. 176+3. (London: C. Baker, 244 High Holborn, W.C.1, 1946.)

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For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or Pensions may be granted to persons who comply with these conditions. For particulars, apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

**CIVIL SERVICE COMMISSION  
SCIENTIFIC CIVIL SERVICE**

The Civil Service Commission invite applications for a post at the National Physical Laboratory (Department of Scientific and Industrial Research) in one of the grades Senior Scientific Officer and Principal Scientific Officer. The post requires an engineer or physicist to take charge of work on Automatic Controls which has recently been started. The programme includes fundamental research and development in the theory, design, testing and application of automatic controllers and instruments for incorporation in industrial processes and plants. In addition, the Laboratory will collaborate with and advise industrial organisations on control problems.

Candidates, who should be over the age of 30, must possess a good honours degree in engineering or physics or an equivalent qualification and should have a good knowledge of mathematics and suitable research experience. Experience in the theory and design of automatic control apparatus and instruments, and in the supervision of a small team of investigators is of value, but not essential.

Salaries (men) for Senior Scientific Officer £535 x £25-£730, for Principal Scientific Officer £775 x £30-£1,060. Salaries are increased by a consolidation addition (in place of war bonus) which is £90 for Senior Scientific Officer and ranges from £90 at the minimum to £110 at the maximum for Principal Scientific Officer. Salaries and consolidated additions are somewhat lower for women than for men. Superannuation provision will be made under the Federated Superannuation System for Universities.

Further particulars and an application form may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1861. Completed application forms must be received at the Civil Service Commission not later than November 28, 1946.

**METROPOLITAN WATER BOARD  
APPOINTMENT OF WELL ENGINEER**

The Metropolitan Water Board invite applications from Chartered Civil Engineers for appointment to the Board's Permanent Staff as Well Engineer—Grade B (1), salary scale £590-£25-£690 per annum, plus a cost-of-living bonus which is at present £80 per annum.

Candidates should possess a sound knowledge of hydrogeology and have had responsible experience in the supervision, inspection, repair, maintenance and the construction of wells and boreholes. The Board have 47 well stations and the person appointed will be required to make underground inspections and to inspect the gathering grounds for the detection of possible sources of pollution. Age limits, not less than 30 nor more than 45 years of age.

Particulars of this appointment and a form of application may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope, quoting reference (N).

C. W. STOKER,  
Clerk of the Board.

Offices of the Board,  
New River Head,  
Rosebery Avenue, E.C.1.

**BELFAST EDUCATION  
COMMITTEE**

**COLLEGE OF TECHNOLOGY, BELFAST**

Principal: D. H. ALEXANDER, M.Sc., M.I.Mech.E. Applications are invited for the position of Teacher of Mathematics. Applicants should hold an Honours Degree in Mathematics or in Engineering with Mathematics as a main subject. The salary attached to the position is from £315 by £15 to £600 per annum to £350 by £15 to £650 per annum according to qualifications. Allowance will be made in fixing the commencing point on the salary scale for previous teaching experience and for approved industrial or commercial experience, up to a maximum of ten increments.

Application forms and full particulars may be obtained from the Principal, College of Technology, Belfast, with whom applications must be lodged not later than Friday, November 8, 1946.

Canvassing is strictly forbidden and will disqualify.  
J. STUART HAWTH,  
Director of Education.

**UNIVERSITY COLLEGE, LONDON**

Lecturer, Grade II, required as soon as possible in the Department of Physiology. Applications to be submitted at once to the Secretary, University College, London (Gower Street, W.C.1).

**MIDDLESBROUGH EDUCATION  
COMMITTEE**

**CONSTANTINE TECHNICAL COLLEGE  
MIDDLESBROUGH**

Principal: H. V. FIELD, B.Sc., Wh.Sch., M.I.E.E. Applications are invited for the post of full time Lecturer in Chemistry. Candidates should have a good honours degree in Chemistry, with special knowledge of Physical Chemistry, and preferably have had some industrial experience. Commencing date, January 1, 1947, or as soon as possible thereafter.

Application forms and further information available from the undersigned, to whom the completed forms should be returned within fourteen days of the date of this advertisement.

STANLEY HIRST,  
Director of Education.  
Education Offices,  
Middlesbrough.

**BRITISH IRON AND STEEL  
RESEARCH ASSOCIATION**

The above has a vacancy for a Mathematical Physicist in the Senior Scientific Officer Grade as Head of the Theoretical Physics Section in the British Iron and Steel Research Association Physics Laboratory at Battersea.

Researches will include work on the Theory of Similarity in models of all kinds, the design of experiments and the calculation of the observable properties of metals from theoretical models.

University degree essential, higher degree an advantage. Age range—28-38. Salary £600-£800 p.a. according to age, qualifications and experience. All appointments are superannuated under the F.S.S.U.

Written applications only, giving full curriculum vitae, to the Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, by November 11, 1946.

**BRITISH IRON AND STEEL  
RESEARCH ASSOCIATION**

Research Assistant required by the above Association to work in the Information Section. Duties will include reading scientific and technical journals and dissemination of research reports.

Applicants should have a University degree or equivalent technical qualifications, previous experience or knowledge of the Iron and Steel Industry not essential. Salary according to age, qualifications and experience. Written applications only giving full curriculum vitae to the Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

**BRADFORD EDUCATION  
COMMITTEE**

**TECHNICAL COLLEGE, BRADFORD**

Applications are invited for appointment as Tutor for Women Students, with qualifications in Chemistry, Physics or Mathematics.

Basic salary according to the Burnham Scale which is from £270 to £420 per annum. Commencing salary according to qualifications and experience, and the post will, subject to approval, be a Special Post under the Burnham Award with an additional allowance of £40 net per annum.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College within two weeks from the date of publication of this advertisement.

THOS. BOYCE,  
Director of Education.

**UNIVERSITY OF CAPE TOWN  
SENIOR LECTURER IN ZOOLOGY**

Applications are invited for a Senior Lectureship in the Department of Zoology. The post is vacant from 1947, salary scale £675 plus £25-£775 per annum, plus a temporary cost of living allowance. Qualifications in comparative physiology and experimental methods are desirable. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service. Write quoting G.412, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

**UNIVERSITY COLLEGE OF  
SWANSEA**

The Council of the College invites applications for the post of Professor of Geology and Head of the Department of Geology and Geography. Salary £1,250 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 9, 1946.

**UNIVERSITY OF CAPE TOWN  
SENIOR LECTURER IN PHYSICS**

Applications are invited for a Senior Lectureship in Physics. The post is vacant from 1947. Salary scale £675 by £25-£775 per annum plus a temporary cost of living allowance. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service.

Write quoting A.328 to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

**UNIVERSITY OF LONDON**

Heath Clark Lectures.—A course of five lectures, entitled "British Pioneers in Social Medicine from Percival to Simon," will be given by Professor Emeritus Major Greenwood, D.Sc., F.R.C.P., F.R.S., at 5.30 p.m. on October 28, 29, 30 and 31, and November 1, 1946, at the London School of Hygiene and Tropical Medicine (Keppel Street, Gower Street, W.C.1). The chair at the first lecture will be taken by Sir Allen Daley, M.D., F.R.C.P., D.P.H. (Medical Officer of Health, County of London). Admission Free, without ticket.

JAMES HENDERSON,  
Academic Registrar.

**UNIVERSITY OF LONDON**

A course of three lectures on Physiology will be given by Prof. Sir Joseph Barcroft, C.B.E., F.R.S. (Agricultural Research Council, Cambridge) in the Physiology Theatre of University College (Gower Street, W.C.1) at 5 p.m. on Thursdays, October 31, November 14 and 28, 1946. Lecture 1. Movements of the Human Foetus. Lecture 2. Recent Work on Placental Transmission. Lecture 3. The Flora of the Alimentary Canal. The Chair at the first lecture will be taken by Prof. C. A. Lovatt Evans, D.Sc., LL.D., F.R.S. (Jodrell Professor of Physiology, University of London). Admission Free, without ticket.

JAMES HENDERSON,  
Academic Registrar.

**LEEDS COLLEGE OF  
TECHNOLOGY**

**Principal: C. CHEW, M.Sc.Tech., F.R.I.C.  
DEPARTMENT OF CHEMISTRY**

Applications are invited for the post of full-time Lecturer in the above department, duties to commence in January 1947.

Candidates should possess a good honours degree of a British university, together with teaching and industrial experience. The selected candidate will be required to teach mainly Organic with some Physical Chemistry. Salary according to the Burnham Scale.

Further particulars and form of application, to be returned within three weeks of the appearance of this advertisement, will be forwarded on receipt of a stamped addressed foolscap envelope.

GEORGE GUEST,  
Director of Education.  
Education Offices,  
Leeds, 1.

**UNIVERSITY OF BIRMINGHAM  
FACULTY OF MEDICINE**

**LECTURES IN BACTERIOLOGY**

Applications are invited from graduates holding a Science Degree of a British University for the post of Lecturer in the Department of Bacteriology, at a commencing salary of £500 per annum.

Previous teaching experience is not essential, but preference will be given to applicants who have had some practical experience of the applications of Bacteriology to Agriculture or Industry.

Further particulars may be obtained from the undersigned, to whom applications should be sent not later than November 16, 1946.

C. G. BURTON,  
Secretary.

The University,  
Edmund Street,  
Birmingham, 3.

**UNIVERSITY OF BIRMINGHAM  
DEPARTMENT OF ANATOMY**

Young graduate with degree in Zoology required for research in Anthropometric Studies. Some statistical knowledge essential. Duties to commence as soon as possible. Commencing salary £300-£550 per annum, according to qualifications and experience.

Applications should be sent to C. G. Burton, Secretary, The University, Edmund Street, Birmingham, 3.

**UNIVERSITY COLLEGE, LONDON  
DEPARTMENT OF PHARMACOLOGY**

**LECTURES ON CURARE**

Two Lectures will be given by J. W. Trevan, M.B., B.S., F.R.C.P.(Lond.), F.R.S., on Curare on Tuesdays, November 26 and December 3 at 5.30 p.m. Those professionally interested are invited. Physiology Theatre, entrance Gower Street, W.C.1.

**UNIVERSITY OF CAPE TOWN  
SENIOR LECTURER IN PHYSIOLOGY**

Applications are invited for the post of senior lecturer in the Department of Physiology. The salary scale is £675 x £25-£775 per annum. The lecturer will be required to teach in practical classes of human and experimental physiology, and to take part in the routine lecturing of the department. He will also be expected to do research work. He must have scientific qualifications in Physiology. A medical qualification would be a recommendation. Applications from serving personnel and ex-volunteers will receive special consideration and applicants are advised to give details of their military and other national service.

Write quoting G.83 to Ministry of Labour and National Service Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned completed by December 12, 1946.

**UNIVERSITY OF LONDON**

A course of two lectures in Human Anatomy and Morphology will be given by Professor N. Goomaghtigh (University of Ghent) at Middlesex Hospital Medical School (Mortimer Street, W.1) on Wednesday, October 30 and Friday, November 1, at 5 p.m. Lecture 1, "New Anatomical Facts regarding the Renal Circulation." Lecture 2, "Endocrine Function of the Renal Arterioles in Regard to Hypertension." At the first lecture the chair will be taken by Professor J. Kirk, M.B., Ch.B., F.R.C.S.E. (S. A. Courtauld Professor of Anatomy in the University of London). Admission Free, without ticket.

JAMES HENDERSON,  
Academic Registrar.

**MOUNT VERNON HOSPITAL AND  
THE RADIUM INSTITUTE  
NORTHWOOD, MIDD.**

Assistant Engineer or Technician required by the X-ray Department preferably with experience of X-ray and Vacuum technique and of electrical wiring, to assist in the maintenance of several 200 kilovolt X-ray installations. Salary scale £275-£350 by increments of £15 p.a., commencing rate according to experience.

Applications, stating age and experience, accompanied by testimonials, to be forwarded to the Secretary, from whom further particulars may be obtained.

**THE UNIVERSITY OF SHEFFIELD**

Applications are invited for a post of senior Lecturer in Physiology. Salary £750, rising by £50 every two years to £1,000, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance.

Applications (four copies), including the names and addresses of referees, and, if desired, copies of testimonials, should reach the undersigned (from whom further particulars may be obtained) by November 10, 1946.

A. W. CHAPMAN,  
Registrar.

**THE UNIVERSITY OF SHEFFIELD**

Applications are invited for a post as Lecturer in Chemistry. The Lecturer will be required to be specially qualified in Physical Chemistry. Salary £550, rising by £25 every year to £650 and then, if the appointment is renewed, £700, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance.

Applications (four copies), including the names and addresses of referees, and, if desired, copies of testimonials, should reach the undersigned (from whom further particulars may be obtained) by November 16, 1946.

A. W. CHAPMAN,  
Registrar.

**MEDICAL RESEARCH COUNCIL**

**RADIOTHERAPEUTIC RESEARCH UNIT  
HAMMERSMITH HOSPITAL, DUCANE ROAD, W.12**

The Medical Research Council wishes to make two junior appointments to the Unit for work mainly in the field of radioactive tracer research. Applications are invited from physicists having knowledge and experience either of electronics or of the application of photographic emulsions to radiation studies.

Applications should be sent to the Director of the Unit at the above address.

**ROYAL HOLLOWAY COLLEGE  
UNIVERSITY OF LONDON**

**APPOINTMENT OF AN ASSISTANT LECTURER IN  
PLANT PHYSIOLOGY**

The Governors invite applications for the above post, which will be vacant in January 1947. Applications are required not later than November 9, 1946. Full particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey.

**MACKINNON RESEARCH  
STUDENTSHIP**

The President and the Council of the Royal Society are prepared to receive applications for a Mackinnon Research Studentship of the value of £550 per annum inclusive of a superannuation allowance of £50, awarded for the purpose of furthering original research in the physical sciences including chemistry, geophysics, astronomy and engineering sciences.

The appointment is, in the first instance, for two years, but may be renewed annually up to a maximum of five years.

Applications must be received not later than December 31, 1946. Forms of application can be obtained from the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

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Further particulars may be obtained from the Advisory Bacteriologist, Provincial Laboratory, Bank House, Newport, Shropshire.

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The Governors invite applications from British Subjects for appointments in the Chemistry Department, viz.: (1) Lectureship in Inorganic Chemistry, Salary Scale £400-£15-£595, (2) Lectureship in Fuel Technology, Salary Scale £450-£15-£685. A degree or equivalent qualification is essential and some teaching experience desirable. Candidates may be placed on the scale according to qualifications and experience. Further particulars and application form may be obtained from the Principal to whom applications must be submitted not later than November 15, 1946.

J. CAMERON SMALL,  
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RICHARD H. HUNTER,  
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Applications are invited from engineers with a flair for the mechanical design of heavy precision machinery who can produce evidence of their ability to do original design and development work. They should be between 35 and 40 years of age, have a good general education and University Degree, or equivalent in Mechanical Engineering, and workshop experience. The commencing remuneration will be of the order of £1,000 per annum. Box 732, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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Association, Great West Road, Brentford, Middlesex. Applications are invited for the post of Assistant Librarian. Candidates should hold a recognised qualification in Librarianship and have had experience in classification and cataloguing, preferably in a technical library. Initial salary according to qualifications. Salary range of the appointment £300 to £500. Superannuation provision under the Federated Superannuation System for Universities. Applications to be addressed to the Director, Motor Industry Research Association, Great West Road, Brentford, Middlesex.

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**Physicist or Physical Chemist required**

by large industrial undertaking in the Midlands, for research on silicates, glasses and other ceramic materials. The post offers excellent opportunities for a young man with first-class qualifications. Previous experience in industry is not essential but applicants should produce evidence of their aptitude for original work. Apply, in confidence, giving full particulars of age, experience and salary required to Box 730, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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(Continued on page cxlviii)

(Continued from page cxlvii)

**British Non-Ferrous Metals Research Association** has immediate vacancies on its Research Staff for:

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**Research Assistant required** for London area. Candidates should have experience of research allied to industry, and preferably some knowledge of magnetic materials and their use in electrical instruments. Applicants should give details of experience, age and salary required. Box 736, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

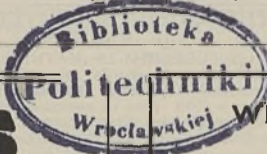
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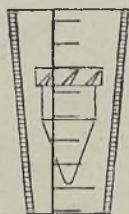
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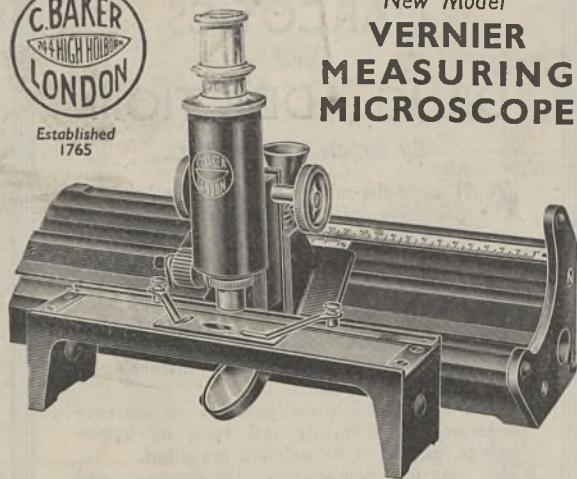
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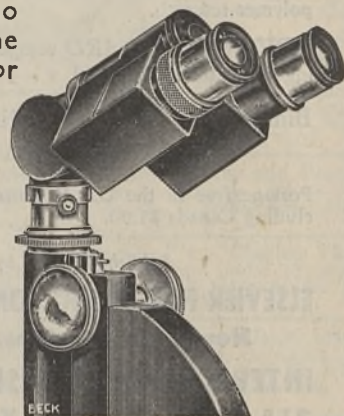
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