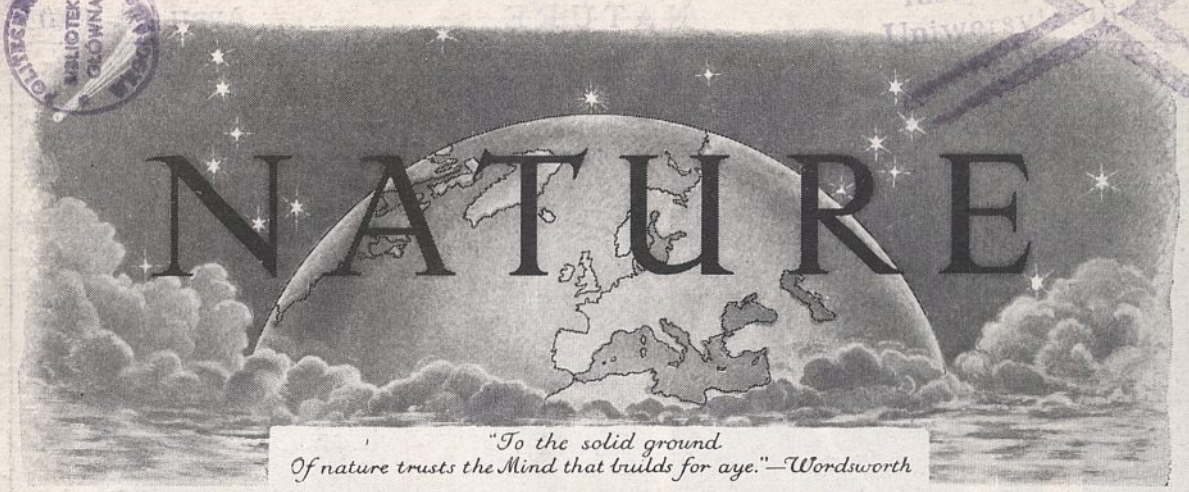


Vol. 145, No. 3676 SATURDAY, APRIL 13, 1940 ONE SHILLING

NATURE

Vol. 145 SATURDAY, APRIL 13, 1940 No. 3676

CONTENTS

Editorial and Publishing Offices:
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London
The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

Advertisements should be addressed to
T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211
Registered as a Newspaper at the General Post Office

Editorial & Publishing Offices :
MACMILLAN & Co., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

NATURE

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 145 SATURDAY, APRIL 13, 1940 No. 3676

CO-OPERATION IN COLONIAL ADVANCEMENT

UNQUESTIONABLY the most striking fact to emerge from Lord Hailey's "African Survey" is the vastness of the field for scientific research and the application of its results to the needs of the native populations which are afforded by that continent. On a careful examination of the evidence which has been brought together of Lord Hailey's work of impartial observation, it is patent that if these peoples are to benefit to the full from the increased interest in their lot now manifested by the European Powers responsible for their future, a more carefully considered and scientifically informed approach to the problems of the administration of their affairs and of their future development is demanded. Nor is this an affair merely of the moment or the immediate future. No measures for the promotion of native advancement, however well-intentioned, will prove beneficial in the long run—as experience has shown time and again—which has not been framed in the light of the fullest knowledge of the essential character of native culture and its reactions to impact from outside.

As Lord Hailey has shown in detail, there is a considerable difference in outlook, in purpose and in method as between the administrative services of the various European powers concerned with African peoples. While it is doubtful whether it would be practicable, or even advisable in view of the wide differences in temperament, culture and attainment of the various African peoples, to attempt to secure absolute uniformity in administrative methods, yet unquestionably some agreement as to the general direction of policy in native development is more than desirable. In fact, sooner or later it may become an essential condition of European participation in the promotion of African development.

In these circumstances, it is a reassurance for the future that Allied co-operation is to be as effective in the colonial field as in other spheres of the joint interests of France and Great Britain. As a result of Mr. Malcolm MacDonald's recent conference in Paris, the more or less tentative approaches of the French and British colonial administrations in recent years are to be reinforced by the creation of an organization which will secure a permanent liaison between London and Paris. In the French and British Colonies themselves, which in many parts of the world, but more especially in Africa, lie adjacent to one another, there will be conferences from time to time between the governors of the British and French territories, while contact will be established between the administrative and specialist officers of the respective services.

How far this co-operation between French and British colonial authorities will lead ultimately towards any close community in fundamental principles of administrative policy it is of course at present impossible to say. On a superficial view, in outward form French colonial administrative methods, by the employment of native local chiefs and headmen, bear a certain resemblance to the methods of British 'indirect rule'; but there is at present a fundamental difference in attitude towards native authority as an instrument of administration. This would militate against anything in the nature of a condominium such as exists in the New Hebrides, which has been put forward by some as a desirable or possible outcome of the present approach to joint and common action in the Colonies between France and Britain.

British native administrative policy, fortified by experience in many parts of Africa, is wedded

to the principle of 'indirect rule'; but it has not been thereby immune from criticism. On one hand, opinion among the more advanced and highly educated natives, especially in West Africa, is prone to regard its respect for native institutions and the desire to preserve their influence unimpaired as an attempt on the part of administrator and anthropologist to retard native development; on the other hand, the impartial judgment of qualified European observers fears an indiscriminate application of the principle in circumstances in which its cardinal factor, the native institution, is no longer operative, as for example in urbanized or industrialized populations, which have become cosmopolitan, in an African sense, rather than tribal. In the train of thought to which this gives rise, it is probably wise to give full weight to arguments which tend to emphasize the fact that 'indirect rule' in effect is 'local government' and stress its educative value.

At the same time, it should not be overlooked that in the light of the modern methods of investigation of social anthropology, the application of indirect rule has at times failed in scientific appreciation of the facts of native institutional practice upon which *ex hypothesi* it should be founded.

There is a larger and more far-reaching consideration to which attention may be directed. While indirect rule has as its immediate aim the preservation of tribal authority and the conservation of the forces which make for tribal integration, it does this as a means to an end—or so at least it is held by enlightened opinion—the ultimate advancement of the native peoples of Africa to take such a place among the peoples of the world as their capacities, circumstances and opportunities admit. However far they may have to go, some conception of direction, and the agencies by which this end is to be attained, should form a part of that planning on a world-wide basis which must in the long run be a consequence of the present struggle.

It is open to question, however, whether the colonial authorities, both at home and in the field, are not prone to overlook this consideration, and in danger of regarding indirect rule as to be pursued as an end in itself. Even the staunchest upholders of the principle appear to be somewhat vague as to ultimate aims. That the interests of the native population should be paramount, excellent as it may be as a principle of government, depends in its application too much upon the interpretation of 'interests' to afford any precise guidance.

In the recently issued White Paper on colonial development, while generous financial assistance is promised for both development and research, stress is laid on the primary purpose of assisting the colonies towards becoming self-supporting. Now Africa, as a whole and on the whole, is poor country, and in any event the burden of development for long must fall upon white shoulders. In the course of that development, involving presumably a change-over from what is now a bare subsistence basis for the native population to something in the nature of an industrial or potentially commercialized form of production, concern for native 'interests' may be in danger of suffering a sensible diminution.

The issues involved in the relations of a white and a native African population have been set out, though in a widely different context from that in which indirect rule has been applied, with admirable lucidity and an absence of bias by Prof. R. F. A. Hoernlé in his Phelps-Stokes Lectures for 1939*. He discusses there the native problem as it now presents itself in the Union of South Africa. As in other of the older colonies of Great Britain in Africa, the relations of white and black in South Africa up to a point have reflected the growth of a sense of responsibility in the mother country, whether due to the humanitarianism which abolished slavery or the consciousness of the 'white man's burden,' by which, in the eyes of many, imperialistic expansion found its justification. It has its modern counterpart in the 'trusteeship' which is now the avowed principle of the mandatory and colonial administration. In South Africa, however, the 'liberal spirit' which once fostered native advancement has given way, under stress of racial feeling, which is closely bound up with questions of economic competition, to a reaction which approaches native policy primarily and to all intents and purposes solely from the point of view of the maintenance of the dominance of the white and superior race in the Union. When it is remembered that here the black population outnumbers the white in the ratio of between three and four to one, the difficulties which confront those who advocate a more liberal approach to the problem become easily understood.

* South African Native Policy and the Liberal Spirit: being the Phelps-Stokes Lectures delivered before the University of Cape Town, May 1939. By R. F. Alfred Hoernlé. Pp. xiv+190. (Lovedale, C. P.: The Lovedale Press, 1939.) 5*s*.

It is a far cry from the complexity of social and racial conditions in South Africa to the relatively simpler societies to which indirect rule has been applied. Yet the germs of South Africa's problem are there; and they will grow unless measures be taken in time. It has been said that we are waging a war in which the aim of the Allies is to establish Christian civilization as against the paganism of nationalism and the worship of the State. But as Sir Francis Younghusband has pointed out, neither Islam nor Hinduism, nor Confucianism nor other creeds can be excluded from our aims, insomuch as we welcome their assistance. Our battle is for the principles which lie at the root of Christianity, it is true, but are no less the articles of faith of all men of good will irrespective of creed—the dignity and integrity of the individual man free to develop mind and body to the limits of his capacity within free institutions. For better or for worse, white civilization has impinged upon the black. It is incumbent upon us, if we are to be really true to the principles for which we stand in the present struggle, to see to it that our rule over the less advanced peoples is a tutelage which does not overlook their claims to co-operate in a world order in the coming era of, we hope, a more rational, as well as a more humanitarian, world.

ANGLO-FRENCH CO-OPERATION IN SCHOOLS

ON September 3, Lord De La Warr, who was then president of the Board of Education, visited Paris to discuss with the French Minister of Education, M. Sarraut, the contribution which the schools of the two countries can make towards Anglo-French solidarity.

The event followed a discussion in London at the end of January last on intellectual co-operation between visiting French Ministers and their opposite numbers. Committees were afterwards set up by the Education Ministries of both countries, the aim of which is to develop existing means and to devise fresh ones for increasing among the school children of each country knowledge and appreciation of the life and culture of the other country. During the visit, which was marked by a broadcast in French by M. Sarraut and Lord De La Warr, members of the two committees met to discuss each other's work. After the visit to London to which we have already referred, a special commission of experts was set up in France to recommend ways of ensuring that French children obtain a thorough knowledge of Britain and the British, the affinities and differences of the two peoples, and their common aims in civilization. Any report which the commission has now prepared would doubtless be discussed during the Paris visit.

This move towards closer intellectual co-operation would have been desirable even had there been no war. In the present circumstances, it is inevitable and essential as a part of plans for Allied co-operation which grow more and more comprehensive. The Anglo-French declaration of war and peace policy carries with it the necessity of closer contacts between the youth and intellectual life of the two countries. Upon those who are young now will rest the responsibility of clinching victory and securing the maintenance of peace in the future. That responsibility must obviously entail closer understanding in the realm of ideas. It is in the schools, as Lord De La Warr pointed out in his broadcast, that the two peoples, so different in many ways, can learn of one another. It is in the schools that they may learn what they have both given, and are giving, to civilization and culture, what are the things for which, and against which, the present war is being waged. There was grim warning in Lord De La Warr's statement that, from the point of view of the future, the most terrible crime of the Nazi régime is the deliberate perversion of the minds and souls of their young people.

In France, where educational machinery is more centralized than in Britain, rapid innovations are possible. In English schools, nevertheless, special means have already been devised towards the ends in view. More than half a million are learning French, and the number can be increased by new effort. New programmes have been drawn up for school broadcasts and new plans for a wide circulation of films and for special lecturers to tour the schools. There are possibilities, too, of new books on French life, and of arranging exchange visits of teachers and children. These activities should make a substantial contribution to the preservation and development of the ideals for which Britain and France stand.

THE ULTRACENTRIFUGE

The Ultracentrifuge

By The Svedberg and Kai O. Pedersen, in co-operation with J. H. Bauer and E. P. Pickels; G. Boestad; E. O. Kraemer and J. B. Nichols; O. Lamm; A. S. McFarlane; R. Signer. (International Series of Monographs on Physics.) Pp. x + 478 + 31 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 40*s*. net.

PROF. SVEDBERG'S institute at Uppsala has been for some years now a world-famous international club, with notices in several languages which may or may not include Swedish. The book just published summarizes the work of the staff and visitors with the ultracentrifuges during fifteen years of steady progress. It is significant of its international character that the authors consist of three Swedes, one Dane, four Americans, one Scotsman, and a Swiss. Of the two chief authors, Prof. Svedberg confines himself mainly to the constructional part, showing clearly how, "given the height and thickness of the column of solution and its distance from the centre of rotation, all other mechanical characteristics of the ultracentrifuge can be directly derived". The other main author, Dr. Pedersen, expounds, with the same unflagging patience with which he helped to develop, all the minute points of detail which must be observed before the apparently simple results can be obtained. The section on results, also largely by Dr. Pedersen, is fairly short, which is right, since these are all in the literature and a full bibliography is given, whereas much of the technical part is published here for the first time. The greatest interest of all, perhaps, is contained in the section on rotor design, where the succession of hopes, disappointments, and triumphs reads like a novel. Visitors have always heard of mysterious conferences with a "steam turbine expert from Stockholm" when a new rotor was in contemplation. The mystery man now seems to be revealed as G. Boestad. One wonders whether he is the artist responsible for the quite unearthly beauty of the modern rotor (see Fig. 97).

The book as a whole has both the advantages and drawbacks of a composite work. Every detail is written by someone who knows all about it, but despite the strongly unifying personality of Svedberg, it is not one of those books in which every word follows inevitably on its predecessor. There is too much repetition, due partly to the otherwise attractive method of covering the ground first in outline and then in detail, partly to imperfections in the scheme of classification or to different interpretations of it by different authors. But in spite of this, and of the fact that it is a standard work of reference, the book is quite surprisingly easy to read. As a work of reference it might profitably have incorporated some of the invaluable hints contained in a typed document known as "Watson's Manual", such as what to do when the rotor temperature soars skyward, or the oil pressure suddenly vanishes. A more serious omission is the account of results obtained with air-driven ultracentrifuges, but as explained in the preface they have been included in the bibliography.

It is interesting to speculate on the future of the ultracentrifuge. So far as resolving power goes, not much more can be expected, even if refinements such as synchronized light-source, oval cell-holes, etc., are introduced. The power-consumption has been greatly diminished recently, but it now seems scarcely worth pushing it much lower. The capital cost remains, as always, high, being due more to the large number of accessories than to any single item. The ease of operation, including measuring the results, is now as good as could be desired if one is content to guess the base-line instead of measuring it; but it would be a great convenience if some means could be found for obtaining the true base-line without an extra run and for automatically subtracting it. On the whole, therefore, no sensational technical developments are to be expected. What about applications? It can be safely predicted that whenever a new protein is isolated (or is thought to have been isolated) it will be sent as now to an ultracentrifuge centre for study of its homogeneity, sedimentation constant, molecular weight, and possibly *p*H-stability curve.

It is possible that purely ultracentrifuge researches will give place almost entirely to this monotonous but highly necessary work as the rate of isolation of new proteins increases and the general laws of protein aggregation cease to have any more surprises; but the ultracentrifuge will also continue to be of importance as an adjunct in other research, for example, in any experiments on the action of reagents on proteins or in the study of pathological sera, plastics, etc., which are highly complicated subjects still in their infancy. If I dare predict a negative, it is that the preparative separation of the lower molecular proteins by ultracentrifuging will never be a useful method, although the apparatus for it already exists. The separation of high-molecular substances like the viruses is another question, and here the method has thoroughly established its usefulness.

Finally, a word on the still controversial question of air-drive versus oil-drive. Svedberg originally chose the latter on grounds of efficiency, and the figures quoted in his book amply justify the choice; but the question of drive has become coupled with three other questions, namely horizontal or vertical axis of rotation, material of rotor, and hydrogen or high vacuum as surrounding medium. For optical measurements the horizontal axis is better, while for preparative purposes the vertical one is essential. The two rotor materials are steel and duralumin. Steel gives slightly higher resolving power at the cost of a large increase in strength of casing and foundations, in power required to accelerate and in thickness of bearing and therefore power required to drive. Since the air-drive is too inefficient to be used satisfactorily with steel, the exponents of it have had to develop the possibilities of duralumin, but have reaped the latter's own advantages in compensation. One of these, the small bearing shaft, has made it practicable to run in high vacuum instead of hydrogen; and apparently if the vacuum is good enough it is definitely superior to hydrogen. Thus in every way except resolving power and possibly length of life, duralumin is superior to steel; but for low-molecular proteins resolving power is of cardinal importance, so that until some new material is produced, steel will continue to be used where the appreciable difference in capital cost can be afforded.

J. St. L. Philpot.

FUN AND PHYSICS

Mr. Tompkins in Wonderland

Or Stories of c, G, and h. By Prof. G. Gamow. Pp. x+92. (Cambridge: At the University Press, 1939.) 7*s*. 6*d*. net.

MR. TOMPKINS was a bank clerk seeking distraction at the end of a heavy day. Bored almost to tears by the inevitable Hollywood stuff at the 'movies', and attracted by the title "Space, Time and Cosmology" which he thought might offer something in the Jules Verne vein, he drifted into one of a series of lectures at the local university on topics in modern physics, and that was where his troubles began. He did not understand the lecture. In fact he was not able to follow it sufficiently well even to misunderstand it, and retired to bed in that state of mental depression which is not an unusual after-effect of attendance at lectures on mathematical physics. His rash experiment, however, gave rise to the series of dreams, one might almost say nightmares, retailed in the first half of the book. The second half contains the lectures out of which the troubles arose.

In his dreams Mr. Tompkins finds himself in a succession of universes in which the fundamental natural constants—which in our universe are, fortunately, either so immensely large or so extremely minute that only mathematical physicists need to worry about them—have assumed values which bring their more remarkable consequences under direct observation. In some, that natural "speed limit", the velocity of light, is reduced to ten miles per hour; moving objects become unbelievably flattened; watches gain or lose in a most puzzling way, and a host of other "relativity effects" disturb the equilibrium of the unhappy little bank clerk. In others the "quantum-constant" swells to 1 erg sec. (surely not 1 erg/sec. as is stated in the text) and produces curious consequences in a game of billiards. In yet another the "uncertainty factor" assumes finite proportions, and a frightened gazelle dashing through a grove of bamboos emerges as a diffraction pattern. For details of Mr. Tompkins's adventures in these strange worlds the reader must consult the text.

In a world where popular expositions of the ideas of modern physics have been almost as plentiful as blackberries, Prof. Gamow has hit on something quite novel; and—incidentally—has by his dedication forestalled all possible criticism, for what reviewer could have the heart to comment adversely on a book dedicated jointly to Lewis Carroll and Niels Bohr? If Mr. Tompkins's adventures are not quite as amusing as those of the immortal "Alice", nor his "Wonderland" anything like so convincing as hers, that is because the author's purpose is didactic, and his imagination fettered by his equations. Truth, as portrayed in modern physics, is distinctly stranger than fiction, and the 'wavicle' can never hope to rival the grim reality of the Jabberwock. It would be difficult to imagine any better way of gaining a glimpse of the strange world in which the mathematical physicist lives, during business hours, than by accompanying Mr. Tompkins in his adventures.

The "dreams" collected in this volume first appeared in the pages of *Discovery*, and it is interesting to note how, even during the course of their publication, the outlook of modern physics changed. We do not know whether Mr. Tompkins

was disappointed, or relieved, to be informed by the professor towards the end of the book that the closed pulsating universe in which, in his first adventure, he so narrowly escaped an extremely "stuffy death" was but a nightmare after all, and was no longer regarded as having any physical reality. However, as by this time Mr. Tompkins was busily engaged in courting the professor's daughter, he had possibly ceased to be interested.

The illustrations which enliven the pages of the text have a somewhat smudgy appearance, as if they were suffering from a rather large "wave of indeterminacy". Perhaps this is intentional, but the effect is not attractive. Prof. Gamow's stories fully deserve preservation in book form. Mr. Tompkins, now safely married, no longer needs the dubious excitement of university lectures. Should, however, his father-in-law's expositions, now, no doubt, transferred to the domestic circle, induce still further adventures, we hope Prof. Gamow will be at hand to report them.

J. A. CROWTHER.

CHEMICAL APPLICATIONS OF SPECTROSCOPY

Chemical Spectroscopy

By Prof. Wallace R. Brode. Pp. xi + 494. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 36*s*. net.

IT is unquestionable that this book will have a wide appeal. Everyone engaged in spectroscopy, no matter what branch, will find something of interest and perhaps some useful advice and suggestions within its covers; everyone interested to know 'the how, the why, and the wherefore' of spectroscopy will find an answer to the majority of his queries. Some idea of its scope will be gathered from the chapter headings: introduction; atomic and molecular spectra; emission spectra (apparatus); qualitative analysis, spectrum tables, and standard samples; quantitative analysis; resonance and chemical structure; absorption spectra; absorption spectra (apparatus and methods); application of absorption spectra data; infra-red and Raman spectra; theory and description of colour; laboratory experiments; theory and practice of photography; equipment and arrangement of a spectrographic laboratory. In these chapters are laid down the fundamental theory and practice of spectroscopy, interspersed with valuable information on technique, on recording of spectroscopic data, on teaching spectroscopy, and on the sources from which spectroscopic apparatus and materials are procurable.

But these topics occupy only 313 pages. What of the rest of the book? It is given over to three things. First, a bibliography of books on emission and absorption spectra, followed by a list of 123 references to the most important original publications. Then come 120 pages (pp. 327–446) of spectral data arranged in tabular form. These tables, all that a student will require, give persistent lines by wave-length from 1850 A. to 7950 A.; the persistent lines of elements (in alphabetical order); the principal lines by wave-length from 2000 A. to 7998 A.; the principal lines of seventy-two elements (in alphabetical order), with ionization states, intensities of arc and spark spectral lines, wave-lengths of control lines and of lines from other elements, the presence of which in a sample would give interference and probably vitiate results; spark spectrum of air; principal lines of discharge spectra of ten elements (alphabetized); Fraunhofer lines in the sun's spectrum; various conversion tables. Finally, there are thirty-five full-page charts which appeal because of their usefulness—and their novelty. They show the iron spectrum from 2310 A. to 5090 A., and on them are marked identified iron lines and the indicated positions of the principal lines of other elements. These charts are "intended for use as a projection screen or for the superposition of an enlarged strip of the unknown spectrum and adjacent iron comparison spectrum". We must congratulate Prof. Brode on these tables and charts and pay admiring tribute to the industry and patience which their compilation has required.

The book contains a very large number of diagrams and photographs. Whilst, generally, these are very good, there are certain criticisms which must be made. The diagrams are characterized by a neatness and compactness which quite frequently results in the reproduction of diagrams on such a reduced scale as to make them rather difficult to examine, particularly as lettering is sometimes so small as to necessitate re-focusing the page for comfortable reading (for example, Figs. 4.4 (p. 68), 8.19 (p. 165), 9.11 (p. 208), 12.33 (p. 272)). Many photographs of apparatus are not too well reproduced, they are slightly fuzzy, and it is questionable if photographs of apparatus without diagrams of the optical system (there are several) will mean very much to a beginner. Some of the spectrograms lose clearness and definition by being reproduced on such a small scale (for example, Figs. 3.30 (p. 54), 4.6 (p. 71), 12.8 (p. 246)).

This book is essentially a practical book, and those who go to it for treatment of the theory of spectra will find it disappointing. The author has limited his discussion of theory to very concise statements on fundamental points. Particularly is this so with respect to his treatment of infra-red and Raman spectra. Whilst there is no doubt that these spectra constitute a field of their own, it is to be regretted that, since the author has elected to include them, he did not extend this chapter so as to give more detailed information on the specialized technique required for their study, concluding with a short account of the scope and utility of each when used separately and when the data from both are correlated. A detailed discussion would not have been necessary, and yet the undoubted success of these methods in the elucidation of molecular structure constitutes an important branch of chemical spectroscopy. But perhaps, on the whole, it might have been preferable to have omitted their discussion altogether.

Chapter xii, which deals with laboratory experiments, merits special attention. The exercises commence with the calibration of a spectrograph and then go on to the qualitative and quantitative determination of elements, the measurement of visible and ultra-violet absorption spectra, and the use of the photronic cell. The exercises, perfectly straightforward in themselves, are described in a most complete, careful, and attractive way, and will prove extremely useful as a basis for an elementary experimental course in chemical spectroscopy. The only criticism which may be made is that these exercises can, however, only be carried out when there is available in the laboratory a considerable quantity and range of spectroscopic apparatus.

No book of this size and importance can be expected to be entirely free of errors or devoid of sections or features to which some measure of adverse criticism can be applied. This book is no exception. But the feeling left in the mind of the reviewer after perusing it is that the book, although rather expensive, is a welcome and timely addition to the literature of the subject and can be thoroughly recommended.

W. Rogie Angus.

HUMAN EMBRYOLOGY

The Essentials of Human Embryology

By Prof. Gideon S. Dodds. Second edition. Pp. ix+316. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1938.) 20*s*. net.

As was to be expected in a work on human rather than comparative embryology, the second edition of Prof. Dodds's text-book, which is intended mainly for medical students, does not differ greatly from the first, published nine years earlier. Many of the chapters are little if at all altered, but there are certain sections in which changes have been introduced as a result of recent researches. These relate more particularly to the early stages of development, the testis and ovary, the placenta, the ages of embryos, the formation of bone, the pharynx and its derivatives, the blood vessels, and the growth of nerve fibres. Moreover, the chapter on ovulation, menstruation, and pregnancy has been almost entirely rewritten.

In the fourth chapter there is an interesting account of the four very young ova known as the Miller, Bryce-Teacher, Peters and Spee ova. The section on the determination of the age of embryos includes useful tables illustrating the growth, and one of these, which is supplied by Dr. Streeter and hitherto unpublished, includes ages below eight weeks, the figures being based upon young human embryos compared with accurately timed monkey embryos. It is to be noted that in the chapter on the nervous system there is included a brief account of Speidel's recent research on the growth of nerve fibres in the web of the tail of the tadpole.

The chapter on ovulation and the related processes deals with certain matters which are not beyond dispute, and the statements made are not always quite accurate. Thus, in the formation of the corpus luteum, the follicular cavity is partly filled in by the ingrowth of connective tissue and vessels from the wall and not simply by the hypertrophy of the epithelial cells, as here described. Further, the hæmorrhage which takes place before œstrus in the bitch cannot correspond to the inter-menstrual bleeding of women occurring at about the time of ovulation, since the latter process in the dog does not supervene until œstrus, and it is well known, as pointed out by Heape, that the bitch will not usually receive the male until external bleeding is quite or nealry over.

Such defects as those indicated, however, must not be held to detract from the general usefulness of the book.

F. H. A. Marshall.

A SKELETON HISTORY OF SCIENCE

Science since 1500

A Short History of Mathematics, Physics, Chemistry, Biology. By H. F. Pledge. Pp. 357 + 15 plates. (London: H.M. Stationery Office, 1939.) 7*s*. 6*d*. net.

THIS book gives a very compact summary of the history of the chief sciences during the period indicated in the title, and also some retrospects covering earlier periods. The mode of presentation varies. Some of the chapters follow the main divisions of science, others confine themselves to some special problem, while others again are rather mixed bags the contents of which are strung together on somewhat slender threads.

The attempt to crowd so much into a single volume inevitably involves large gaps. The principal weakness of the book lies, however, in its inclusion of too much, rather than of too little, in the allotted space. The actual text consists of little more than 300 pages, and there is an index of 27 double-column pages listing some 3,000 names and subjects. In the circumstances, we have something like a skeleton rather than a living body. The various catalogues and handbooks published by the Science Museum are all of them more or less helpful. The present volume is probably the most ambitious, and probably one of the least helpful, of them all. The claim that the book is suitable for the general reader, for the beginner, etc., cannot be seriously sustained. If this was really one of the author's aims, then he should have reduced the number of facts dealt with, and thereby made room for more adequate explanations, so as to make the dry bones live. Additional space for expository purposes could also have been gained by omitting most of the illustrations, which are more curious than important, and some irrelevant matter.

It seems odd that Mr. Pledge, who makes quite severe demands on the reader's previous knowledge of science, should have refrained from assuming an elementary knowledge of European geography, and considered it necessary to devote 12 pages to maps and tables showing the birthplaces of men of science. I have not checked their accuracy, but one error attracted my attention because it is repeated in the main text. Mr. Pledge asserts twice that Spinoza was not born in Holland (pp. 51f.). But he was; namely, in Amsterdam. Again, Mr. Pledge sacrifices two pages to a facsimile and translation of a passage from a thirteenth-century Hebrew manuscript in which motion is described as a cause of heat. To judge from the section in which the facsimile is inserted, it appears to be regarded by Mr. Pledge as an anticipation of the kinetic theory of heat. Actually, the passage is irrelevant, as it has no bearing on the question of *molecular* motion, nor on the question whether heat is a kind of substance or a kind of energy. Incidentally, it may be pointed out that the facsimile is printed upside down!

Mr. Pledge does occasionally depart from the narrow path of bare summary. But his remarks, in those cases, strike one as tendentious and misleading, or at least as very questionable. For example, in a chapter on early mathematics, the notion of infinity is dealt with in a manner which betrays a curious mixture of ideas pertaining to mathematics, sociology, and theology, and the net result is summed up in the following delectable statement: "For the step-by-step communion with the infinite by a series of sacraments, science has substituted the step-by-step communion with it by a series of hypotheses and experiments. But the infinity remains." What has this to do with the mathematical conception of infinity? Again, here is Mr. Pledge's amusing incursion into comparative psychology: "the domestic dog appears to believe that he can impart motion to his master infectively by fervent imitation of the actions of going for a run"! Mr. Pledge's adventures into the realm of philosophy are on the same level of infelicity. The terms "philosophy" and "philosophical", etc., are used in such varied and nebulous senses that one is made to wonder what he really means by them; and, even apart from this vagueness, his quasi-Comtean remarks about the relation between philosophy and science are made in defiance of the fact that eminent thinkers like Descartes, Leibniz and Kant were men of science as well as philosophers, and that the same sort of combination is found among such contemporaries as Whitehead, Russell and Eddington.

Finally, reference may perhaps be made to another kind of crudity which rather mars the book, namely, the use of such phrases as "the Jew, L. Kronecker", the "Jew convert" Cantor, etc. Mr. Pledge most probably does not mean to be unfriendly, but the use of such expressions reminds one of a significant remark made, more than a hundred years ago, by a journalist of distinction. Some people, he protested, hate the Jews merely because they are Jews, some tolerate them in spite of their being Jews, and some even like them just because they are Jews; but nobody ever seems to forget that they are Jews! A. WOLF.

VISCOSITY AND MOLECULAR STRUCTURE

By Dr. H. Mark and R. Simha

THE development of the molecular theory of matter has as a consequence that an increasing number of empirical constants, by which one characterizes the behaviour of a macroscopic sample, are brought into quantitative relation with the molecular structure of the material. For example, it has long been known that the *index of refraction* can be connected with the *mobility of the electric charges* in a given substance, and therefore can be used to determine the electrical polarizability of the molecules in a quantitative way. Similarly, the *dielectric constant* can be used to get quantitative information on the *distribution of the electric charges* in the molecules of a given substance, and it was P. Debye, especially, who succeeded, together with a number of collaborators, in establishing a quantitative theory which combines the macroscopic empirical constant with the molecular properties.

Recently, it seems that another quantity, which has been used for some time to characterize a given system from an empirical point of view, must be understood and evaluated from the angle of the molecular theory of matter. This is the *internal friction* or *viscosity* of solutions. This property has been accounted for in ideal gases by the kinetic theory of gases, by consideration of the masses and velocities of the individual molecules and their irregular collisions. But our knowledge of the viscosity of condensed systems had not progressed so far, although it was obvious that much valuable information would be obtained if viscosity could be interpreted kinetically.

During recent years, some special developments have been particularly favourable to the solution of this problem. The most important of them are : (1) the development of a quantitative theory of liquids ; (2) the accumulation of a large amount of experimental data on high polymeric substances and their solutions, and the development of the ultracentrifuge, which enabled us to get independent information on high molecular compounds.

This progress encouraged the attempt to trace the viscosity of solutions, and especially of solutions containing high molecular substances, back to the fundamental properties of their elementary particles, namely, to the size and shape of the molecules and to their power to fix a certain amount of solvent on themselves. Such attempts were started about fifteen years ago from different points of view. An increasing number of scientific investigators have turned to the subject since then, and we are now obtaining a first insight into the connexion between the viscosity of a solution and the fundamental properties of the dissolved material. It is not suggested that any finality has been reached in this field, but it seems that experimental conditions which are necessary to get trustworthy information have been worked out, and that the results which can be presented to-day are consistent among themselves and agree with the findings by other experimental methods.

It may therefore be appropriate to enumerate briefly the different essential steps which have led to this kinetic elucidation of viscosity and to present a few results which may be presumed to have reached a certain degree of reliability. It may be that in the future such results will have considerable interest in biochemistry, physiology and chemical industry.

Early Fundamental Investigations

Einstein[10] was the first to derive with incomparable clarity an equation showing how spherical particles which are dispersed in a liquid would raise its viscosity. He found, so early as 1905, that the increase of internal friction is proportional to the total amount of dissolved volume, but surprisingly independent of the degree of dispersion. A few large spheres produce the same viscosity increase as many small ones, provided their total volume remains constant. A few years later, Bancelin[1] and Sven Odén[36] confirmed experimentally Einstein's theoretical results.

Having received experimental confirmation, the Einstein equation could be used to determine the total volume of the dissolved phase, that is, the degree of swelling or solvation which the material undergoes during solution. For example, it was found that a molecule of cane sugar carries with it about five or six molecules of water tightly fixed upon its surface during the diffusion in the liquid.

But the combined theoretical and experimental results seemed to block any possibility of getting information concerning the size of the dissolved particles, because it was found that the viscosity should be independent of this quantity.

However, during the following years an increasing number of empirical facts showed that there evidently was some relation between particle size and viscosity in quite a number of cases. Measurements of Biltz[3], Berl and Buttler[2], Hatschek[21], Duclaux and Wollmann[9], Ostwald[30], and Staudinger[35] gave indications that the viscosity of very dilute solutions of many typical high molecular substances decreases if one degrades the original material, and that it is increased if one raises the molecular weight. As this is apparently in disagreement with the Einstein equation, it was concluded that these substances do not behave as spherical particles.

From here on a double development became necessary: (*a*) to accumulate more reliable and quantitative empirical data in order to have a sound experimental background; and (*b*) to derive theoretical equations for non-spherical particles.

The Problem of Non-Spherical Particles

Much successful work was contributed in both directions. It was especially Staudinger and his collaborators who extended viscosity measurements considerably, investigating systematically the influence of molecular weight, concentration, temperature, and solvent; and they established an empirical rule, the well-known viscosity equation of Staudinger[35].

This equation states that the viscosity increase due to the dissolved substance is proportional to its molecular weight, provided that the solution is sufficiently diluted. Very careful viscosity measurements by Meyer and v. d. Wijk[29], and by Kraemer and Lansing[25] showed, however, that this relation is not exact but is subject to certain deviations. But it can be safely regarded as being a valuable rule for the estimation of molecular weight, and it has proved to be very fruitful for further progress in this field.

While this experimental material was accumulating, a series of successful attempts to develop equations for non-spherical particles was made. Jeffery[23] was the first to start this development. He was followed by Eisenschitz[13], Boeder[5], Haller[20] and Kuhn[27]. These investigators developed equations making it possible to calculate the viscosity increase due to longish particles, as the Einstein equation did for spherical particles. Obviously these relations were expected to explain theoretically the Staudinger equation, but at first sight there seemed to be a lack of agreement.

The Staudinger equation states that the viscosity increase is proportional to the molecular weight, while hydrodynamics indicate that it is proportional to the square of the molecular weight. Guth and Mark[18] proposed qualitatively an explanation for this discrepancy, but Kuhn[27] was the first to work out a complete and consistent theory.

If one assumes that the dissolved particles are *not stiff rods but flexible threads*, the experimental findings and the theoretical equations harmonize in a manner which shows that the idea of long flexible chains rolled or wound up to a more or less cluster-like unit is the right way out of the dilemma.

Development of the Hydrodynamical Method

To get a final check on the value of this explanation, further experimental and theoretical work was undertaken. Eirich, Bunzl and Margaretha[12] studied systematically the behaviour of model suspensions with particles of exactly known size and shape. Glass, silk, rayon, mushroom spores, bacteria, microscopic crystals, etc., were used; the size varied from 1μ to 100μ diameter, the shape from spherical particles to rods with an axis-ratio of about 50. The viscosity of proteins was carefully investigated by Fahry and Green[14] and by Polson[32]; the latter giving an extensive comparison of the data obtained by viscosity measurements with the results of the Svedberg ultracentrifuge. At the same time Houwink and Klaassens[24], Kraemer and Lansing[25], Bogue[6], Kratky and Saito[26], and others contributed valuable experimental material on different high polymeric substances.

The hydrodynamical treatment was pushed forward by Guth[17,19], Huggins[22], Kuhn[27], and Simha[34], in the direction of both spherical and non-spherical suspensions, taking into account the influence of higher concentration and of the Brownian movement.

Another group of recent articles represents comprehensive work aiming at the comparison of all available data and their survey from a common point of view. Sakurada[33], and particularly Bredee and de Booys[7], and Huggins[22], have contributed in this direction.

Conclusions

As the result of the experimental and theoretical work briefly described above, some data contained in the following tables can be usefully considered. They show that although we still have to consider that we are in an early stage of the complete molecular interpretation of viscosity, a number of very interesting molecular constants can be derived from such measurements.

Table 1 shows the size and shape of some protein molecules as determined by viscosity measurements, and at the same time the corresponding values obtained with the Svedberg ultracentrifuge.

TABLE I. SIZE AND SHAPE OF PROTEIN MOLECULES IN AQUEOUS SOLUTION*

Substance	Molecular weight		Axis ratio	
	from viscosity	from ultra-centrifuge	from viscosity	from ultra-centrifuge
Ovalbumin	41,800	42,000	8·5	3·8
Hæmoglobin	70,300	68,000	5·9	3·8
Serum albumin	71,800	70,000	9·8	4·9
Homarus hæmoglobin	793,000	800,000	—	—
Tobacco mosaic virus	$17\text{-}43\times10^6$	—	36·9	—

* Compare refs. 4, 7, 14, 16, 28, 32.

TABLE 2. MOLECULAR WEIGHT, SOLVATION AND SHAPE OF SOME CELLULOSE DERIVATIVES*

Substance	Molecular weight	Volume of the solvated particle as multiple of the dry volume	Deviation from the spherical shape†
Nitrocellulose	500,000	345	2·5
,,	150,000	121	3·7
,,	40,000	40	2·6
Cellulose acetate	50,000	97·5	3·0
,, ,,	14,000	31·3	3·2
,, ,,	6,400	13·2	2·1

* Compare refs. 2, 7, 8, 9, 15, 35.
† Spherical shape is characterized by the value zero.

It can be seen that, as regards the size of the particles (molecular weight), the two methods agree fairly closely, while viscosity gives a higher axis-ratio than the ultracentrifuge.

Table 2 contains similar information on the molecular weight, solvation, and shape of some cellulose derivatives. In this case no experimental data from the ultracentrifuge were available, and therefore an experimental check of the values is not possible. However, other methods (osmotic pressure, diffusion, etc.) confirm the above values and show that they certainly reflect to a considerable extent the true conditions in these high molecular suspensions.

TABLE 3. MOLECULAR WEIGHT, SOLVATION AND SHAPE OF SOME POLYSTYRENE SAMPLES*

Molecular weight	Volume of the solvated particle as multiple of the dry volume	Deviation from the spherical shape†
280,000	205	7·3
220,000	80·5	5·7
23,000	15·4	3·1
2,400	2·65	0·4

* Compare refs. 7, 31, 33, 35.
† Spherical shape is characterized by the value zero.

TABLE 4. SOLVATION OF DISPERSED SUBSTANCES WITH APPROXIMATELY SPHERICAL PARTICLES*

Substance	Degree of solvation (per cent)
Mushroom spores	nil
Colloidal sulphur	nil
Kresol-formaldehyde-resin	10–40
Cane sugar	50
Ovalbumin	120
Gamboge	800
Gelatine	1,000–2,000

* Compare refs. 1, 4, 6, 7, 12, 14, 24, 32, 36.

Similar data concerning some samples of polystyrene are given in Table 3. They are equally supported by the results of other experimental methods.

Tables 2 and 3 show that with increasing molecular weight the solvation of the substance investigated increases, and in the case of styrene the deviation from the spherical shape also assumes higher values.

Table 4 gives the solvation of some systems the particles of which are approximately spherical, and shows that different materials behave very differently as regards their power to absorb certain amounts of solvent and to carry them about during their molecular movements.

If account is taken of the fact that it is very difficult to get any trustworthy quantitative information on size, shape, and solvation in the region of such high molecular weights, it will certainly be admitted that viscosity measurements provide a very valuable and welcome means of obtaining quantitative information on the molecular structure of such materials.

LITERATURE

[1] Bancelin, M., *Koll. Z.*, **9**, 154 (1911).
[2] Berl, E., and Buttler, R., *Z. Schiess- und Sprengst.*, **5**, 82 (1910).
[3] Biltz., W., *Z. phys. Chem.*, **73**, 481 (1910).
[4] Bincer, H., *Koll. Z.*, **59**, 82 (1932).
[5] Boeder, P., *Z. Phys.*, **75**, 258 (1932).
[6] Bogue, R. H., *J. Amer. Chem. Soc.*, **43**, 1764 (1921).
[7] Bredee, H. L., and de Booys, *Koll. Z.*, **79**, 31 (1937).
[8] Dobry, A., *Koll. Z.*, **81**, 190 (1937).
[9] Duclaux, J., and Wollmann, E., *C. R.*, **152**, 1580 (1911).
[10] Einstein, A., *Ann. Phys.*, **17**, 549 (1905).
[11] Eirich, F., *Koll. Z.*, **74**, 270 (1936); **81**, 7 (1937).
[12] Eirich, F., Bunzl, M., and Margaretha, H., *Koll. Z.*, **74**, 276 (1936).
[13] Eisenschitz, R., *Z. phys. Chem.*, A, **158**, 78 (1931); **163**, 133 (1933).
[14] Fahry, K. R., and Green A. A., *J. Amer. Chem. Soc.*, **60**, 3039 (1938).
[15] Fikentscher, H., and Mark, H., *Koll. Z.*, **49**, 135 (1929).
[16] Frampton, V. L., and Neurath, H., *Science*, **87**, 468 (1938).
[17] Guth, E., *Koll. Z.*, **74**, 147 (1936).
[18] Guth, E., and Mark, H., *Erg. ex. Naturw.*, **12**, 115 (1933).
[19] Guth, E., and Simha, R., *Koll. Z.*, **74**, 266 (1936).
[20] Haller, W., *Koll. Z.*, **61**, 26 (1932).
[21] Hatschek, E., *Koll. Z.*, **7**, 301 (1910); **13**, 88 (1913).
[22] Huggins, M. L., *J. Phys. Chem.*, **42**, 911 (1938); **43**, 439 (1939); *J. Appl. Phys.*, **10**, 700 (1939).
[23] Jeffery, G. B., *Proc. Roy. Soc.*, A, **102**, 161 (1922).
[24] Klaassens, K. H., and Houwink, R., *Koll. Z.*, **76**, 217 (1936).
[25] Kraemer, E. O., and Lansing, W. D., *J. Phys. Chem.*, **39**, 156 (1935).
[26] Kratky, O., and Saito, G., *Cell. Chem.*, **16**, 585 (1935).
[27] Kuhn, W., *Z. phys. Chem.*, A, **161**, 1, 247 (1932); *Koll. Z.*, **62**, 269 (1933); **68**, 2, (1934); **76**, 258 (1936).
[28] Lauffer, M. A., *Science*, **87**, 469 (1938).
[29] Meyer, K. H., and v. d. Wijk, *Helv. Acta*, **18**, 1067 (1935).
[30] Ostwald, W., *Koll. Z.*, **24**, 7 (1919).
[31] Philippoff, W., and Hess, K., *Z. phys. Chem.*, B, **31**, 237 (1936).
[32] Polson, A., *Koll. Z.*, **88**, 51 (1939).
[33] Sakurada, J., *Z. phys. Chem.*, B, **38**, 407 (1938).
[34] Simha, R., *Koll. Z.*, **76**, 16 (1936).
[35] Staudinger, H., *Ber.*, **59**, 3013 (1926); *Koll. Z.*, **51**, 71 (1930); compare also his book on high polymeric compounds (Berlin, 1932).
[36] Odén, Sven, *Z. phys. Chem.*, **80**, 709 (1912).

PLANT HUNTING THROUGH THE CENTURIES*

By F. KINGDON WARD

IN a sense, man has been searching for useful plants ever since he first appeared on the earth. Even in his hunting days before the end of the Ice Age he probably supplemented his diet with berries, seeds and roots. But for our present purpose we may ignore man before he became a cultivator, merely noting that even in those remote days he was a plant hunter.

We may perhaps picture primitive man slouching painfully across that early European landscape, haunted by the spectre of hunger, a child of sudden overwhelming impulse, fearful and bewildered, clutching, famished, at a handful of grass seeds or coloured berries, gnawing tough fruits, or chewing leaves. Through these bitter centuries he was learning gradually the first lesson man was compelled to learn in his dealings with the tremendous, infinitely old vegetable kingdom which he was destined one day to control: the difference between cellulose and starch or sugar, the difference, that is, between the structural materials of plants and the products they manufacture and set aside for future use; the cell wall and the cell contents. For cellulose is insoluble and therefore useless to man as food, since he cannot assimilate it; but sugar is soluble and starch is easily converted into sugar. Only the plant store-houses—fruits and seeds and certain usually underground parts and growing points—contain available food. The object of cultivation, besides being a matter of greater convenience, is to increase the soluble cell contents and eliminate as much as possible of the framework.

To get the botanical exploration of the world into perspective, it is necessary to go back eight or ten thousand years. The outline of the world was not then very different from what it is to-day. But there have been great changes in the mantle of vegetation since then, changes in the relative positions, and in the extent of forest, steppe and desert which are ultimately dependent on rainfall. It was vegetation, and hence climate, which determined not only which direction wandering man should take, but also where he should first begin to settle.

Although man must have been a hunter before he became a herdsman and a husbandman, through long ages all three must have existed together in different parts of the then habitable world. Man could have hunted only on the steppes; he could not have lived in the desert, and in the forest he would have been a complete vegetarian. It would therefore be misleading to divide the time period into the three ages of hunting, herding and husbandry. Broadly speaking, herding suggests a nomadic, cultivation a settled, life. But there are many villages in Tibet to-day where no crops are grown, while in many parts of the world agriculture is itself nomadic. In densely forested regions the same patch of ground can only be cultivated at long intervals, and there comes a time when the village has to move. Abandoned village sites are common, for example, in far northern Burma.

Since we are dealing with a continuous evolution, no classification of the plant exploration period on a time basis can be other than arbitrary. Nevertheless, the following rough guide may be found convenient, though it involves a good deal of overlapping.

(*a*) *The Search for Food Plants.* Prehistoric period, from the beginnings of cultivation to the invention of writing, from about 7000 B.C. to about 4000 B.C.

(*b*) *The Search for Economic Plants, other than staple foods, but including many food plants of secondary importance.* Historic period, from 4000 B.C. to the discovery of the New World in A.D. 1492.

(*c*) *The Search for Garden Plants.* Modern period from A.D. 1492 to the present day.

This corresponds to some extent with three successive steps in the evolution of civilization, namely, (i) the search for economic plants, or as it is called to-day, raw material; (ii) the large-scale cultivation in any convenient part of the world of economic plants; and (iii) the large-scale manufacture of synthetic products from simple vegetable raw material. So we take up the story of plant hunting at the end of the pre-agricultural age; the earliest plant hunters sought food plants.

Cultivation must have arisen independently in several centres; settlement was the basis of civilization. The primitive tribes of the eastern Himalayas, although new-comers (their chief crop is maize, which was unknown in Asia before the discovery of America) show traces of what early agriculture may have been. In the vicinity of Abor and other villages, fruit trees such as Artocarpus, peach, cherry, Citrus, quince, are much commoner than elsewhere, showing how settled people eat the fruits and spit out the seeds, which germinate in the village clearing.

* Substance of a course of lectures delivered at the Royal Institution on January 16, 23 and 30.

In the Mishmi Hills, the medicinal herb *Coptis Teeta* grows in the forest, above the highest cultivation. The natives clear the ground, cut down a few trees, and encourage the Coptis by stifling opposition. These tribes also show how from very early times man has used vegetation in its raw state, as timber, etc. The use of bamboos for water-tubs, lianas for ropes, or the fibrous bases of palm leaves for cloaks are examples. The first thing man ever made for himself was a wooden (cellulose) club. One of the latest things he has provided himself with on a vast scale is also made of cellulose—nitro-cellulose, the basis of many high explosives.

The natural distribution of plants over the earth has until recently been a decisively limiting factor in man's economy. Until the exploration of the world was far advanced, the people of Malaya had no chance of cultivating Brazilian rubber, nor the people of Brazil of cultivating Arabian coffee. Nor were these substances required in bulk. Not only are the plants of different parts of the world different, even for the same climate, but also they are of unequal value. Nowadays this unevenness of distribution can be levelled up by transporting any plant from where it grows naturally to any part of the world where it will grow. Plants regarded as of less importance are swept away to make room for huge crops of one kind, such as rubber, quinine, sugar cane or tung oil. The vegetation of the earth is everywhere being rapidly altered by man.

It has been shown by de Candolle, and more recently by Vavilov and others, and endorsed by antiquarians, that the earliest civilizations began in those regions whence most of our oldest cultivated crops have been derived. But nowadays the great centres of civilization bear no relation to, or are quite independent of, the original homes of the cultivated crops. That is a very significant fact.

After food, man's chief need was clothing. When animal skins became rarer, he turned to cellulose, and wore leaves. To-day most of the world's clothing is made of cellulose products such as cotton and rayon. The art of weaving is older than that of writing.

In the Ancient World new ideas diffused slowly, but they were quickened later as the result of pilgrimages, campaigns like that of Alexander, and trading. When civilization was disintegrating all over the world between A.D. 1050 and A.D. 1250, owing to the attacks of barbarians, cellulose came to the rescue with the increasing use of paper, which made books possible. Knowledge was preserved without accumulating error, and degenerating into legend. The earliest paper—papyrus (pith), *Aralia japonica* (pith), and palm leaf—was practically pure cellulose and useless for books. But the invention of paper which would take print was a fundamental step in the forward march of civilization. Printing itself was of less importance than paper ; it increased the speed of diffusion, without any corresponding increase of accuracy, so that myths were as readily propagated as truth ; for example, in modern times the widely believed story of mummy wheat germinating.

From the beginning, agriculture has had a disastrous effect on the natural cover of vegetation, and one of ever-increasing severity, especially in areas of natural grassland and in mountainous forested country where shifting cultivation is practised. The plough has proved one of the most destructive weapons ever put into the hands of man. Within the last few centuries pastoral man has become almost as destructive as agricultural man, as a result of cutting down forest to increase the area of pasture. The damage is clearly seen in many parts of the eastern Himalayas, where the local climate is being altered, and much land becoming derelict.

Two hundred years after Marco Polo's journey, the overland route through Eurasia was virtually closed. Diaz then rounded the Cape, and Columbus discovered the New World. As a result, the age of maritime exploration began, and more was learnt of tropical than of any other type of vegetation. The coasts and the estuaries of great rivers were explored. But for lack of roads, the interiors of the continents remained hidden, and it was not until the nineteenth and twentieth centuries, and the intensive search for gold, that the building of roads and railways made inland exploration possible. The historic voyages of the seventeenth and eighteenth centuries did nothing to make known the vegetation of the interiors of continents. The interior of Africa, of Australia, of Central Asia and of South America have been known to scientific men for little more than a century ; the interior of Tibet, and of New Guinea, for less than fifty years. Now that transport problems have been solved, new obstacles in the form of 'national interests' are making scientific exploration over considerable portions of the least-known parts of the world increasingly difficult.

After food and fibre plants, man sought dyes, drugs, soap, scents and such-like things. While searching for food plants he may have discovered soothing or uplifting properties by chance, for example, opium poppy seeds, which the Mishmis eat, tobacco, hemp. Fermentation of his stored grain taught him the use of alcohol. In modern times, oil-producing fruits and seeds are in great demand. The plantation industry grew up with the Mechanical Revolution ; raw material was needed to feed the machines. When the topography of the world had been mapped, the mapping of the

vegetation and of the rocks followed. From the beginning, unusual looking plants attracted man's attention ; and it was but a short step to cultivate flowers. With the advance of civilization, horticulture took a prominent place. In spite of the intensive exploration of the world for new plants during the last 1,500 years, not one unknown economic plant of any importance has been newly discovered. Even tung oil and soya bean, than which few plants have come into greater prominence recently, were cultivated several thousand years ago. On the other hand, many beautiful garden plants have been newly discovered.

Apart from horticulture, perhaps five hundred species of plants are now cultivated on a commercial scale—a very small proportion of the total known flora. The tendency is to reduce rather than increase the number, as the chemist learns how to synthesize plant products. Thus coal tar dyes supersede vegetable dyes, although coal tar is itself, ultimately, derived from vegetation ; and better varieties of wheat drive out inferior varieties. The increasing cultivation of herbs for the herb drug market perhaps restores the balance.

Apart from the staple cereal and fibre plants, and the various sources of such things as cellulose and timber, the most important economic crops to-day are : rubber, soya bean, quinine, tea, coffee, cocoa, sugar cane, banana, tung oil, varnish tree (Rhus), tobacco, opium, sisal and jute. The chief supply of nearly every one of these is now far from its original source, often in a different continent, as coffee, rubber, quinine and sisal. This has been brought about at the expense of the original vegetation, as a direct result of the growing economic interdependence of mankind. But it only became possible when the main features of the world's vegetation were known. It is obviously an advantage that all men who want tea or soap should be able to obtain these things, rather than that they should be confined to the few ; but mankind is going through a period of intense economic readjustment in order to achieve this desirable end of plenty of everything for all. There is a further conflict between what men need at any given level of civilization, and what 'interests' can persuade them to want.

The world is far from being botanically explored yet. But much of what remains to be done is predictable, thanks to increased knowledge. This enables us to carry on the work more systematically. There may not seem to be the same careless rapture in exploring a given region for largely predictable plants that there might be in wandering through unexplored worlds. But lack of knowledge is a real handicap. It is because we see the past world through eyes which have been opened that it looks romantic. To contemporary man the vegetation must have been confusing, exasperating and overwhelming. So far as plant exploration is concerned, the present is the age of the intensive specialized botanical explorer and the chemist.

PRESERVATION OF GEOLOGICAL RECORDS*

By Dr. M. Macgregor,

Geological Survey of Great Britain

THE preservation in a carefully documented and permanent form of geological records of all kinds is a matter which should be regarded as of the utmost importance, and the opportunity is taken here of stressing the need for conjoint action to deal with it. If the examples used by way of illustration are drawn entirely from Scottish sources, it is partly because they have come directly under my own observation and partly because the suggestions advanced may gain in cogency if their application to one particular region is emphasized.

The importance of preserving geological sections of outstanding or critical significance has long been recognized. These may be conveniently grouped into three broad, more or less arbitrary, categories. They may, for example, illustrate unique episodes in the history of the earth ; they may represent landmarks in the progress of geological thought or symbolize striking advances in our knowledge of geological processes ; they may, again, be sections that require re-examination and re-consideration from time to time in the light of modern research. For these and other reasons—historical, educational and scientific—the question of their preservation is a challenging one for all geologists.

These three categories may be very briefly dealt with. It would not be easy to select a more impressive illustration of the first of them than the little trial quarry at the roadside 3½ miles north-west of Inchnadamph, in Sutherlandshire (Geol. Surv. Photo. C. 2019). Here the basal beds of the Torridon Sandstone, containing wind-facetted pebbles, rest discordantly upon an

* Substance of an address prepared for the Conference of Delegates of Corresponding Societies at the Dundee meeting of the British Association.

eroded and weathered surface of Lewisian Gneiss. Not only does this section allow us a glimpse of a land-surface that existed in early Torridonian times, more than 500 million years ago, but also it illustrates clearly and diagrammatically the structural relations of two of the most ancient rock-formations known. It would be a great loss if the section were to be swept away during the road-widening schemes that are in contemplation, and assurances have been obtained that it will not be destroyed. Another striking example that may be adduced is the well-known "Fossil Grove" at Victoria Park, Whiteinch, now a museum under the care of the Parks Department of Glasgow Corporation (Geol. Surv. Photos. C. 3560–61).

Of sections falling within the second category two instances may be given. The first of these is the historic exposure in the River Jed, near Jedburgh, discovered by Hutton in 1787 and described by him as providing unassailable evidence for elevation of the land, followed by erosion, subsidence and a fresh cycle of deposition. The originality of Hutton's genius is perhaps nowhere more fully exhibited than in his interpretation of the Jed River section. This exposure (Geol. Surv. Photo. C. 3494), which shows the nearly horizontal sandstones and marls of the Upper Old Red resting unconformably on highly folded Silurian rocks, was in danger of being overgrown and obscured, but now, owing to the generosity of Provost Veitch, it has been largely cleared of vegetation and debris and a pathway constructed to it. The second example which may be quoted under this heading is the striated rock-surface on the south face of Blackford Hill, Edinburgh, known as Agassiz' Rock (Geol. Surv. Photo. C. 2079). This also is of historic interest, since it was during a visit to the locality in the latter part of 1840 that Agassiz recognized the grooved surface as the work of glaciers. A number of years ago the Edinburgh Town Council, at the request of the Edinburgh Geological Society, agreed to protect the rock-face with a railing and to erect a commemorative tablet.

Within the third category may be fitly included various sections on the slopes of Arthur's Seat, Edinburgh, which have from time to time been re-interpreted in the light of increasing knowledge. Some of these, on Salisbury Craigs (Geol. Surv. Photos. B. 928–9), were at one time in danger of being quarried away, but the whole area of Arthur's Seat is now a national park under the custody of H.M. Office of Works.

Clearly, however, the preservation of important or critical sections is only practicable in a limited number of cases, and in this connexion brief reference may be made to the exposures of fossiliferous clays and sands which were laid bare about 1868–69 in Cowden (or Cowdon) Glen, Renfrewshire, during the construction of a railway line between Caldwell and Neilston. James Geikie, Croll, Bennie and other geologists who examined the excavations came to the conclusion that the fossiliferous beds, with their mammalian and other remains, were deposited between two distinct boulder clays and were accordingly interglacial in age. Craig, on the other hand, claimed: (*a*) that much of the 'upper' boulder clay was due to landslips at the side of the valley bringing down portions of the 'lower' boulder clay over the laminated material; and (*b*) that where it was definitely *in situ* above the latter it was of a gravelly nature (with lumps of the underlying sediments) and owed its formation not to the action of ice but to that of water. While the interglacial age of these beds is now generally accepted, Gregory and Currie in 1928, after a review of the available evidence as presented by earlier workers and a critical examination of the vertebrate remains, concluded that the deposits were "post-glacial and probably Neolithic in age". The question is certainly an important one in its bearing upon the Glacial and post-Glacial history of the region. It cannot be discussed here, but the Cowden Glen sections will serve as illustrations of ones which we would much like to re-examine in the light of later work.

Perhaps the most important aspect of the problem, however, concerns the preservation in a permanent form of geological records in general. Although much has been accomplished in this respect, it is certain that a systematic and co-ordinated effort to deal more fully with the problem is both essential and urgent. Much valuable geological information can be obtained from excavations made for various purposes connected with industrial and allied undertakings, from boring and mining developments, from tunnelling and quarrying operations, from roadway and sewage schemes, from factory and housing extensions, and from temporary exposures in constructional work of all kinds. The machinery for dealing with shafts and borings for minerals more than 100 ft. in depth is already in existence, but in regard to the other operations enumerated there is a wide field not covered by any co-ordinated activity.

Much of the information that might be derived from such sources is lost, or is available only in a form that is difficult, and indeed often impossible, to interpret. Engineers and foremen in charge of constructional work, surveyors, well-sinkers and the like have their own special tasks and their own aims in view, and they cannot be expected to provide records in the form and with the detail required by the geologist. It is surely the duty of

the latter to see that the exact information he needs is carefully collected and made available for purposes of research. This is done in the case of borings for minerals, and it seems essential that it should be done systematically in regard to temporary sections of all kinds.

The importance of such investigations and of their repercussions not only on scientific but also on economic problems is not sufficiently realized, and the opportunities they offer for adding to our knowledge are too often neglected. Certainly they will often be of small importance individually, but collectively they may well amount to an impressive body of valuable geological data. Their significance in the preparation of detailed geological maps need not be stressed. Temporary excavations have contributed much to our knowledge of the geological succession and structure in different areas, notably, so far as Scotland is concerned, around Edinburgh and Glasgow. On the other hand, it would be easy to cite examples of temporary exposures which were not examined and about which little or no information is now available. The cumulative loss to geology must be very considerable, and it is in the hope of minimizing it that the problem is raised anew. In the past, the preservation of records has been left too much at the mercy of accident, and it would seem essential to establish, or try to establish, some definite system of efficient safeguards.

Thus there are two objects to keep steadily in view. The first of these is the preservation, wherever possible, of sections of outstanding or critical significance. In a number of cases this has been secured through the co-operation and assistance of public bodies, and geologists must feel deeply indebted to these for their action. Private assistance has, as already stated, come to our aid in the case of the Jed River unconformity, while acknowledgment should certainly be made of the generous action of Major-General J. W. Stewart, when in 1930 he conveyed to the ownership of the Royal Society of Edinburgh the ground at Inchnadamph on which the Peach and Horne memorial stands (Geol. Surv. Photos. C. 3550–51). Where preservation of important sections is possible, however, appeals for co-operation and assistance will come more effectively from a committee representative of geological opinion throughout the country. One other thing must be said in this connexion. It will not be out of place to suggest that geologists themselves are not always entirely free from blame in this matter, and that some restraint might be put on indiscriminate collecting at specially important and limited exposures.

The second and, in my opinion, the more urgent claim on our attention, is the preservation of carefully annotated records of exposures that are likely to be destroyed or to disappear, and of sections that are temporarily opened for examination. Included among the latter are excavations of all kinds as well as borings for whatever purpose these may have been sunk. The information they yield, scientific and economic alike, ought to be made available in a permanent and accessible form. To ensure this will require the active co-operation of geological and natural history societies and of university geological departments throughout the country, each responsible for a particular region and each reporting annually to a central organizing committee, either of the British Association or of the Geological Society. Brief abstracts of the work done in the different regions should be published at intervals, and these abstracts ought unquestionably to indicate where the fuller details are available, whether published or preserved in manuscript form. What is required is a register of new information derived from temporary sections and some system of ensuring that the full records, including any diagrams and photographs, are permanently retained. There is nothing extreme in this suggestion, and it ought to be possible to institute an efficient system of precautions against avoidable loss.

OBITUARIES

Sir Thomas Heath, K.C.B., F.R.S., F.B.A.

SIR THOMAS LITTLE HEATH, who died on March 16, was one of the most learned and industrious scholars of our time. He was born on October 5, 1861, the third son of Mr. Samuel Heath of Thornton Curtis in Lincolnshire. Sent to school at Clifton College, Heath went on with a foundation scholarship to Trinity College, Cambridge; and there, reading for double honours, he took a first in both parts of the Classical Tripos, and was twelfth Wrangler in 1882. Those years in Trinity are pleasant to look back upon. Henry Jackson was at his best; Acton, Glaisher and Robertson Smith intensified the atmosphere of learning; William Wyse, H. H. Turner, Henry Head and Alfred North Whitehead were among the undergraduates; James Gow was writing his "History of Mathematics"—a "convenient compilation", as G. J. Allman called it, but good enough to start Heath on the work of his life. He won his Trinity fellowship in 1885, as his eldest brother, R. S. Heath, afterwards professor of mathematics in Birmingham, had done two years before; and many

years later the College awarded him its honorary fellowship, the most prized of all his many honours.

In 1884 Heath entered the Treasury, after heading the list in the Civil Service competition. He was a faithful servant, and, winning all the promotion open to him, rose to be permanent secretary of the Treasury and controller of the Civil List, conjointly with Sir John (afterwards Lord) Bradbury. After the War of 1914–18, when even the Treasury was greatly changed, Heath left it for the responsible but less arduous office of comptroller-general of the National Debt Office, which he held until his retirement in 1926; in the following year he published "The Treasury", a little volume of reminiscences of Whitehall. He was succeeded at the Treasury by Sir Warren Fisher; the two men had married sisters a few years before.

Heath was one of those fortunate men who live two lives in one, and enjoy both without neglecting either. Cayley was a busy London solicitor for many years, during which much of his finest work appeared; and Heath wrote one big and famous book after another, after the day's work in Whitehall was done. He took to Greek mathematics as an undergraduate; he came to be the acknowledged master of his subject in Great Britain, and to rank with Loria, Tannery and Zeuthen, next after Heiberg, the greatest Hellenist and historian of them all. While he was still an undergraduate, or very soon after, he wrote articles on Pappus and on "Porisms" for the "Encyclopædia Britannica" under Robertson Smith; and about the same time he published, in Henry Jackson and Ingram Bywater's *Journal of Philology*, a little paper on "The σ of Diophantus", an old puzzle which Heath succeeded no better in solving than others had done*. This and the article on "Porisms" were a foretaste of his first book, on "Diophantus of Alexandria", which came out in 1885, the year of his fellowship. This "youthful work", as Heath afterwards called it, won immediate acceptance, and ran out of print before long. It was written before Paul Tannery revised the text and redirected attention to the remarkable connexion between Diophantus and Fermat; twenty-five years later Heath republished the book, re-written in great part, with a long and admirable supplement on Euler and Fermat.

A year after his Diophantus, Heath published his "Apollonius of Perga" (1896), next year that on "Archimedes", and eleven years later (1908) his great three-volume edition of "Euclid". For "Archimedes" and for "Euclid" Heath had Heiberg's text to build on, save that the "Archimedes" lacked Heiberg's subsequent and very valuable discoveries. But with all due allowance for this, what great books these of Heath's are! No English editor had dealt with Apollonius since Halley two hundred years before, and even the received translations of Euclid were a hundred years old. To translate these books faithfully, and annotate them with all that had been most usefully written by Cantor, Bretschneider, Camerer and the rest, had been Heath's labour of love for years.

Heath had now dealt with Apollonius, Euclid and Archimedes, the three great "Greeks", who in Asia, Egypt and Sicily made the Golden Age of Greek mathematics; then he set to work to end and crown his labours with "A History of Greek Mathematics". It is a book not only for the mathematician but also for every scholar, for mathematics is the greatest of all the legacies of Greece. Of that Golden Age, of the dim Pythagorean times before, and of the later Silver Age, with Diophantus, Pappus, Ptolemy and the rest, we find all or well-nigh all we want to know in Heath's orderly and copious book. It has, doubtless, the *défauts de ses qualités*. Heath has little of the critical taste and gift of brevity which make Allman's book look like a little gem, after fifty years; nor had he Heiberg's fathomless erudition, deep as his own was; nor does he show, or ever want to show, much imagination or speculative curiosity. Like so many other classical scholars he never seemed to care about what Egyptians or Babylonians *may* have known or done; but when at last these great secrets began to be explored Heath became deeply interested, and he reviewed Otto Neugebauer's "Vorgriechische Mathematik" for NATURE with full insight and appreciation.

There are yet other works of Heath's, and not a few. After finishing his "Diophantus" and before settling down to the "History", he wrote a book on that 'Copernicus of Antiquity', Aristarchus of Samos, led on to do so (as he says) by H. H. Turner, his comrade both at Clifton and at Trinity. Half of the book deals with Aristarchus; the other half is a sketch of Greek astronomy, from the starry heavens of Homer and Hesiod down to Plato and Eudoxus, then on more briefly to Hipparchus and Ptolemy.

I think that Heath was at his best when he dealt, encyclopædically, with the life and work of individual men. As a historian he was more sober than a man need always be; he lacked colour, and was afraid of imagination. He found even Paul Tannery "prone to run away with an idea", and *ex abundante cautela* is a tag I have heard him use and recommend. He might have told stories, even about I.47, which would have helped to lighten the three volumes of his "Euclid". But this was not Heath's way. He was a quiet, patient scholar, rejoicing in the things which mattered to him, and which, after all, are the things which matter most to all lovers of learning. Not many years ago he brought out a pretty little volume containing the Greek text of Euclid's first book. The introduction and notes are interesting, but I find the short preface still more so, in which he talks of the "thrill of pleasure" with which he first cast eyes on the Greek text, in the days when he was young and when that text was extant only in old and rare editions. Now he has brought this and many another famous book within reach of us all; and in doing so he has left us an example of sixty years of unstinted and unwearied work, all done for the mere love of it.

D'ARCY WENTWORTH THOMPSON.

* The Diophantine equations hark back, as Heath explains, to the *hau*, or *heap*-calculus, of the Egyptians, and I suggested long ago that the Diophantine σ, answering to our x, might stand for σωρός, a *heap*. But Heath saw reasons to the contrary.

Sir Patrick Laidlaw, F.R.S.

SIR PATRICK LAIDLAW died on March 19 in his fifty-ninth year. His death is a major loss to medical science and a most grievous blow to all those who were privileged to know him personally.

Patrick Playfair Laidlaw, the son of Dr. R. Laidlaw, who was medical officer in the Seychelles, was born on September 26, 1881. A family removal to Cambridge enabled him to enter the Leys School, and from school he proceeded to St. John's College with a scholarship. He completed his medical course at Guy's Hospital and graduated B.Ch.(Camb.) in 1907.

Whilst still a student at Cambridge, Laidlaw gave evidence of his remarkable gifts for research by the publication of several papers on anatomical subjects and one outstanding piece of work on blood pigments. After a few years as demonstrator of physiology at Guy's, he joined the staff of the Wellcome Physiological Research Laboratories, and there, during the next five years (1909–14), he published, either alone or with his colleagues, more than a score of papers on pharmacological subjects, the best known of which is the classical work on histamine, carried out in collaboration with H. H. Dale. This happy and fruitful association with Dale was temporarily broken in 1914 when Laidlaw returned to Guy's as lecturer in pathology, but was renewed in 1922 when he was invited to rejoin the staff of the National Institute for Medical Research. Although never very happy in his academic teaching posts, Laidlaw's strenuous war years at Guy's had helped to give him the remarkable depth and width of knowledge in several medical sciences, which rapidly bore fruit in the new environment. He collaborated in important protozoological and biochemical investigations, but it is for his pioneer researches on virus diseases that he will be most especially remembered.

Laidlaw's study of canine distemper in collaboration with G. W. Dunkin will long remain a model for those engaged in virus research. In a series of papers they described the pathology of the disease in dogs and ferrets, brought forward irrefutable proof that the disease agent concerned is a filterable virus, and finally reported the successful immunization of dogs and ferrets by means of formolized virus vaccines. The outstanding importance of this work was immediately recognized and their method of prophylaxis adopted in veterinary practice.

His next major research was on influenza. Together with C. H. Andrewes and Wilson Smith he succeeded, in 1933, in isolating a virus from patients. This discovery provided a new basis from which to attack the many problems presented by epidemic influenza, and Laidlaw with his colleagues spent the next three years in laying the foundations of our newer knowledge of the disease. On his appointment as deputy director of the National Institute in 1936, he took a less active share in the influenza work but remained always at the service of those who carried it forward. On the outbreak of the War he turned with fresh enthusiasm to new virus problems, and continued working at them until the day of his death.

Laidlaw's work brought well-deserved recognition in his later years. He was elected a fellow of the Royal Society in 1927, was awarded its Royal Medal in 1933, and was elected F.R.C.P. in 1934. The following year he was honoured with knighthood. Shortly before his death he became an honorary fellow of his old college, St. John's, Cambridge.

It is not, however, as a famous man that Laidlaw will be mourned by those who knew him well, but as a wise and ever-helpful colleague, a generous and most loyal friend. Of a shy and reserved disposition, he shunned the limelight and detested anything which savoured of self-advertisement. His keen critical faculty was at the service of those who sought his advice, but was most constantly directed against himself and his own work. His curiosity had no bounds and urged him to incessant probings in new directions, so that his 'unsuccessful' experiments were a constant stimulus and source of inspiration to those around him. Well might he have said with Leeuwenhoek, "The work which I've done for many a long year was not pursued in order to gain the praise I now enjoy but chiefly from a craving after knowledge." W. S.

Prof. E. Branly

PROF. EDOUARD BRANLY, the inventor of the coherer, which enabled Marconi to develop wireless communication and who is known in France as the 'father of wireless', died on March 25 at the age of ninety-five. He was born at Amiens on October 23, 1844, and after showing great brilliance as a schoolboy entered the École Normale. In 1868 he became a professor at the Lycée of Bourges.

Branly's bent, however, was for research work. He therefore went to the Sorbonne and took up work in the physical laboratory and began his study of electricity and magnetism. He was a poor man, and in order to become self-supporting he qualified as a medical man and practised medicine for about twenty years, spending all his spare time in electromagnetic research, for which he received the degree of doctor of science. In 1873 he went to the Institut Catholique in Paris, where he set up a small laboratory, and it was here that his investigations led to the discovery that the electrical resistance between loose particles of metal, such as iron filings in contact with one another, diminishes under the influence of electric action.

In 1872, Branly published a paper on the "Measurement of the Intensity of Currents by the Electrometer"; in 1892, one on "The Electrical Resistance at the Contact of Two Metals", and in 1893 one on "The Property of Discharging Electrified Bodies Produced in Gases by Incandescent Bodies and by Electric Sparks" and in the same year, one on the "Resistance of Thin Metallic Films". The last four of these papers were published in abstract in the *Journal of the Institution of Electrical Engineers.*

Branly made a series of observations into the variations of conductivity of a large number of materials under varying electrical influences. He found that substances which responded best to the phenomenon

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

of sudden increase of conductivity were iron, copper, brass, aluminium, zinc and similar metals. He discovered also that the conductive effect on metallic filings, caused by a nearby electrical discharge, persists for a comparatively long period, but disappears rapidly if subjected to a shock. He obtained the required result by tapping the tube in which the filings are contained. In this way he discovered a principle which was adopted in the original Marconi system. Marconi was very grateful for the help he had received from Branly. He acknowledged this help in his first cross-Channel marconigram in 1899, which was addressed to Branly. It read as follows: "Marconi sends M. Branly his respectful compliments across the Channel this fine achievement being partly due to the remarkable researches of M. Branly."

In 1889 Lodge showed that if two small metal spheres were arranged so that they were nearly touching and separated only by a very minute film of air, the current from a small battery was unable to pass between them. This was proved by the fact that no reading was observable when a sensitive galvanometer was placed in a circuit between them. When, however, a Leyden jar was suddenly discharged in their vicinity, the air film was broken down and they cohered, making electrical contact with one another and allowing a current to pass through the galvanometer. This experiment was described in the year 1890 before the Institution of Electrical Engineers and an account of it appears in the *Journal*. In 1890, Prof. Branly proved the very important fact that filings could be made to cohere by an electric discharge taking place in their vicinity. He described his researches in "La Lumière Électrique" (May and June 1891), and he showed that metal filings could be decohered by a slight concussion. Lodge realized the importance of this fact. He introduced modifications in the Branly coherer and improved its sensitiveness considerably.

Lodge exhibited his apparatus in 1894 before the British Association at Oxford, and received signals at a distance of 150 yards. At the time, the idea did not occur to him that this instrument might be turned to practical use for long-distance radiotelegraphy. In 1902 Branly made another coherer in the form of a tiny tripod, having steel points at the end of each leg. He stood this upon the surface of a flat plate of steel. Under normal conditions no current passed between the tripod and the plate, but in the presence of the Hertzian wave coherence took place. He arranged his recording apparatus in such a way as to jar the plate immediately the wave had passed, thus effecting decoherence.

Throughout the rest of his long life, Branly went steadily on with research work on wireless waves and made a number of discoveries which he communicated at various times to French scientific bodies. He also wrote a number of papers which appeared in the *Comptes rendus* of the Paris Academy of Sciences. Even after the outbreak of War he remained at work in Paris, but in October, yielding to the persuasion of his family, he returned to the country. He was made a Grand Officer of the Legion of Honour and received many foreign distinctions.

Dr. A. G. Jacques

IN the field of experimental cell and general physiology the name of Alfred George Jacques had become increasingly prominent during recent years. *Science* announces that Jacques died by drowning on February 20, 1939—and to many readers of NATURE this news, already a year old, must come with the shock of surprise and it will occasion widespread regret among experimental biologists.

Though A. G. Jacques was born in England at Sutton, Surrey, on April 18, 1896, he was educated mainly in Canada, later obtained the Ph.D. degree at Harvard, and his name rightfully attained prominence from his work at the Rockefeller Institute for Medical Research. In fruitful collaboration with Dr. W. J. V. Osterhout, Jacques' early work was devoted to problems of cell physiology, using the large vesicles of Valonia and Halicystis as experimental material. These fascinating organisms still claimed his attention until his death which, it is learned, occurred at Bermuda, where he had conducted much of his experimental work. Theoretical and experimental works mainly published under his name, in the *Journal of General Physiology*, present an impressive record of a career so prematurely ended.

Jacques investigated the mechanism which regulates the composition of the sap of the large vesicles which he studied—he accepted the challenge which the outstanding accumulation of inorganic salts in plant cells presents—and his name will be identified with theories of salt absorption based on the view that salts enter cells in the form of undissociated molecules. This view arose from an ingenious series of experiments, in which Jacques collaborated, which showed that certain weak electrolytes (H_2CO_3, H_2S, NH_4OH, etc.) penetrate most readily as neutral molecules, and, therefore, their entrance into the sap was controlled by the *p*H relations of sap and external solution. This novel idea was extended by Jacques in his later work to embrace the entrance of the alkali metals into cells. A steady stream of papers, both theoretical and experimental, appeared under his name. It would be idle in short space to summarize his work; neither should we declare that he had reached his final goal; but the distance he had travelled in a few years of active work is the measure of the loss which science sustains by his untimely death. The challenge of the problem to which Jacques devoted himself still remains—those who take it up where he perforce relinquished it will long recognize his worth and regret his passing.

F. C. STEWARD.

WE regret to announce the following deaths:

Sir James MacKenna, C.I.E., formerly agricultural adviser to the Central Government of India, and director of the Agricultural Research Institute, Pusa, on April 3, aged sixty-seven years.

Dr. Oran Raber, plant physiologist and conservationist to the U.S. Forest Service, on February 29, aged forty-seven years.

NEWS AND VIEWS

Scandinavia

AUSTRIA, Czechoslovakia, Poland, Finland, and now Denmark and Norway have been attacked in turn by the reactionary forces of Europe. By sheer weight of numbers and over-powering military forces the totalitarian war machine is proceeding on its way, leaving as it passes a trail of physical and spiritual destruction. The University of Copenhagen includes the world-famous Institute of Physics presided over by Prof. Niels Bohr, For.Mem.R.S., whose genius has been responsible for much of our present knowledge of atomic physics. A letter from his Institute appears elsewhere in this issue. Prof. G. Hevesy, For.Mem.R.S., has worked there for the past few years. Prof. August Krogh, For.Mem.R.S., also of the University of Copenhagen, has an international reputation for his studies in animal physiology, and Prof. Boysen Jensen is equally well known for his work on plant physiology. There is also the famous Carlsberg Institute, whence much fundamental work on biochemistry has come. The name of Prof. Th. Mortensen, the distinguished zoologist and oceanographer, will also be associated with the Carlsberg Institute. Prof. N. E. Nørlund, For.Mem.R.S., director of the Danish Geodetic Institute, is known to mathematicians, astronomers and geodesists.

Norway has an active University at Oslo. Meteorological investigations initiated by Prof. V. F. K. Bjerknes, For.Mem.R.S., are the basis of modern weather forecasting. Prof. J. Hjort, For.Mem.R.S., is well known as a marine biologist; Prof. C. Størmer's work on the aurora will be familiar to many readers of NATURE. Prof. L. Vegard is a well-known astrophysicist on its staff; a letter signed by him also appears in our pages this week. The publications of the Bergen Museum are widely known. It is worth remarking that the names mentioned above include no fewer than six foreign members of the Royal Society. It cannot be expected in present circumstances that scientific work will proceed in these and other institutions in Denmark and Norway. Whether they take an active or a passive part in the present struggle, the peoples of these two countries will have the support of all who believe in the fundamental principles of academic and individual freedom.

Dr. S. Zuckerman

IN April 1939 Dr. S. Zuckerman was appointed to the chair of anatomy in the University of Birmingham, and plans were immediately discussed for the establishment in the Department of Anatomy of an experimental unit in order to allow the new professor to continue and develop the programme of work on which he has been engaged for some years. Unfortunately, the War has interrupted these discussions, and the plans have necessarily been shelved for the moment. In view of this, and also because Dr. Zuckerman is engaged in war work elsewhere, he has had to postpone the assumption of his appointment at Birmingham until more propitious times. Meanwhile Dr. C. F. V. Smout is the acting head of the Department of Anatomy at Birmingham. Dr. Zuckerman entered on his academic career as a medical student of the University of Cape Town. After spending two years there as a demonstrator of anatomy he came to London as a Union Research Fellow, and qualified in medicine from University College in 1928. During 1928–32 he was research anatomist of the Zoological Society of London. During 1933–34 he worked in the United States, first as a research associate in the Primate Laboratories at Yale and afterwards as a Rockefeller Fellow. On his return to England he joined Prof. Le Gros Clark at the University of Oxford as a Beit Fellow and Departmental demonstrator. Later he was appointed University demonstrator and Nuffield research worker in endocrinology, and he continues to hold these appointments for the present. While at Oxford Dr. Zuckerman has played an important part in the development of research laboratories of a modern type in the Department of Human Anatomy.

Dr. Zuckerman's first work was concerned with the processes of development and growth in monkeys and apes, and with the mechanisms underlying the social behaviour of these animals. Many of his early researches were incorporated in his books "The Social Life of Monkeys and Apes" and "The Functional Affinities of Man, Monkeys and Apes". These behavioural studies led him on to an inquiry into the reproductive mechanisms of primates—particularly the menstrual cycle and its control by hormonal and neural factors. This again, from observations on the relation of changes in water metabolism to the menstrual cycle, has turned his attention more recently to the problem of the interrelation of the adrenal glands and the gonads. Dr. Zuckerman has also published a number of papers dealing with the prostate gland and other male accessory reproductive organs, as well as the histogenesis of tissues which are sensitive to œstrogenic stimulation.

Gold Medallist of the Society of Antiquaries

THE Gold Medal of the Society of Antiquaries of London, which is regarded by archæologists as the highest mark of recognition of distinguished service to their science, has been awarded for the year 1940 to Aarne Michel Tallgren, professor of the archæology of Finland and the North in the University of Helsinki, for his studies in the prehistory of the Eurasiatic continent, with more especial reference to the development of culture in the northern regions of that tract. For more than thirty years his studies have been devoted to the elucidation of the broader problems of this field, upon which he has brought

to bear a vast knowledge of detail combined with unfailing judgment and soundness of inference.

Since the close of the War of 1914–18, Prof. Tallgren's publications dealing with the archæology and cultural history of Finland and adjacent regions of the northern tract have brought him an outstanding reputation as an international authority on the study of European prehistory. An even greater service to archæological studies has been rendered by his periodical publication, *Eurasia Septentrionalis Antiqua*, which he founded in 1926 and edited, contributing liberally to the contents himself until, in 1939, the action of the Soviet Government, by cutting his line of communications with Russia, deprived him of the material essential to the continuation of his studies and constrained him to stop publication (see NATURE, 144, 971; 1939). This action of the Soviet followed Prof. Tallgren's account of conditions in Russia in his "Archæological Studies in Russia" (1936).

Epidemiology of Evacuation

IN his presidential address to the Section of Epidemiology and State Medicine of the Royal Society of Medicine on April 5, Dr. J. A. Glover, chief medical officer of the Board of Education, stated that in the evacuation carried out in Britain last autumn there were moved 1,270,000 persons, made up as follows: 734,883 school children, nearly all moved in the first two days before the beginning of war; (2) some 260,300 young children accompanied by (3) some 166,200 mothers and other adults; and (4) 12,291 expectant mothers. All these persons were moved with punctuality and precision without a single casualty in four days. As regards the incidence of infectious disease, the record of the first four months was extraordinarily good. The cases of diphtheria and scarlet fever notified were only two thirds of those which occurred in the corresponding period of 1938, and the cases of poliomyelitis were only one third, although all these three diseases had their seasonal maxima in autumn and were diseases to which school children were particularly liable. There was a decline in notifications of puerperal pyrexia.

There had been small epidemics of enteric fever before evacuation took place, but notifications afterwards fell, and in November and December were well below those of 1938. The expected epidemic of measles was not realized and particularly avoided the big cities, and especially London. The health record of evacuated special schools was very good. The comparative freedom from infectious disease was attributable to the careful preparations of the Ministry of Health, the good work of the medical and nursing services, the care of the foster parents and teachers, the general soundness of the environmental hygiene, and the splendid weather of the early autumn. Dr. Glover maintained that the general policy of dispersal in billets was preferable to that of concentration in camps, in view of the much greater risk of spread of disease in such concentrations of children. In conclusion, he stated that the evacuated child who remained in the reception areas benefited greatly in health.

National Union of Students: London Medical Committee

THE London Medical Students' Committee of the National Union of Students was formed shortly after the War began. The first important action which the committee took was to get the status of medical students defined by the Ministry of Health. Up to this time hospital authorities and the Ministry of Health both disclaimed responsibility. The position is now clearly that medical students have no obligations to the Ministry, and vice versa. A request was received recently from one of the northern universities that the London Committee should organize a conference on medical student life and work. The Committee is accordingly arranging a meeting to discuss the teaching of medicine and the methods of study, which, it is hoped, will be held in a Midland university in May. The conference will be divided into three main sections. The first part will be devoted to the pre-clinical student, the second to the clinical student, and the third to the newly qualified doctor.

There has been much discussion in the Press recently on reforms in medical education. Efficient teaching is no less necessary now than it was before the War; in fact, with the prospect of courses being shortened, efficient teaching becomes even more necessary. The conference will therefore have two sessions on education in all its phases, and from the experience of delegates endeavour to formulate an improved scheme of medical teaching. This will be combined with an endeavour to assure to the newly qualified medical man adequate house appointments to make him fit to carry out his duties. Medical students have suffered as much as others from many recent hasty decisions, and the prompt response to attempts to cut out subjects (for example, pathology from the Conjoint Board Examination) from the curriculum has shown a very healthy feeling on the part of students that standards must not be lowered, and was perhaps instrumental in maintaining the standard of the curriculum. The medical practitioner has certain duties to the public, and therefore his qualifications must be such as to enable him to carry out these duties, whether in war-time or in the time of peace.

Pharmacopœia Revision

DR. C. H. HAMPSHIRE, secretary of the Pharmacopœia Commission, gave an account of the work which is being done in preparation for a new "British Pharmacopœia" in a lecture delivered at an evening meeting of the Pharmaceutical Society on April 9. He confirmed that the Commission hopes to provide standards not only for crude drugs and chemicals but also for as many galenical preparations and compounded drugs as possible, adding that it is essential that standards for such substances should have due regard to the possible loss of active matter during manufacture and subsequent storage. The greater part of the lecture was devoted to an exposition of recommendations made by various committees for the inclusion of new substances in the

next "Pharmacopœia". Dr. Hampshire exhibited specimens of these substances, classifying them in their appropriate groups. With regard to vitamins, he said the principal preparations of this group recommended for description are: Standardized concentrated solutions of vitamins A and D; a vitaminized oil standardized to contain vitamins A and D in the proportion contained in a good average specimen of cod liver oil; halibut liver oil containing not less than 30,000 units of vitamin A per gram; and pure crystalline aneurine hydrochloride to replace the adsorbate of vitamin B_1, described in the "Addendum, 1936".

Dr. Hampshire explained the reasons for some of the proposed additions to the "Pharmacopœia". Thus mandelic acid and calcium mandelate are both in use in the treatment of urinary infections; sulphanilamide is recommended as the best known member of the sulphonamide group which is free from patent complications; parachlorometacresol is recommended for use as a bactericide in sterilizing solutions for injection, and as a bacteriostatic preservative in certain solutions. He said that the proposed inclusion of the sera and other biologically tested preparations is necessary in order to bring this section of the work of the "Pharmacopœia" up to date. In this field the "Pharmacopœia" is kept closely in line with the regulations under the Therapeutic Substances Act; the regulations provide for the control of biologically tested substances in Great Britain and Northern Ireland, while the "Pharmacopœia" extends the control to other parts of the British Empire in which the "Pharmacopœia" is accepted as a legal standard. The revision has included a full review of all analytical procedure described in the various monographs and in the appendixes. In two directions a considerable increase in analytical methods is proposed: (*a*) the addition of new tests and assays for galenical preparations and compounded drugs; and (*b*) the addition, in a number of instances, of assays for the alkaloidal content of salts of various alkaloids.

Astronomical Investigations of Horrox

PROF. F. J. M. STRATTON has published a very interesting and full account of the work of Horrox (*Occas. Notes Roy. Astro. Soc.*, No. 7; 1939). To many astronomers, Horrox's fame rests almost entirely on his observation of the transit of Venus on November 24, 1639 (O.S.), his own calculations having shown an error in the Rudolphine tables, and also that a transit should take place on the above date. This was only a small part of his work, for, in addition to improving the tables then in existence, he was the first to show that the moon's orbit around the earth is an ellipse, the earth being at a focus. An excerpt from some of his writings at the age of eighteen shows that he anticipated Newton in connecting the movements of the planets with that of a body falling to the earth. The motion of the line of apses was explained by Horrox as due to the disturbing effect of the sun, and he was able to illustrate the idea by a simple pendulum experiment. In addition to his explanation of other difficulties connected with the motion of the moon, he detected the long inequalities in the opposite sense in the motions of Jupiter and Saturn, and he showed that comets move in elliptic orbits around the sun.

Although he undertook regular observations of the tides, no published work of Horrox on this subject survives, but he expressed the hope to Crabtree less than a month before his death that he would shortly detect the secret of the tides. Kepler's value of the distance of the sun was 3,500 times the earth's radius, and Horrox gave the value as 15,000, that is, about two thirds the correct value. It is amazing that Newton adopted 5,000 fifty years later, instead of using Horrox's 15,000. When it is remembered that these results were obtained by one who had only attained the age of twenty-one and that he was practically self-taught and unaided, it is not surprising that astronomers have kept his name in affectionate remembrance for hundreds of years. What fields would Horrox have explored if he had not died at the early age of twenty-two in 1641, the year before Newton was born? In 1874, when a transit of Venus occurred, a memorial was erected to him in Westminster Abbey, and over the monument are carved the words in which Horrox reported that he had abandoned the observations of the sun to carry out his spiritual duties in the Church.

King Psusennes's Tomb at Tanis

Now that the jewellery associated with the sarcophagus of King Psusennes at San el Hagar, in Lower Egypt, has been removed to the Cairo Museum, further details are becoming available which serve to indicate more fully the cultural and historical significance of the find. The similarity in the circumstances of discovery with those of the discovery of the tomb of Tutankhamen is striking. For years Lord Carnarvon and Howard Carter excavated in the Valley of the Kings without notable success until they made their great discovery. At Tanis, which had already been explored by both Mariette and Petrie with indifferent results, Prof. Montet pursued his investigation of the relics of the obscure Twenty-first and Twenty-second Dynasties for nine years from 1929, before last year he made the remarkable discovery of the gold and silver sarcophagus of King Shishak, of the Twenty-second Dynasty, in the otherwise rifled tomb of King Psusennes, of the Twenty-first Dynasty.

The tomb of Psusennes, son of Smendes, founder of the Twenty-first or Tanite Dynasty, is situated in the temple of Rameses. It is of solid rose granite, it is stated in a communication from the correspondent of *The Times* in the issue of April 6, and is a few metres underground. Entrance is at present down a shaft about four metres deep through rock and sand. A small anteroom leads by a short passage, about two metres long, and hewn through solid granite, into the funerary chamber. This is also small, measuring only seven metres long by about three metres wide and high. The sarcophagus itself

is 3½ metres long, and not less than 2½ metres wide. An unusual feature of the outer sarcophagus is the decoration on both the upper and under surface of the cover. On the upper surface is a full length image of the king dressed as Osiris. Broken features of the image of the inner sarcophagus suggest that it was damaged when being introduced into the tomb.

Antiquity: a Sutton Hoo Number

Antiquity of March last is devoted to a detailed account of the discovery, excavation and finds of the Sutton Hoo ship-burial. The excavation is described by Mr. C. W. Phillips, who points out that until 1939 the archæology of Britain in Anglo-Saxon times has had to concern itself little with either ship-burials or to a great extent with rich burials of any kind, for omitting those of Kent, and a few important burials at Taplow, Broomfield and elsewhere, the most striking feature of Anglo-Saxon graves is their almost universal poverty. In the more detailed description of the finds Mr. T. D. Kendrick gives accounts of the gold ornaments, the large hanging bowl and the jewellery; the silver is described by Mr. Ernst Kitzinger, and a summary account of the coins is contributed by the editor, Mr. O. G. S. Crawford. Mr. W. F. Grimes is responsible for a description of the methods followed in salvaging the finds, "an exciting and exacting task, extending over more than a week", in which he was first called to participate when the gold purse and its trappings had been found. Serious problems were presented by corrosion, but their solution called for no new and elaborate technical methods, but rather the application of simple readily available means to deal with an unexpected range of materials, each apart from the gold objects with its own set of problems. The identity of the individual whom the mound and its contents commemorated is discussed in full detail by Dr. H. Munro Chadwick, who accepts the possibility that it may have been the cenotaph of a king lost at sea—the editor of *Antiquity* here points out that there never has been question of a burial. After discussion of the various possibilities Dr. Chadwick elects for Redwald (*ob. c.* 624–5) as the most probable. The series of photographs accompanying these contributions constitutes a valuable record of this notable find.

Indian Farming

THIS new monthly magazine, issued by the Imperial Council of Agricultural Research, replaces the bi-monthly *Agricultural and Livestock in India*, published by the Council since 1931. The aim of *Indian Farming* is to present scientific information in a popular form, and to form a link between the research worker and the cultivator. The format of the new journal is more pleasing than that of its predecessor and should appeal to a wider public. The contents include original articles on agricultural science, short notes on selected research work, reports from research stations, "answers to correspondents", practical hints to farmers, and book reviews. The popularization of agricultural science is a task as difficult as it is important, and the editorial committee is to be congratulated on its good beginning in seeking the happy mean between over- and under-simplification. The first article, by Sir Jagdish Prasad, on agricultural research in war, puts in a timely plea for the continuation of pure research during a period of stress when the demands for immediate results are most pressing.

Fluorescent Enamel Paints

THE Continental Lithograph Corporation, 952 East 72nd Street, Cleveland, Ohio, has put on the market a series of 'enamel paints' (Conti-Glo Fluorescent Lacquer Enamels) with which brilliant fluorescence effects can be obtained when they are illuminated by radiation in the 'near ultra-violet'. Such a radiation can be conveniently obtained from tungsten filament lamps having bulbs of 'black' glass; these are supplied by the same Company. They are mounted in aluminium reflectors in order to concentrate the ultra-violet energy on the enamelled surface.

Tested with a mercury vapour lamp screened by a plate of ultra-violet transmitting glass, the samples appear to justify the maker's claims. The colours include white, pink, and orange, with various yellows, greens, and blues. Moreover, the fluorescent hue is markedly different in some cases from that of the paint in ordinary light; thus a cream paint becomes a green in the ultra-violet and a rose colour fluoresces red, while a white becomes a blue. These enamels have interesting possibilities for entertainment and decoration. They are said to be easily applied by ordinary spraying and brushing methods, and can even be applied (diluted with lacquer-thinner) to fabrics.

Saliva Superstitions

THE December issue of *Folk-Lore* contains a richly documented article on this subject by Miss Rachel Sclare, of Leeds, who illustrates the medicinal and curative properties attributed to saliva throughout the ages and different parts of the world by quotations from the New Testament, the writers of classical antiquity (Theocritus, Tacitus and Pliny), the Middle Ages (Hildegarde of Bingen, Maimonides, and Albertus Magnus), and modern times (Brand, Tylor and Frazer). The diseases for which saliva has been used both as a curative and less frequently as a prophylactic measure are numerous, and include sore eyes, blindness, rheumatism, headache, toothache, warts, burns, wounds, etc. As a prophylactic, saliva has been employed as a protection against infectious diseases and as an antidote to poisons, as well as a means of averting ill-luck. The belief in the magical properties of saliva, which still flourishes not only in primitive races but even in England as well as in other civilized countries, appears to be founded on the supposition that this secretion possesses a vital force closely connected with man's blood and the whole of his person.

The Bed of Procrustes

A WITTY and amusing paper with this title was read by Mr. Gordon D. Knox before a meeting of the Tenterden Toc H (Tenterden: K. P. Press, 1940. 1*s.*).

It will be recalled that, in Greek legend, Procrustes made all travellers who visited him lie on a bed of fixed length, stretching their limbs if they were too short and lopping them off if they were too long. Mr. Knox suggested that this treatment, although murderous when applied to human beings, is beneficial when applied to problems. It is a great advantage to make a wide range of problems conform to one fixed type, namely, that usually known as the method of ratio or proportion. Examples were given of applications to arithmetic, algebra, geometry and applied mathematics.

Books on the History of Science and Medicine

CATALOGUE 55, recently issued by E. P. Goldschmidt and Co., 45 Old Bond Street, W.1, is devoted to bibliography and reference books, particularly those dealing with the history of science and medicine. Attention may be directed to the following items: A. Claudius's "Histoire de l'imprimerie en France" (1900–1914), Du Cange's "Glossarium mediæ et infimæ Latinitatis" (1883–1887), Thomas James's "Catalogue of the Bodleian Library" (1620–1635), J. S. Bailly's "Histoire de l'Astronomie ancienne—Histoire de l'Astronomie moderne—Traité de l'astronomie Indienne et Orientale" (1781–1787), L. Choulant's "Handbuch der Bücherkunde für die aeltere Medizin" (1828), John Ferguson's "Bibliographical Notes of Histories of Inventions and Books of Secrets" (1883–1916), John Leland's "Laboryouse Journey and Serche for Englandes Antiquitees" (1549), and Andrew Borde's "Fyrst Boke of the Introduction of Knowledge" (1548).

Aftershocks of the Great Turkish Earthquake

As anticipated by the seismologists at the Istanbul Observatory, aftershocks of the great Turkish earthquake of December 27 (NATURE, January 6, p. 13) still continue, and these have been accompanied by floods possibly due to changes of land-level occasioned by the shocks. The region most affected recently has been near the scene of the original disaster. On April 3, two violent earthquake shocks occurred in the region of Amasya in Anatolia. No casualties are reported. Following torrential rains, the Yesil Irmak and the Tersakar Dere burst their banks, flooding wide areas, including the famous apple orchards near Amasya, and also inundating about thirty villages, some of which have had to be abandoned. Twenty-five villages were cut off by the floods. No casualties have been reported.

Cerebro-Spinal Fever

CEREBRO-SPINAL fever, caused by infection with the meningococcus, was epidemic in Great Britain in 1931 and 1932, some 2,200 cases being notified in each year. The number of cases then declined, and in 1935 and 1936 the annual total was about 900. Since then there has been again a rise, to 1,500 cases in 1939. In the first seven weeks of this year there were 1,753 cases, and 623 new cases were notified in the week ending March 2. In view of the prevalence of this epidemic, the Ministry of Health has issued a "Memorandum on Cerebro-Spinal Fever" (Memo. 234/Med. H.M. Stationery Office. 2*d.* net). It discusses the epidemiology of the disease, the control of contacts (who may be carriers of the meningococcus) and diagnosis, and describes the treatment and general measures of prevention. Formerly, the administration of anti-meningococcal serum was the only specific treatment, and is still desirable in the very acute cases. Treatment has, however, now been revolutionized by the use of the drugs sulphapyridine and sulphanilamide, and full directions are given as regards dosage and method of administration.

Announcements

PROF. WALTER W. STEWART has been elected to succeed Mr. John D. Rockefeller, jun., who has retired from his position both as chairman and as member of the Board of the Rockefeller Foundation. Prof. Stewart, who is fifty-five, was during 1928–30 an economic adviser to the Bank of England. In 1931 he was appointed American member of the special advisory committee to the Bank for International Settlements. He is a professor of economics at the Institute for Advanced Study at Princeton University.

THE Ettore Marchiafava Prize, founded by the University of Rome on October 28, 1938, for the best work on morbid anatomy or general pathology, has been awarded to Profs. Mario Monacelli, director of the clinic for dermatology and syphilis at Messina, and Giulio Raffaele, of the University of Rome.

AT the recent annual general meeting of the Institute of Metals, held in London, the following officers were elected: *President*, Lieut.-Colonel the Hon. R. M. Preston; *Vice-Presidents*, Dr. S. F. Dorey, Engineer Vice-Admiral Sir George Preece and Mr. A. J. G. Smout; *Treasurer*, Lieut.-General Sir Ronald Charles; *New Members of Council*, Dr. W. E. Alkins, Mr. G. L. Bailey, Captain F. C. Braby, Colonel P. G. J. Gueterbock, and Prof. D. Hanson.

AN after-luncheon lecture will be given at the Chemical Club, 2 Whitehall Court, London, S.W.1, on April 15 by Mr. Arthur Elton, who has taken for his title "The Interpretation of Science by the Film". Mr. Elton is at present at work on the Government scheme, initiated by Sir Kenneth Clark, of propaganda films of a technical nature.

A CONGRESS of Forensic Medicine, Insurance and Criminal Anthropology will be held at Naples during May 30–June 1. Further information can be obtained from the general secretary, Prof. Gennaro Punzo, Via Luciano Armanni 3, Santa Patrizia.

ACCORDING to a census on June 30, 1939, the total aboriginal population of Australia was 77,269, including 25,712 half-castes. Nearly half the total full-blooded natives were in Western Australia. In New South Wales there were only 794.

LETTERS TO THE EDITORS

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

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 593. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Mass Centre in Relativity

THE question whether there exists in relativity mechanics a theorem analogous to the classical law for the motion of the mass centre (conservation of total momentum) has, as far as we can see, never found a satisfactory answer. Eddington[1] has taken this fact as the starting point for a general attack against the usual application of wave mechanics to fast-moving particles without contributing himself anything positive to the question. The reason why this problem has never been seriously treated seems to be this.

In classical mechanics the internal potential energy depends on the simultaneous relative positions of the particles; therefore one can separate the relative motion from the translatory motion of the centre. In relativity, however, all forces are retarded, the interaction does not depend on simultaneous relative positions and the separation of the relative motion from the translation of the whole system loses its meaning.

Quantum mechanics circumvents this problem by considering interactions as produced by emission and reabsorption of other particles. We were induced to reconsider this problem by its bearing on a relativistic and 'reciprocal' formulation of second quantization. Without touching this question, we shall state here some simple results concerning free particles. It is clear that in this case there must exist a 'rest system' Σ°, that is, a Lorentz frame in which the total momentum vanishes. The problem is to describe the relative motion in an invariant way.

We start by bringing the classical derivation into a form permitting generalization. If $\mathbf{r}_1$, $\mathbf{r}_2$ are the position vectors, $\mathbf{p}_1$, $\mathbf{p}_2$ the momenta of two particles, we form the vector of relative position and that of total momentum

$$\rho = \mathbf{r}_1 - \mathbf{r}_2, \quad \mathbf{P} = \mathbf{p}_1 + \mathbf{p}_2, \tag{1}$$

and determine their canonical conjugate variables, components of the vectors π and $\mathbf{R}$. A simple calculation shows that these are not uniquely determined but have the form

$$\pi = (1 - a)\,\mathbf{p}_1 - a\mathbf{p}_2, \quad \mathbf{R} = a\mathbf{r}_1 + (1 - a)\,\mathbf{r}_2, \tag{2}$$

where a is an arbitrary constant. Hence another condition must be added.

We postulate that the kinetic energy $p_1^2/2m_1 + p_2^2/2m_2$ assumes the form $P^2/2m + \pi^2/2\mu$. This condition leads to a determination of the three constants a, m, μ, namely,

$$a = \frac{m_1}{m_1 + m_2}, \quad m = m_1 + m_2, \quad \mu = \frac{m_1 m_2}{m_1 + m_2},$$

which introduced into (2) give the usual expressions for relative momentum and centre of mass.

In relativity, the energies E_1, E_2 of two free particles are given by

$$E_1^2 = m_1^2 + \mathrm{p}_1^2, \quad E_2^2 = \mathrm{m}_2^2 + \mathrm{p}_2^2. \tag{3}$$

We consider now the 4-vectors $\mathbf{p}_+ = \mathbf{p}_1 + \mathbf{p}_2$, $E_+ = E_1 + E_2$ and $\mathbf{p}_- = \mathbf{p}_1 - \mathbf{p}_2$, $E_- = E_1 - E_2$. A simple calculation leads to

$$E_+^2 = m_+^2 + p_+^2 + \pi^2, \quad E_-^2 = m_-^2 + p_-^2 - \pi^2; \tag{4}$$

here $m_+ = m_1 + m_2$, $m_- = m_1 - m_2$

and

$$\pi = 2m_1 m_2 \sinh \Gamma/2, \tag{5}$$

where Γ is the 'angular distance' of the two 4-vectors, given by

$$m_1 m_2 \cosh \Gamma = E_1 E_2 - \mathbf{p}_1 \mathbf{p}_2. \tag{6}$$

Γ is invariant, hence π is invariant also. π has a simple meaning in the case of equal masses. In the rest system Σ°, where $\overset{\circ}{P} = \overset{\circ}{p}_+ = \overset{\circ}{p}_1 + \overset{\circ}{p}_2 = 0$, we have $m_1 - m_2 = m_- = 0$, and $\overset{\circ}{E}_1 - \overset{\circ}{E}_2 = \overset{\circ}{E}_- = 0$; hence $\pi^2 = (\overset{\circ}{p}_-)^2$. This shows that π is the length of the vector $\boldsymbol{\pi}$ representing relative momentum.

For different masses π can be described as the relative momentum in that Lorentz frame (which always exists) in which

$$E_1 - E_2 = \pm\,(m_1 - m_2).$$

The first equation (4) can now be written

$$E^2 = M^2 + P^2, \quad M^2 = \mu^2 + \pi^2, \tag{7}$$

where $\mu = m_1 + m_2$ is the sum of the rest masses, M the total internal energy, which represents also the rest mass of the whole system, and $\mathbf{P} = \mathbf{p}_+ = \mathbf{p}_1 + \mathbf{p}_2$ the total momentum.

Taking the components of $\mathbf{P}$ and $\boldsymbol{\pi}$ as new canonical momenta, one can determine the conjugate co-ordinates, $\mathbf{R}$ and ρ. They are linear in $\mathbf{r}_1$, $\mathbf{r}_2$; the coefficients are, however, not constants but functions of $\mathbf{p}_1$, $\mathbf{p}_2$.

For small $\mathbf{p}_1$, $\mathbf{p}_2$ the formulæ reduce to the classical ones.

It is interesting to remark that in relativity there exists a 'reciprocal'[2] theorem obtained by interchanging co-ordinates and momenta.

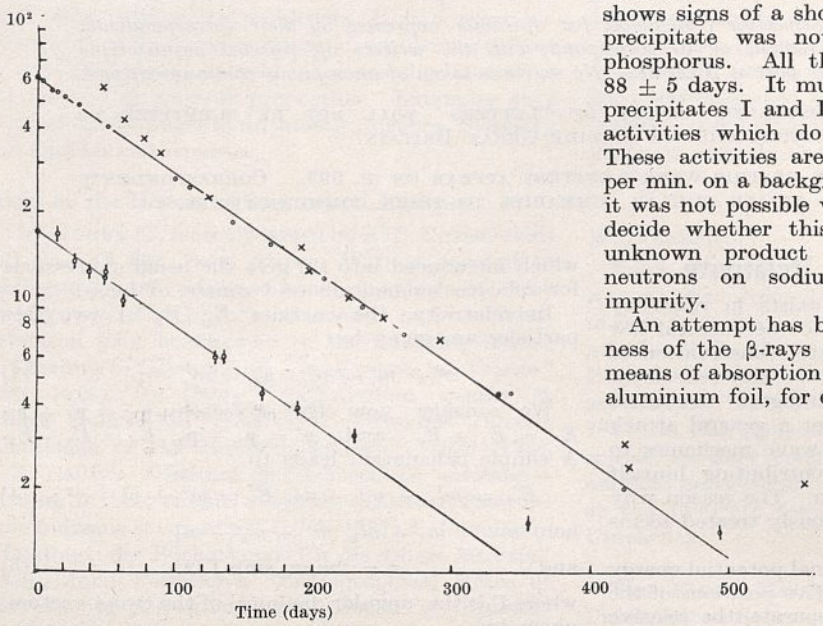
MAX BORN.
KLAUS FUCHS.

Department of Applied Mathematics,
University of Edinburgh.

[1] Eddington, A., *Proc. Camb. Phil. Soc.*, **35**, 186 (1939).
[2] Born, M., *Proc. Roy. Soc. Edinburgh*, (ii), **59**, 219 (1939).

Radio-sulphur

A RADIOACTIVE isotope of sulphur produced by the action of neutrons on carbon tetrachloride and decaying with a period of 80 days was first observed by E. Buch-Andersen[1]. In view of the very weak activity found, doubt was expressed as to the existence of this isotope. This fact induced us to investigate the action of fast neutrons on carbon tetrachloride and sodium chloride. In both cases the radioactive sulphur was obtained; the use of sodium chloride was found, however, to be preferable. Recently[2], the $^{35}_{16}S$ has been produced by the action of deuterons on sulphur, by making use of the Berkeley cyclotron.



DECAY CURVES FROM THREE BARIUM SULPHATE PRECIPITATES: ×, PRECIPITATE I; o, PRECIPITATE II; ϕ, PRECIPITATE III.

The neutron sources, consisting of 600 mgm. radium plus beryllium, were placed in the centre of a glass vessel containing 2 kgm. of pure sodium chloride. After the lapse of two months, the sodium chloride was dissolved in water, and 20 mgm. of inactive sodium sulphate was added. In order to oxidize the radioactive sulphur possibly present in elementary state, nitric acid and hydrogen peroxide were added, and the sodium kept boiling for several hours. 100 mgm. of sodium phosphate was added, and the phosphorus was precipitated as ammonium phosphomolybdate. This procedure was repeated several times until the precipitate showed no essential activity. Finally, the sulphur was precipitated in the usual way as barium sulphate.

The activity of barium sulphate precipitates was measured by means of a Geiger counter provided with an especially thin mica window with regard to the very soft β-radiation emitted from the $^{35}_{16}S$. The window was mounted on a concave cylindrical surface (radius 38 mm.) in order to make it possible to use an extremely thin mica foil as a window. It has been shown[3] that mica disks of 1·2 mgm./cm.² and 1 cm. in diameter could stand evacuation of the counter only when mounted on such a concave surface. This mica window absorbs very little of the very soft β-radiation from sulphur.

The accompanying graph shows decay curves from three different barium sulphate precipitates obtained by the method described above; the decay was followed for more than 500 days. Precipitate I shows signs of a shorter period, indicating that this precipitate was not completely free from active phosphorus. All three curves show a half-life of 88 ± 5 days. It must, however, be mentioned that precipitates I and III seem to show weak residual activities which do not follow the 88-day decay. These activities are, however, so minute (1 count per min. on a background of 3 counts per min.) that it was not possible with the present arrangement to decide whether this weak activity is due to an unknown product obtained by the action of neutrons on sodium chloride or to traces of impurity.

An attempt has been made to estimate the hardness of the β-rays emitted by our preparation by means of absorption measurements. A 30 mgm./cm.² aluminium foil, for example, reduced the activity to less than 10 per cent of its initial value. In the present arrangement, the β-rays from uranium were reduced to half their intensity by 125 mgm./cm.² of aluminium. This enables us to estimate the upper limit of the β-rays from sulphur to be $1{\cdot}0–2{\cdot}0 \times 10^5$ ev., in agreement with Libby[4].

HILDE LEVI.

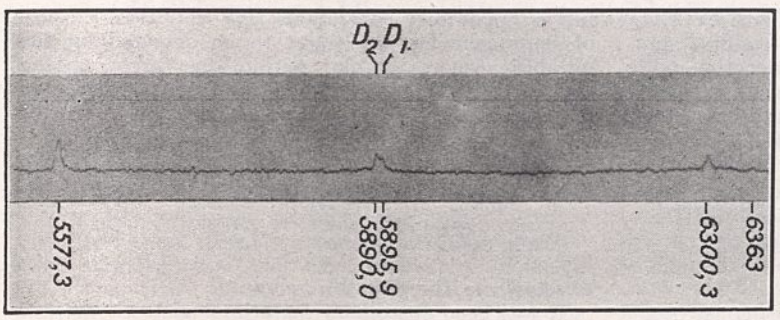
Institute of Theoretical Physics,
University, Copenhagen.
Feb. 26.

[1] NATURE, **137**, 457 (1936); *Z. phys. Chem.*, B, **32**, 237 (1936).
[2] Voge, H. H., *J. Amer. Chem. Soc.*, **61**, 1032 (1939); Tuck, J. L., *J. Chem. Soc.*, 1293 (1939).
[3] Arnold, W., Frisch, O. R., and Levi, H., *Rev. Scient. Instr.*, **10**, 197 (1939).
[4] Libby, W. F., and Lee, D. D., *Phys. Rev.*, **55**, 245 (1939).

Origin of the Yellow Line in Twilight and the Night Sky Luminescence

THE appearance in the night sky spectrum of a yellow line was observed in 1929 by Slipher[1], who measured a wave-length 5892, by Dufay[2], Sommer[3], Cabannes[4] and by Vegard and Tönsberg[5]. The latter gave the wave-length 5892·6, and finding the line considerably broader than a single atomic line, they concluded that it had a fine structure. Twilight spectra giving the yellow line were obtained by Vegard at Oslo on January 13, 1936, and Tromsö in February of the same year[6].

Taking into account the time of exposure, the yellow line should be about 50–100 times stronger in twilight than in the night sky. In 1936 Currie and Edwards[7] published observations from the Polar Year programme showing the yellow line in twilight spectrograms. In November 1937 Bernard, working at the Tromsö Observatory, made further systematic investigations regarding the enhancement of the yellow line in the spectrum of twilight[8]. The wave-length found for the yellow line corresponds to the mean wave-length of the yellow doublet (D_1D_2) of sodium.



All the earlier wave-length measurements, which were based on spectrograms taken with very small dispersion (500–600 A./mm. at $\lambda = 5900$), were unreliable as a basis of interpretation.

An important step further was taken by Bernard[8], and at the same time and independently by Carbannes, Dufay and Gauzit[9], who analysed the fine structure with an interferometer and showed that the yellow twilight line had two components, the difference of wave-length of which was nearly equal to, or a single rational fraction of, that of the two components of the yellow sodium line.

These interferometer pictures, however, did not permit any wave-length determination, and until more accurate wave-length measurements were available, the origin of the yellow line could not be regarded as settled.

By means of a large glass spectrograph which at the yellow line has a dispersion of 99 A./mm., we obtained at Tromsö two spectrograms of twilight giving separation of the two components of the yellow line. The separation of the two components is shown in the accompanying reproduction of a microphotometer curve of one of the spectrograms, which also showed the green and red auroral O I-lines.

The D_1D_2 doublet of sodium was used as a comparison spectrum and *no difference between this doublet and that of twilight was observable in the comparator microscope. The two doublets also agreed with regard to relative intensity of the components.*

These results, together with the interferometer observations, show conclusively that the yellow twilight line is the D_1D_2 doublet of sodium.

E. TÖNSBERG.
L. VEGARD.

Oslo and Tromsö.
March 9.

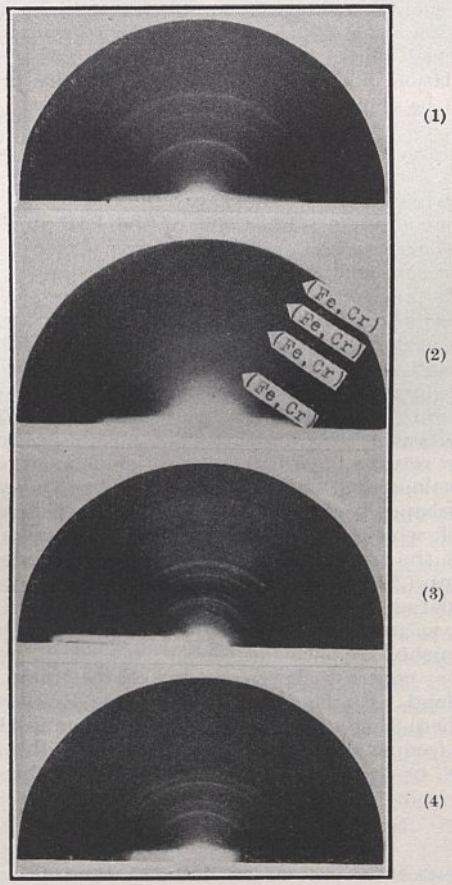
[1] Slipher, V. M., *Pub. Astro. Soc. Pac.*, 41, 263 (1929).
[2] Dufay, J., *C.R.*, **194**, 1897 (1932).
[3] Sommer, L. A., *Z. Phys.*, **77**, 374 (1935).
[4] Cabannes, J., *J. Phys.*, **5**, 601 (1934).
[5] Vegard, L., and Tönsberg, E., *Z. Phys.*, **88**, 709 (1934); **94**, 413 (1935).
[6] Vegard, L., and Tönsberg, E., *Geof. Publ.*, **11**, No. 16 (1937).
[7] Currie and Edwards, *Terr. Mag.*, **41**, 265 (1936).
[8] Bernard, R., *C.R.*, **206**, 448, 928 (1938); *Z. Phys.*, **110**, 291 (1938).
[9] Cabannes, J., Dufay, J., and Gauzit, J., *C.R.*, **206**, 1525 (1938); NATURE, **141**, 1054 (1938).

Oxide Film on Stainless Steels

ELECTRON diffraction methods have been used by Miyake[1] in studying the oxide film on a stainless steel (17 per cent chromium) at high temperatures (600–900° C.), and the substance was thought by him to be $FeCr_2O_4$ co-existing with Cr_2O_3 or with a solid solution of Cr_2O_3 and α–Fe_2O_3. Also G. P. Thomson[2] in his work on some reflection experiments states that "the naturally occurring film on stainless steel is possibly $FeCr_2O_4$ (cubic : a = 8·1 A.)".

The entire range in the iron-chromium system has been covered in the present study of the surface of these alloys at different temperatures. An example of the pattern given by an iron-chromium solid solution is shown in Fig. 1, which was obtained from a surface of an alloy containing 26 per cent chromium. Fig. 2, which was taken from the above specimen after heating for 200 hours at 200° C., already shows a pattern revealing the existence and identity of an oxide. When heated to 600° C., the oxide became crystalline within an hour (Fig. 3), clearly proving to be the α–Fe_2O_3 type (hexagonal). This α–Fe_2O_3 type was obtained with alloys of the entire iron-chromium system when heated at temperatures lower than about 600° C., and the oxide is without doubt α–$(Fe,Cr)_2O_3$.

At higher temperatures, however, the form of the oxide obtained is entirely different. The pattern which is shown in Fig. 4 (1000° C. for 15 minutes) is similar to that of the Fe_3O_4 type (cubic) and is



(1) PATTERN (FE, 26% CR), (AS POLISHED). (2) OXIDE RECOGNIZABLE (200° C., 200 HR.). (3) OXIDE DEVELOPED, α-$(Fe, Cr)_2O_3$ (600° C., 1 HR.). (4) OXIDE TRANSFORMED, $FeCr_2O_4$ (1,000° C., 15 MIN.).

the same as the one Miyake identified with $FeCr_2O_4$.

In interpreting the experimental results summarized above, it is natural to consider the oxide formed at lower temperatures as the naturally occurring film, which in the case of stainless steels has now been shown to be α–$(Fe,Cr)_2O_3$.

I wish to express my thanks to Dr. Iitaka for his guidance and encouragement.

TADASI TOKUMITU.

Institute of Physical and Chemical Research,
Tokyo.
Feb. 5.

[1] Miyake, S., *Sci. Pap. Inst. Phys. Chem. Res. Tokyo*, **31**, 161 (1937).
[2] Thomson, G. P., Unpublished observation cited by Thomson and Cochrane in "Theory and Practice of Electron Diffraction", 179 (London: Macmillan, 1939).

Scandinavian Influence in Scottish Ethnology

A FEW months ago[1] we appealed to centres of the emergency blood transfusion service, and in particular to those which we were supplying with testing serum, to allow us to assemble the extensive data on blood group frequencies in Great Britain, then for the first time becoming available. We were confident that such a collection would throw light on the precision with which such extensive groupings can be relied on to determine the gene-ratios in our population, and we hoped further that this precision might be sufficient to detect with certainty any such small variations of ethnographic significance as might exist within our island.

In a preliminary survey, exhibited at the meeting (January 12, 1940) of the Pathological Society at Cambridge, it was shown that a consistent gradient in the frequency of the antigen A is found as we pass from southern England to Scotland. Further data since accumulated bring our totals to 10,969 for Scotland and 8,716 for northern England, which show clearly intermediate frequencies. For southern England our compilation amounts to 106,477.

The values we present are not entirely unselected. A few returns have had to be set aside as apparently anomalous, and only in some cases has the cause of disturbance been ascertained. Systematic errors, not all of which are yet understood, do undoubtedly affect the frequency of the rarest of the four blood-groups (AB). As a further precaution, we have calculated the gene-ratios from the other three groups only, as in this way the effect of grouping errors is diminished.

The contrast between our three main areas, Scotland, England north of the Humber, and southern England, may be shown either in the relative frequencies of the four distinguishable phenotypes, or in those of the three allelomorphic genes:

TABLE 1
PHENOTYPIC FREQUENCIES

	O	A	B	AB
Scotland ..	52·019	34·233	10·429	3·318
N. England ..	48·600	40·340	8·536	2·524
S. England ..	45·232	43·162	8·508	3·097

The change in the ratio $A : O$ is not, apparently, influenced by the traditional and political Border, but is apparently continuous, and doubtless a cause of heterogeneity, too slight to be detected on the numbers yet available, within the three chosen regions. The corresponding gene-frequencies are as follows:

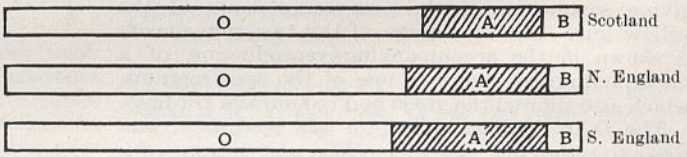
TABLE 2
GENE FREQUENCIES

	O	A	B
Scotland ..	72·247	20·783	6·970
N. England ..	69·587	24·549	5·864
S. England ..	67·207	26·744	6·048

as shown in the diagram below.

It has been customary for ethnologists to suppose that the northern inhabitants of Britain differ from their southern neighbours by reason of a greater infiltration of Scandinavian blood. The modern Scandinavians, however, differ from the English in having not a lower but a higher frequency of A. Thus if, setting aside the small fraction of these populations carrying the gene B, we compare the phenotypic ratios $A/(A + O)$, we find, using the best available series, Norway 58·0, Sweden 58·6, Denmark 50·0, against S. England 48·8, N. England 45·4, Scotland 39·7.

English contact with neighbouring Europe has been extensive since the Roman period; the values for Holland 48·6, Belgium 46·6, France 50·1, and Spain 53·4 are fully in accordance with the view that the English province has been influenced by settlement or intermixture with neighbouring Continental peoples. No Continental population, however, in the north or in the south, comes near to the Scottish ratio.



The only foreign sample we know of comparable to the new Scottish data is from Iceland. A sample of 800 in Wiener's collection gives the ratio $A/(A + O)$ as low as 36·6, slightly more extreme than the Scottish value. Now, Iceland was undoubtedly colonized from Norway, and, though men and women from Scotland and Ireland occur frequently in the Icelandic Sagas, it is not believed to have been extensively colonized from the British Isles. The stock from which the Icelanders sprang would seem to have just the blood-group constitution needed to harmonize with the gradient found in Great Britain, but in recognizing this stock as genuinely Scandinavian, we must distinguish it sharply from the modern Scandinavian peoples, which have evidently changed greatly, by infiltration from central or eastern Europe, since the Viking period. The Scottish and N. English blood-groups show, certainly not modern Scandinavian, but it may well be a proto-Scandinavian influence.

R. A. FISHER.

Galton Laboratory,
Rothamsted.

G. L. TAYLOR.

Galton Laboratory Serum Unit,
Cambridge.
March 14.

[1] *Brit. Med. J.*, Oct. 21, 1939.

Kallikrein and Histamine

Kallikrein, Frey and Kraut's circulatory hormone, has been extensively studied from the pharmacological point of view by Frey, Kraut and Werle[1] and considered by Szakall[2] as the regulator of the capillaries and small vessels. This last condition would introduce some relationship between kallikrein and histamine. Recently, Ungar and Parrot[3] have shown that kallikrein produces secretion of gastric juice, and more recently Schneider and Springorum[4] have demonstrated the close similarity between the circulatory effects of kallikrein and histamine in the dog. All these facts have justified the inclusion of kallikrein among the histamine-like substances, although its physical and chemical properties exclude the idea of its being histamine itself.

To demonstrate the effects produced by kallikrein upon the small vessels of the rabbit skin we employed the trypan blue test. Kallikrein (= padutin) was injected intracutaneously in the adult rabbit and, five minutes after, a solution of trypan blue (1 per cent) was injected into the ear vein. A more and more extensive and beautiful blue spot appears in the locality of the intradermal injection. This positive reaction has been obtained by injection of irritant substances[5] and by a proper concentration of histamine[6]. Since the rabbit's skin is very rich in histamine, one might be induced to interpret this positive test as characteristic of a liberation of histamine. By assuming that kallikrein exerts its action by liberating histamine from the tissues, this would provide an explanation for its pharmacological properties.

Initially, a difficulty for this hypothesis would be the inactivity of kallikrein upon the isolated guinea pig gut. Moreover, we have verified that kallikrein inhibits the contracting action of histamine upon that organ; therefore, even if it liberated histamine from the smooth muscle, this last active substance would have its action inhibited by kallikrein itself. But in another way the hypothesis has been rendered very improbable by the fact that we have verified that kallikrein is also extremely active even upon the skin of very young rabbits (200 gm.), while histamine and a substance liberating histamine (turpentine) are not active or only very slightly so. Furthermore, in perfusion experiments with guinea pig lung kallikrein has been found devoid of any histamine liberating activity. Thus the pharmacological activity of kallikrein does not involve a liberation of histamine.

Indirect evidence has been put forward by Frey and Kraut[1] as well as by Szakall[2] for an increase of the capillary permeability after injection of large amounts of kallikrein. Since the seepage of the trypan blue into the intradermal injected area is very characteristic of an increase of capillary permeability, the experiment described above is a direct demonstration that kallikrein produces an abnormal filtration of colloidal matter through the walls of the capillaries.

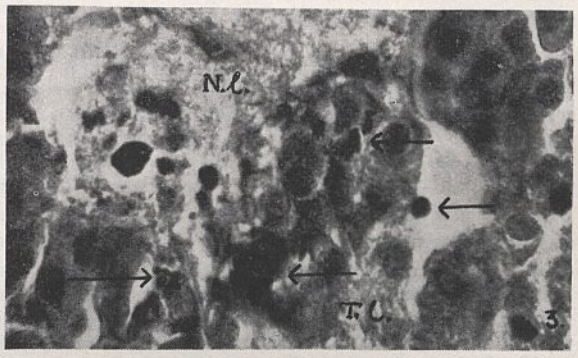
M. Rocha e Silva.

Instituto Biologico,
São Paulo,
Brazil.
Feb. 16.

[1] Frey and Kraut, *Archiv. exp. Path. u. Pharm.*, **133**, 1 (1928); Werle, *Klin. Woch.*, **15**, 848 (1936); *Muench. Med. Woch.*, **11**, 407 (1937).
[2] Szakall, *Biochem. Z.*, **269**, 92 (1934).
[3] Ungar and Parrot, *C.R. Soc. Biol.*, **122**, 1052 (1936).
[4] Schneider and Springorum, *Z. klin. Chir.*, **194**, 373 (1939).
[5] Rocha e Silva and Bier, *Arg. Inst. Biol.*, **10**, 219 (1939).
[6] Bier and Rocha e Silva, *Virchows Archiv.*, **303**, 325 (1939).

The Herring Material in the Perch Pituitary

In an investigation of the histology of the pituitary of the perch (*Perca fluviatilis*) a process of some general interest has come to light. Cells having the appearance of eosinophile leucocytes are present in the middle glandular or transitional lobe, and from them can be traced a succession of cells with fewer and larger inclusions to precise and brightly staining eosinophilic spheres which come ultimately to lie free among the cells of the lobe. In some series these spheres can be seen in all locations from the transitional to the nervous lobe, where they represent the larger elements of the Herring material in this form. Here in turn they appear to break down and form a characteristic granulation.



Photograph No. 1 (all photographs × about 1,000) shows two of these 'sphere cells' at an early stage among transitional lobe eosinophiles, No. 2 shows later stages, and No. 3 shows some spheres among the transitional lobe cells (*T. l*) and some in a process of the nervous lobe (*N. l*). No. 2 recalls certain cells noticed by Charipper[1] in the pituitary of Necturus, in which they appear to discharge directly into blood vessels. Herring[2] first described this material in the nervous lobe and looked upon it as probably secretion passing up to the third ventricle, but it has since been claimed to be simply unusual nerve endings in the lobe or an artefact due to precipitation. The sequence described here, however, including the demonstration of its origin, suggests that it is definitely secretory.

T. Kerr.
Zoology Department,
University of Leeds.
March 11.

[1] Charipper, H. A., *Anat. Rec.*, **49**, 345 (1931).
[2] Herring, P. T., *Quart. J. Exper. Physiol.*, **1**, 121 and 261 (1908).

Inhibition of Respiration at Sub-optimum Substrate Concentrations

THE following note on respiration systems arose out of some calculations made for Mr. G. D. Greville in connexion with measurements of tissue respiration at the Middlesex Hospital, London. The case considered here is that with the substrate concentration less than the optimum and with carbon monoxide present as a respiratory inhibitor. The resulting equations are different from those originally obtained by Warburg[1], but, in correspondence, he has agreed with the present results.

We consider a homogeneous system respiring in a medium containing oxygen, carbon monoxide, and substrate.

In the absence of carbon monoxide, let A_s be the respiration with substrate concentration s, less than the optimum, and A the respiration with substrate concentration equal to or greater than the optimum.

In the presence of carbon monoxide, let A'_s and A' be the values corresponding to A_s and A. We now define

$$\varepsilon = A_s/A\,; \qquad \varepsilon' = A'_s/A'\,;$$
$$n_s = A'_s/A_s\,; \qquad n = A'/A\,;$$

so that

$$\varepsilon' n = \varepsilon n_s. \tag{1}$$

Let σ_{O_2}, σ_{CO}, and σ_s be those fractions of the catalyst which are combined with oxygen, carbon monoxide, and substrate respectively. When oxygen only is present, the respiration depends directly on σ_s, provided that the oxygen partial pressure is not less than a certain minimum value, which is always exceeded in practice, that is,

$$\sigma_s = \varepsilon. \tag{2}$$

When oxygen and carbon monoxide are present, residual respiration/inhibited respiration equals

$$n_s/(1 - n_s) = \sigma^s_{O_2}/\sigma^s_{CO}\,, \tag{3}$$

where $\sigma^s_{O_2}$ is that fraction of the whole catalyst which is in combination with oxygen and substrate simultaneously, and similarly for σ^s_{CO}. If the sum of the oxygen and carbon monoxide partial pressures is not less than a certain minimum value, then $\sigma_{O_2} + \sigma_{CO} = 1$, and this is the case in practice. We assume that the probability of finding an oxygen and a substrate molecule simultaneously in combination with a given catalyst molecule is equal to the product of the separate probabilities of finding oxygen or substrate molecules in combination with that same catalyst molecule, and similarly for carbon monoxide. That is, we assume that the distributions of both oxygen and carbon monoxide over the catalyst are independent of the distribution of substrate. Then

$$\sigma^s_{O_2} = \varepsilon\,\sigma_{O_2},$$

and similarly

$$\sigma^s_{CO} = \varepsilon\,\sigma_{CO}.$$

Therefore, from (3),

$$n_s/(1 - n_s) = \sigma_{O_2}/\sigma_{CO}. \tag{4}$$

Now, in the equilibrium state, rate of combination of oxygen with enzyme equals rate of dissociation of oxygen-enzyme complex plus rate of removal of oxygen by chemical reaction, that is,

$$\lambda_1 p_{O_2}(1 - \sigma_{O_2} - \sigma_{CO}) = \lambda_2\sigma_{O_2} + \lambda_3\sigma\,\sigma_{O_2}; \tag{5}$$

and similarly for carbon monoxide,

$$\mu_1 p_{CO}(1 - \sigma_{O_2} - \sigma_{CO}) = \mu_2\sigma_{CO}. \tag{6}$$

where p_{O_2} and p_{CO} are the pressures of oxygen and carbon monoxide in the solution, respectively, and λ_1, λ_2, λ_3, μ_1, μ_2 are constants.

Now, from equations (2), (4), (5), and (6), we have

$$\frac{n_s}{1 - n_s} = \frac{\sigma_{O_2}}{\sigma_{CO}} = \frac{p_{O_2}}{p_{CO}} \cdot \frac{a}{b + \varepsilon}, \tag{7}$$

where $a = \lambda_1\mu_2/\mu_1\lambda_3$ and $b = \lambda_2/\lambda_3$.

Also, from (1), we have

$$\frac{n_s}{1 - n_s} = \frac{\varepsilon' n}{\varepsilon - \varepsilon' n}. \tag{8}$$

It is evident from (7) that when the substrate concentration is diminished so that the system becomes unsaturated with respect to substrate, the respiration is less markedly depressed by carbon monoxide only when ε is not negligible in comparison with b. That is, when the rate of removal of oxygen by chemical reaction cannot be neglected in comparison with the rate of dissociation of oxygen-enzyme complex, or, in terms of the constants of the system, $\varepsilon\lambda_3$ is comparable in value with λ_2.

Publication of this result has been delayed many months because it was thought that an opportunity for verification might occur. As this has not been possible, the result is put forward in the hope that other workers in this field might be able to test it.

W. F. FLOYD.

Department of Physiology,
Middlesex Hospital Medical School,
London, W.1.
March 8.

[1] *Biochem. Z.*, **189**, 354 (1927).

Photodynamic Hæmolysis by Carcinogenic Hydrocarbons

IN recent publications, Mottram and Doniach[1,2,3,4] reported that many carcinogenic hydrocarbons have a photodynamic effect upon Paramecia and upon the skin of mice. These hydrocarbons under the same experimental conditions did not cause photodynamic hæmolysis of erythrocytes.

This report deals with experiments made in order to find out whether by using a longer time of exposure, and a different technique of preparing the colloidal solutions of the three carcinogenic hydrocarbons, 3:4 benzpyrene, 1:2:5:6 dibenzanthracene, and methylcholanthrene, photodynamic hæmolysis could be obtained. (The carcinogens used were from the Union Chimique Belge 'Meurice'.)

The colloidal solutions of the hydrocarbons were prepared in the following way: 20 c.c. of isotonic saline solution were poured into a large Petri dish of approximately 30 cm. diameter. To this were added 10 c.c. of an acetone 1 : 10,000 hydrocarbon solution; the whole was left at room temperature, until all the acetone evaporated. The Petri dish was slightly shaken at the beginning in order to spread the solution all over the bottom. When the acetone had evaporated, the solution was poured into a test tube, care being taken to include all traces of hydrocarbon deposited on the wall of the Petri dish in the solution. This solution,

which contains therefore a little less than 1 : 20,000 of hydrocarbon, was used throughout the experiment.

Red blood cells from sheep were washed three times in the ordinary way, and suspended in isotonic saline solution in the proportion of 1 : 100. The experiments were carried out in part by using a quartz mercury lamp (Hanau, type 'Jubiläums Höhensonne', 220 volts, 3·8 amp.; distance 30–50 cm.), and in part in sunlight on bright days in February, March and April in Jerusalem. All the experiments were conducted in simple glass test tubes, of 8–9 mm. diameter.

Preliminary experiments in the dark, temperature measurements, and contemporaneous irradiation of control test tubes containing the suspension of red blood cells without the hydrocarbon, have eliminated the possibility of errors.

The results of our experiments may be summarized as follows :

(1) The colloidal solutions of 3 : 4 benzpyrene, 1 : 2 : 5 : 6 dibenzanthracene, and methylcholanthrene produced photodynamic hæmolysis.

(2) Under conditions in which we worked, in sunlight and with the above-mentioned dilution, the time required for complete hæmolysis was 1–1½ hours for 3 : 4 benzpyrene, 2½–3½ hours for 1 : 2 : 5 : 6 dibenzanthracene, and 1½–2 hours for methylcholanthrene.

(3) With the mercury-vapour lamp, the time required for complete hæmolysis for 3 : 4 benzpyrene and methylcholanthrene was 3 hours; with 1 : 2 : 5 : 6 dibenzanthracene hæmolysis was not complete after 4½ hours. The time required to obtain this hæmolysis by the hydrocarbons is much longer than the time required for them to produce a photodynamic lethal effect upon Paramecia—a fact which might have been foreseen from the results obtained by Mottram and Doniach. While Paramecia suspended in a 1 : 20,000 solution of 3 : 4 benzpyrene and irradiated by the quartz lamp under the above-mentioned conditions were killed in 5–7 minutes, the time required for complete hæmolysis under the same conditions was 3 hours.

Further studies which it is hoped will make it clear whether similar but non-carcinogenic hydrocarbons also possess photodynamic activity are being pursued. As yet, of four non-carcinogenic hydrocarbons tried, 1 : 4 diphenylanthracene, 9 : 10 diphenylanthracene, 1 : 4 : 9 : 10 tetraphenylanthracene and chrysene, not one has shown any photodynamic activity. (The non-carcinogenic hydrocarbons were kindly supplied to me by Dr. E. Bergmann, of the Daniel Sieff Research Institute, Rehovoth.)

M. WOLMAN.

Radiobiological Department,
Cancer Laboratories,
The Hebrew University,
Jerusalem.
Feb. 1.

[1] NATURE, **140**, 588 (1937).
[2] NATURE, **140**, 933 (1937).
[3] *Lancet*, **1**, 1156 (1938).
[4] *Brit. J. Exp. Path.*, **20**, 227 (1939).

Points from Foregoing Letters

M. Born presents a relativistic formulation of the theorem of the mass centre for free particles.

The radio isotope of sulphur, $^{35}_{16}S$, has been prepared by Hilde Levi from sodium chloride and from carbon tetrachloride. The sodium salt, which was found preferable for this purpose, was exposed for two months to neutrons from radium plus beryllium. Sulphur was precipitated as barium sulphate and was found to have a half-life of 88 days.

Using a large glass spectrograph of high dispersion, E. Tönsberg and L. Vegard have obtained spectrograms of twilight in which the two components of the yellow line are separated. This doublet appears, from the microphotometer curve, to be identical with the sodium doublet (D_1D_2).

T. Tokumitu finds that the two kinds of oxides formed on stainless steels are α–$(Fe,Cr)_2O_3$ at low temperatures and $FeCr_2O_4$ at high temperatures. His experimental results suggest that the naturally occurring film is the α–$(Fe,Cr)_2O_3$ form.

R. A. Fisher and G. L. Taylor state that new blood grouping data for England and Scotland show a decided gradient in the ratio $A : O$, antigen A being rarer in Scotland. This is the reverse of the effect of admixture with modern Scandinavians, who have more A than the English. Data from Iceland suggest, however, that Scandinavians of the Viking period conformed with the Scottish, and not with the modern Scandinavian, ratio.

M. Rocha e Silva presents strong evidence for an increase of the capillary permeability produced by kallikrein. The intradermal injection of kallikrein in the rabbit determines a seepage of trypan blue injected into the vein.

T. Kerr describes the origin of the Herring material in the perch pituitary from cells resembling eosinophile leucocytes found in the so-called transitional lobe. The granules of these cells become fewer and larger to form globules of various sizes which are set free in the tissue and find their way into the nervous lobe to form the larger elements of the Herring material. Here in turn they break down to become a fine granulation.

Warburg's treatment of the inhibition of respiration by carbon monoxide at sub-optimum substrate concentrations is incorrect. W. F. Floyd puts forward a solution to the problem with which Warburg has agreed in correspondence, but which has not yet been tested experimentally. The proposed solution shows that the inhibition of respiration is markedly diminished by unsaturation with respect to substrate only when the rate of utilization of oxygen is not negligible in comparison with the rate of dissociation of oxygen-enzyme complex.

M. Wolman has obtained photodynamic hæmolysis by the three carcinogenic hydrocarbons, 3 : 4 benzpyrene, 1 : 2 : 5 : 6 dibenzanthracene, and methylcholanthrene. The four non-carcinogenic hydrocarbons, 1 : 4 diphenylanthracene, 9 : 10 diphenylanthracene, 1 : 4 : 9 : 10 tetraphenylanthracene and chrysene, did not produce any such effect.

RESEARCH ITEMS

Early Mayan Datings

A NEW series of publications of the National Geographic Society at Washington, D.C., is inaugurated by a study by M. W. Stirling, chief of the Bureau of American Ethnology, Smithsonian Institution, of a Mayan dating carved on a broken and re-used stela from Vera Cruz, Mexico ("An Initial Series from Tres Zapotes, Vera Cruz, Mexico", *Nat. Geog. Soc.: Contributed Technical Papers, Mexican Archæology Series*, 1, 1; 1940). This monument was discovered in the course of archæological explorations conducted by a joint expedition of the National Geographic Society and the Smithsonian Institution at Tres Zapotes, Tuxtlas, Vera Cruz. Of some fifty mounds in four groups, each group with a rectangular plaza as a central feature, the easternmost, *C*, includes the second largest mound of the entire series, *C*1. In front of its south base was found a stela set up behind a roughly circular flat stone altar. It was a transverse fragment, intentionally broken in the middle, of a monument carved by an earlier people than those who re-used it. Facing the altar was a 'tiger-face' mask panel in low relief, while across the middle of the back was the greater part of an initial series. The numerals are in a vertical column with bars and dots placed horizontally—a rare but not unknown arrangement. The inscription is imperfect, but as restored by fully supported argument, it affords a dating which coincides with pottery finds, not yet fully worked out, but apparently to be assigned to the Middle American ceramic horizons. Only four other Initial Series are known, in which the style, with the horizontal arrangement of dot and bar, resembles that of this stela *C*, which is also the earliest of a group representing the earliest dates known in the entire body of Mayan inscriptions, and the three earliest of which have been found outside the classic Maya region.

Technique in Prehistoric Trephining

T. WILSON PARRY describes in *Man* of March 1940 the presumable method employed in trephining two prehistoric British skulls. Of these, one was found at Maiden Castle, Dorchester, in 1937 in association with a neolithic beaker of type *B*, the second in 1938 by Stuart Piggott in an early bronze age burial on Crichel Down, Dorset. At the time these two operations were performed, a notable advance in technique had been made, since the removal of a roundel of bone was more difficult and arduous than the elimination of a piece of bone reduced to dust by scraping, the method followed hitherto. In both examples the roundel had been removed from the left parietal. The dimensions in the Maiden Castle (late neolithic) skull operation are: laterally 65 mm.; ant. post., 52 mm.; oblique bevel of bone, 5–8 mm.; vert. thickness of skull, 5–7 mm. The corresponding dimensions in the Crichel Down (early bronze) skull are: laterally 60 mm.; ant. post., 70 mm.; oblique bevel surface, 9–14 mm.; vertical thickness of skull, 5–14 mm. The Crichel Down skull is altogether thicker and heavier than that from Maiden Castle. A specimen from the Grotto of Casa da Moura at Peniche, Portugal, now in the Geological Section of the Lisbon Museum, showing a continuous curving furrow united at both ends, is regarded as the first stage of the removal of a roundel of bone, the operation being unfinished. This method has not hitherto been described, but experiment with a neolithic beaked implement of flint on a recent skull has demonstrated the efficacy of what is here termed "the push plough" method, in which a thin, shallow furrow is gradually deepened until the bone is perforated. In neither skull is there any reparation of bone, so that if the operation was performed on the living, neither recovered.

Epidemic Dropsy in India

THE annual report for 1938 of the All-India Institute of Hygiene and Public Health, Calcutta, summarizes the teaching and research work carried out during the year. A most interesting research has been conducted on the disease known as 'epidemic dropsy'. A critical survey of its epidemiology, with much experimental work, led to the conclusion that this disease is associated with the use of mustard oil containing some toxic constituent. Mustard oil is widely used by the inhabitants for culinary purposes, and it was found that while some samples of mustard oil are innocuous, others are associated with the occurrence of epidemic dropsy, and experimentally induce the lesions associated with the disease. Investigation showed that the non-toxic and toxic oils could be distinguished by certain chemical and physical tests. Further investigation suggested that the toxic mustard oils might derive their toxic properties from some poisonous seed resembling mustard seed and mixed with it. After examination of a number of specimens of mustard seed, the seeds of *Argemone mexicana* were suspected to be the source of the poisonous substance in mustard oil. This plant grows wild and plentifully in various parts of India and becomes mixed with the mustard seeds at the time of harvesting. It was found that a mixture of 6 per cent of the oil expressed from the Argemone seeds with non-toxic mustard oil satisfied the same chemical and other tests as the known toxic oil, and experimentally induced the same lesions as the latter. The nature of the toxic agent is still under investigation.

Carotenoids and the Metabolism of Reproduction

THE possibility that carotenoid pigments have important biochemical roles in sexuality and the processes involved in the metabolism of reproduction is emphasized by R. Emerson and D. L. Fox (*Proc. Roy. Soc.*, B, **128**, 275; 1940). In the life-cycle of certain species of the aquatic phycomycete Allomyces, an asexual or sporophytic generation bearing thin-walled, colourless zoosporangia and thick-walled, brown, resistant sporangia, alternates with a sexual or gametophytic generation bearing colourless female gametangia and orange male gametangia. The pigment in the brown resistant sporangia of the asexual phase belongs to the melanin class and contains no carotenoid material. The orange pigment found exclusively in the male cells of the sexual phase is present in oil droplets within the cytoplasm

and is not found in the walls of the male gametangia, but is still apparent in the male gametes after their emergence from the gametangia. The female gametes, which are more than twice the size of the males, contain no trace of pigment. In the orange pigment of the male cells, γ-carotene was found in high concentrations with variable small amounts of β-carotene. The authors point out the accordance of these findings with the existing knowledge of the synthesis and selective storage of carotenoids or their derivatives in structures associated with reproduction in many cryptogams, higher plants and animals.

Induction of Polyploidy in Rabbit Ova

G. Pincus and C. H. Waddington (*J. Hered.*, **30**, 515–518; 1940) have treated fertilized ova of rabbits *in vitro*, with ethyl alcohol, ether, colchicine or with supra-normal temperatures. These treatments gave a significant decrease in the cleavage rate, while cytological examination showed that fifteen out of forty eggs were tetraploid, most of the tetraploids being in the colchicine series. It is suggested that the inhibition of cleavage and the rate of chromosome division are differently affected so that sometimes tetraploid ova are formed. Tetraploid ova ordinarily fail to cleave, but the few that do cleave do so at a subnormal rate.

Interspecific Hybridization in Medicago Hybrids

THE diploid form of *M. falcata* ($2n = 16$) does not readily cross with *M. sativa* ($2n = 32$), but the more usual hybrids are between the tetraploid *M. falcata* and *M. sativa*. The resulting hybrids form a fertile polymorphic group. Analysis of these hybrids and of artificial hybrids made between diploid *M. falcata* and *M. sativa* are described by G. F. Ledingham (*Genetics*, **25**, 1–15; 1940). A histological examination shows that in the cross *M. falcata* ♀ × *M. sativa* ♂, fertilization takes place and development continues for about a fortnight. In the reciprocal cross, fertilization occurs, but development usually ceases after two days. It is suggested that the rate of physiological activity and cell division of the endosperm embryo and maternal tissue is initiated by the chromosomes of the gametic nuclei.

Fruit Flies of Northern China

IN *Sinensia*, **9** (1938), Nos. 1–2, pp. 1–150, there is an extensive contribution on the Trypetidæ or fruit flies of North China by Y. Zia and Sicien H. Chen. The journal in question, it may be added, is issued by the National Institute of Zoology and Botany, Academica Sinica, Pehpeichang, China. The present study is based upon material collected during a period of twenty-five years. Altogether, thirty-six genera and one hundred and thirty-five species are dealt with in this monograph. It is noteworthy that two of the genera and sixty-two of the species are described as being new. Special mention is made of the occurrence of two species of the genus Rhagoletis, namely, *R. reducta* and *R. scutellata*, for the reason that members of this genus are well known to cause much damage to fruits in Europe and North America. Although the relation of the two species named to horticulture in North China is unknown, their presence is noteworthy and is regarded as a menace to fruit production. It is creditable that, notwithstanding the disturbed condition of affairs in so much of China, the progress of natural science has not been wholly dislocated.

Sand-Dwelling Copepods

A. G. NICHOLLS continues his studies on copepods living in sand (*J. Marine Biol. Assoc.*, **23**; 1939). New species are described from the Firth of Clyde and also from the St. Lawrence River. Revised keys are given for the species of Leptopsyllus and Paramesochra, Leptopsyllus now being restricted to those forms which lack endopods on the second legs. The two genera have been for some time in a state of considerable confusion, and although the author follows Kunz (1938) in basing the distinction on the presence or absence of an endopod on the second leg, he is of the opinion that the separation is not a natural one but will suffice until a thorough revision of these and allied genera has been made. An interesting find from Fintray Bay, Isle of Cumbræ, is *Remanea arenicola* Klie, occurring in relatively coarse sand near low-water mark. This species is so far only known from Kiel Bay. Three new species of Leptopsyllus and four of Paramesochra are described.

Weather and Radial Growth of Trees

AT the recent meeting of the American Association, Charles J. Lyon reported data from a New England forest, where suitable trees in close proximity to a meteorological station were blown down in a hurricane in 1938, as the result of an examination of their radial increment in comparison with the meteorological records. White pine, Scotch pine and red oak showed significant correlation with the rainfall of the spring months; but Austrian pine, Norway spruce and European larch showed no consistent correlation with the precipitation records of any period. There was almost no agreement between growth-rates and temperatures, though all the coniferous trees gave significant correlations between growth-rate and the temperatures of March and April, *before* the growth starts. This is interpreted as an effect of water supply, since the temperature of the air determines the frost in the soil. When the frost remains late in the spring, the water from the melting snow and from the early spring rains runs off to the rivers; but this water is added to the water supply of the trees if the frost leaves the soil early. On the whole, the native white pine tree is particularly sensitive to its water supply, and was the best indicator tree of those tested in this study. The width of its annual rings is a better index of growing conditions for crops and forests than the weather bureau records of rainfall and temperature for the year.

Water Culture of Apple Trees

TREES of many different species have from time to time been grown in nutrient solutions, and the method has been widely used in nutritional studies. H. L. Pearce (*J. Pom. and Hort. Sci.*, **17**, 344; 1940) has recently used the method for comparing the course of absorption of nitrogen and potassium in dwarf and vigorous apple trees. One year old trees of Cox's Orange Pippin on Malling stocks IX and XII were grown in continuously aerated culture solutions for a complete season and the absorption of nutrients and water followed by analysis of the external solution. Growth records showed that the two rootstocks maintained their respective dwarfing and vigorous habits in these conditions, whilst the uniformity of the trees was greater than that obtained in soil. An unusual feature was the fact that the trees on *M* XII, which normally exhibit delayed

blossoming compared to trees on *M* IX, bore blossom as freely as those on the dwarfing rootstock. The vigorous trees absorbed more water per unit leaf area throughout the season than the dwarf trees, though the latter absorbed more per unit increase in fresh weight. The course of nitrogen and potassium uptake was closely similar in the two kinds of tree. The absolute amounts absorbed were greater for the tree on *M* XII, but the ratios of total growth made to nutrients absorbed did not differ significantly. No relation could, therefore, be observed between nutrient absorption and vigour.

Soil Decomposition of Straw

A RECENT paper by T. S. Sadasivan (*Ann. Appl. Biol.*, **26**, No. 3, 497–508; 1939) shows that wheat straw is decomposed in soil largely by the activities of *Fusarium culmorum* and Mucor spp. These fungi were found on six different soils, but they appeared to give place to Penicillium spp. in the later stages of decay, or when the straw was treated with sodium nitrate.

Geochemistry of Fluorine

THERE has been little information available about the amounts of fluorine present in rocks, the lack of data being due mainly to the difficulty, hitherto, of determining fluorine with accuracy. The Willard and Winter procedure (*Ind. Eng. Chem.*, **5**, 7–10; 1933) now furnishes an easy and surprisingly accurate method of analysis. E. S. Shepherd has established (*Amer. J. Sci.*, **117**, 128; 1940) that fluorine is not so insignificant a constituent of the earth's crust as had been supposed. It is evidently present in quantities as great as, and sometimes greater than, chlorine, and this raises a question to which there is at present no satisfactory answer. What becomes of all this fluorine on denudation? The author hopes with continued work to be able to trace the vagaries of this elusive element. Meanwhile, it appears that plutonic rocks characteristically contain about 0·04 per cent. The lavas examined tend to have about 0·01, even where large amounts of fluorine are known to have been exhaled. Obsidian, however, has an average content of 0·07, rising exceptionally to twice this amount. In certain regions, notably the African rifts, there are strong local concentrations. In sedimentary rocks the average is 0·027, but ocean bottom samples have nearly twice as much. No correlation between fluorine and other elements has yet been detected, except a dubious one with potassium. A suggested relationship with phosphorus has not been confirmed.

Molecular Rotation in Organic Crystals

DIELECTRIC constant measurements have established the rotation of molecules in certain crystals, such as those of halogen hydracids and hydrogen sulphide, and also in some organic compounds, including certain polar derivatives of camphane, cyclohexane and ethane. A. H. White, W. S. Bishop, B. S. Biggs and S. O. Morgan (*J. Amer. Chem. Soc.*, **62**, 8, 16; 1940) have extended this field by dielectric constant measurements with crystals of two derivatives of ethane, one of cyclopentane, five of cyclohexane, and thirteen of camphane in the non-aromatic class, and with a number of benzene derivatives (3,4,5-trichloro-*o*-xylene, trichloro-*m*-xylene, 3-nitro-4,5-dichloro-*o*-xylene, 5-nitro-3,4-dichloro-*o*-xylene, pentachloroethylbenzene, pentaethylacetophenone, pentamethylnitrobenzene and *o*-dinitrotetramethylbenzene). In the case of the non-aromatic compounds, the dielectric constant mostly rises abruptly at a transition to a value characteristic of polar liquids, as the temperature is increased. A relatively symmetrical gravimetric and volumetric distribution of atoms around the centre of gravity of the molecule facilitates its rotation in the crystal. In the aromatic compounds the dielectric constant of the solid behaves like that of the corresponding liquid and may be correlated with the dipole moment. The less symmetrical of the molecules cease rotating abruptly at transitions, while the more symmetrical exhibit reduced frequency of rotation but no transitions with falling temperature. The temperature at which the relaxation time reaches a given value depends (with one exception) on the number of chlorine atoms in the molecule in the symmetrical hexasubstituted methylchlorobenzenes.

Magnetic Spectrograph Coils

WHEN a beam of slow-speed electrons or ions is to be analysed by projecting it through a magnetic field, it is advisable to make the field in the vicinity of the trajectory as uniform as possible, and in many cases two equal coils placed coaxially at a distance apart equal to their radii have been used. With the same electric current in the same direction through the coils, the field in the median plane is uniform near the magnetic axis only. M. Ference, A. E. Shaw and R. J. Stephenson, of the University of Chicago, have shown (*Rev. Sci. Inst.*, February 1940) that it may be rendered uniform over the volume of a ring of radius up to a third of that of the coils by bringing the coils a little closer together. The theoretical proof of this is verified experimentally by balancing the field against that of a standard coil, using a small magnet and mirror to test the balance. With coils of 30·776 cm. radius, the field within a ring of mean radius 8 cm. is most uniform with the coils 28·890 cm. apart, and within a ring of 10 cm. with them 27·838 cm. apart. In the latter case the change of field from 9 to 11 cm., and from the median plane to parallel planes 1 cm. away, is only one part in 4,000.

Nebulæ and Star Clusters in the Southern Hemisphere

H. Shapley and J. S. Paraskevopoulos have given some interesting pictorial results of a study of thirty nebulæ and clusters photographed with the 60-inch reflector at the Boyden Station, Bloemfontein, of the Harvard College Observatory (*Proc. Nat. Acad. Sci.*, January 1940). Three quarters of the external galaxies (extra-galactic nebulæ) that are near enough for close classification are spiral in structure, and most of the spirals can be placed in a few common categories. The illustrations given include several instructive curiosities and abnormal forms. One of these shown is *NGC* 55 (exposure 2 hours), which with a major axis of nearly 33′ is probably exceeded in angular dimensions only by the Andromeda Nebula and Messier 33. Its linear dimensions may prove to be outstanding among the external galactic systems. South African plates for the detection of Cepheid variable stars, used as distance indicators, are accumulating. Another plate shows the well-known globular cluster, Omega Centauri (exposure time 1 hour), one of the most remarkable of star clusters. Its total absolute magnitude is comparable to that of the small external galaxies, such as the companions to the Andromeda Nebula.

SUGGESTIONS FOR NEW UNITS IN PHYSICS AND ENGINEERING

A COMMUNICATION received from the Bureau International des Poids et Mesures summarizes the conclusions reached at the meetings last summer of the Consultative Committees for Electricity, Photometry and Thermometry. These conclusions would, in the normal course, have been reported to the International Committee for Weights and Measures at its meetings which were to have been held last September.

The Consultative Committee for Electricity recorded three resolutions. The first contains a recommendation as to the relationships which should be accepted between the existing international units and the proposed new practical absolute units, namely :

1 mean international ohm = 1·000 5 ohm (abs.)
1 ,, ,, ampere = 0·999 9 amp. (abs.)
1 ,, ,, volt = 1·000 4 volt (abs.)

The second resolution contains a number of clauses defining the proposed new units and the procedure to be followed in establishing and maintaining suitable reference standards. The third relates simply to the desirability, in order to avoid confusion, of appending the qualification "international" (abbreviated to "int.") or "absolu" (abbreviated to "abs.") in all references to the two series of units during the period of transition.

The Consultative Committee for Photometry also passed three resolutions. The first of these suggested that, while the 'new candle' should be introduced in legislation as from January 1, 1940, its legal application should be deferred until January 1, 1941. The second records a recommendation that comparisons of lamps at the higher colour temperature of 2800° K. should be organized forthwith between the various national laboratories ; and the third outlines the relationship between the old and new units and the procedure to be adopted for the establishment of the new standards necessary.

The Consultative Committee for Thermometry passed two resolutions. The first of these records that, in the opinion of the Committee, the most probable value of the melting point of ice on the Kelvin scale, according to experiments so far completed, should be taken as 273·15° ± 0·02°. The second recommends that the unit of 'heat' should be the quantity of heat equivalent to the 'Joule', or 10^7 ergs ; that the calorie should be defined as 3600/860 joules, or 1/860 watt-hours ; and that the terms kilogram-calorie, or 'large' calorie, should in future be replaced by "kilo-calorie" ; these recommendations to be submitted for approval, before final adoption, to the International Union of Physics, the Commission of Physico-Chemical Constants, and the Steam Tables Conference. In addition, the Committee recommended certain minor modifications to the existing specifications of the International Temperature Scale.

It will be realized that the functions of the Consultative Committees are purely advisory, and that any decisions based thereon must be taken by the International Committee itself. The fact that, as a result of the War, this Committee was unable to meet as arranged, has left all these various resolutions unconfirmed. In particular, some uncertainty arises as to the precise position with regard to the introduction of the proposed new electric and photometric units, which the International Committee had previously decided should come into force on January 1, 1940. The Consultative Committees concerned both encountered difficulty with regard to implementing these previous decisions.

In a covering letter to the summary, the acting president and secretary of the International Committee suggest that in all the circumstances, since uniformity of international action is most desirable in such matters, the introduction of the new units should be deferred until such time as the Committee is able to issue a further pronouncement.

TYPE TESTS IN ENGINEERING

IN a paper in the *Beama Journal* of January W. A. Coates, c/o Metropolitan-Vickers Electrical Co., Ltd., discusses the significance and value of type tests in engineering. A type test is defined as a text made on one piece of material or apparatus, which is accepted as indicating the characteristics of another. Naturally, therefore, there is always an element of chance when interpreting and applying the results of such tests.

One of the oldest examples of a type test is to be found in the practice of making castings with projecting portions, which are eventually cut or sawn off and tested for mechanical, physical or chemical characteristics or for two or three of them. It is probable that the data obtained in this way apply also to the casting ; the latter, however, would be destroyed in similar tests. The value of tests on samples depends on the skill with which the pieces were located and if the metal were poured so as to ensure a uniform cooling rate with the main body of the casting. More trustworthy data are obtained by testing metal cut from the main body of the casting. In important parts this is often done by trepanning out a piece where a hole is required. The closer that such samples are taken from the metal which will be used, the nearer is the test to a true test.

In electrical work, analogous type tests can be found in Brit. Spec. 137 (1930), which deals with porcelain line insulators. In these tests for ascertaining the puncture and porosity figures, the insulator is destroyed in the process. The mechanical, electro-mechanical and temperature-cycle tests are

carried out on a proportion only to save time and expense. Mechanical tests must, from their nature, be made on insulators one at a time, while temperature cycle tests cannot be made in less than six hours, and are very awkward to carry out with more than a few units at a time.

Skilled craftsmanship plays a greater part in porcelain manufacture, both in the moulding and the firing, than it does in the production of rolled or drawn metal. This is reflected in the incidence of tests. A simple set of tests would usually satisfy a purchaser of several tons of rolled steel, but of the insulators 0·5 per cent is the minimum standard quantity tested. If in these a failure is recorded, a second batch of 1 per cent is tested. A failure on the second group of tests is followed by tests on 1·5 per cent, and if there are defects among these, the whole quantity is rejected. The increasing size of the batch tested is a clear indication of increasing suspicion about the quality of the bulk. In more readily controlled materials it is not usual to increase the percentages tested, even if failure does occur in the initial batch.

Electrical work presents also another class of type-tests such as in those made to determine the impulse voltage characteristics of an insulator or bushing. The impulse ratio depends almost completely upon the physical dimensions and the relative dispositions of dielectrics and conductors in such apparatus. Without changing these features, there is practically nothing that can be done in course of manufacture which would sensibly alter the impulse breakdown values. Thus a type-test on any one of a batch of dimensionally similar units is adequate to prove the characteristics of all. It is, in fact, a purely design test.

The tests carried out by the Home Office Mines Departments at Buxton, to prove electrical apparatus safe for use in explosive atmospheres, are also in this group. Inspection which shows identity of detail conveys full confidence that duplicates of the tested apparatus are equally flameproof.

Recently, the industry has become increasingly aware of a new group of type-tests, namely, those made on circuit breakers, which are covered by certificates issued by the Association of Short-Circuit Testing Authorities or the National Physical Laboratory. These two bodies are now working in conjunction to carry out and certify the short-circuit type-tests made in conformity with the requirements of Brit. Spec. 116 (1937). This standard specification calls for other tests also, but these are of a well-understood nature and may be made with apparatus found in any properly equipped factory.

The over-voltage tests on insulation and those made to check the operation of tripping and closing coils, are carried out on every breaker as a matter of routine. Hydraulic tests to prove tank strength and adequacy of joints need not necessarily be made on every breaker. This also applies to the mechanical endurance test, which consists of opening and closing the breaker 500 times on no-load. A test of this kind is necessary on any complicated mechanism, to ensure that some trifle, which might cause ultimate failure by excessive wear or distortion in service, has not been overlooked in design.

The practical circumstances in which a breaker may have to perform vary widely, and the accompanying electrical and physical phenomena are very complex. It is impossible, therefore, to separate the short-circuit tests into a series, each of which is simple and clearly defined, as can be done, for example, with an insulator. The only possible method of carrying out these tests is to use a testing generator which has short-circuit characteristics like those of the largest power stations. The operation, control, and recording work with such call for technical skill of an uncommon and very high order. The type-tests that have been devised are of an all-embracing character, and represent the worst that could happen in service; they are far more severe than is likely to occur in the majority of cases. It is essential to do this, because the primary duty of the breaker is to protect all other connected apparatus.

It will be generally agreed that the proper fields for type-testing are: (*a*) whenever the process of testing must destroy the article; (*b*) whenever the test is to determine a characteristic which is dependent upon dimensions and physical positions of parts; and (*c*) whenever individual testing would increase the cost of the finished article to an uneconomic level.

DUGGAN-CRONIN BANTU GALLERY, KIMBERLEY

WHEN in 1929 the British Association visited South Africa, the anthropologists in particular were much impressed by the scientific value, as well as by the importance as a record, of the collection of photographs of characteristic types of the native races of South Africa, which had been formed and was still being augmented by Mr. A. M. Duggan-Cronin. This impression was fully confirmed by further examination of the material placed on exhibition by Mr. Duggan-Cronin at the centenary meeting of the Association held in London in 1931.

Mr. Duggan-Cronin's interest in native types was first aroused when, as an employee of the De Beers Company in Kimberley, he was brought into contact with the wide variety of tribesmen who sought employment in the mines. After mastering the technique, he began his photographic series of racial types in 1904; but it was not until 1919 that he was able to undertake work in the field, when at the instance of the Board of the McGregor Institute, Kimberley, he visited the Langenbergen, Griqualand West, to photograph the Bushmen living there. Since that time, each year Mr. Duggan-Cronin, with the financial assistance of the Union Research Grant Board or from the Carnegie funds, has carried on his work, visiting one or other of the South African peoples, until a record has been made of every important Bantu tribe in the Union and of a number elsewhere, as well as of the Yellow races, Bushmen and Korannas. These records, to the number of 2,600, have been mounted in albums and the negatives stored in a strong room of De Beers. The material has also been published in part in eight volumes with the Cambridge University Press, while seven further volumes await publication.

From 1925 onward Mr. Duggan-Cronin, in view

of the fact that no Bantu gallery existed in South Africa, threw his collection open to the public, maintaining the gallery at his own expense. After twelve years, however, it was offered as a gift to the town of Kimberley, subject to the provision of suitable housing. The gift was accepted and the collection was officially declared open in 1938 as the Duggan-Cronin Bantu Gallery by Sir Ernest Oppenheimer, chairman of De Beers Company, in premises, formerly the guest house, generously provided by that company, together with £150 per annum towards the cost of upkeep.

The unique character of many of these photographs as records from the cultural, as well as the racial point of view, was the subject of commendatory reference at an exhibition which was held at a recent joint meeting of the Rhodesia Scientific Association with the newly formed Rhodesia Photographic Society at Salisbury (*Transactions*, 37 ; 1939), when attention was directed to, among others, the complete series illustrating the smelting of iron ore among the Mashona, and the initiation ceremony of the Bomvana Kwetas. In the Bantu Gallery at Kimberley the photographs are supplemented and further illustrated by objects of the tribal culture collected by Mr. Duggan-Cronin.

THE EARTH'S INTERIOR

K. E. BULLEN has examined the recent developments in knowledge of the earth's interior (*Acta Astronomica*, 4, April 1939). The most recent estimate of Gutenberg and Richter shows a radius of the core of 2,920 km., and work on near earthquakes suggests the existence of various crustal layers extending to a depth of the order of 30 km. from the surface of the earth. According to Bullen, if the variation of density between the earth's crustal layers and the central core were continuous, the moment of inertia of the central core would have to be $0{\cdot}57\,Ma^2$, where M is mass of core and a is radius of core. This, being in excess of the value $0{\cdot}40\,Ma^2$ which would hold for a homogeneous sphere, would appear to indicate a virtually impossible distribution of matter inside the central core. Thus some assumption made in obtaining these estimates appeared to need amendment. The amendment suggested by Bullen is that there is a change of material at a depth of the order of several hundred kilometres.

On account of the 20° discontinuity in the travel time graph of P waves from earthquakes which appears to be fairly well established, Jeffreys has suggested either an abrupt change at a depth of 474 km. (uncertainty 20 km.) or an appreciable variation from 300 to 700 km. below the earth's surface. Incidentally, 700 km. gives the depth of focus of the deepest focus earthquake yet recorded. Price and Lahiri have recently suggested a change of material at a depth of approximately 700 km. in the earth on the evidence of variation of electrical conductivity. Following work by Olczak, Jeffreys, Bernal, Benfield and himself, Bullen suggests the following distribution of matter within the earth :

	Depth	Density range
Normal olivine layer	30–474 km.	3·32–3·69 gm. cm.$^{-3}$
Cubic olivine layer	474–2920 km.	4·24–5·57 ,,
Central core	2920–6371 km.	9·77–12·29 ,,

Concerning further density changes within the earth, Gutenberg and Richter have recently directed attention to the possibility of variation within the core itself.

SEVENTY YEARS AGO

NATURE, vol. 1, April 14, 1870

Left-handedness

"J. S." in a letter to the Editor concludes : "Left-handedness is very mysterious ; it seems quite against physiological deductions and the whole tendency of arts and fashion. Prof. Buchanan, of Glasgow, who wrote an able memoir on right-handedness in 1862, thinks that left-handedness may be due to transposition of the viscera, and tells me that his friend Dr. Aitken found such a case. But surely transposition of the viscera must be far rarer than obstinate left-handedness. In cases of left-handed persons which I have examined, the links of the left side were proportionally larger, just as those of the right side are in normal cases. I have also found that left-handedness is hereditary".

Heat Units

THOMAS MUIR, writing from College Hall, St. Andrews, refers, in a letter to the Editor under this title, to the cumbersome terminology used to describe "units of heat", and makes the following comments.

"Define, first, as follows :—A *therm* is the quantity of heat necessary to raise the temperature of 1 gramme of water from 0° C to 1° C. Secondly 1 kilotherm = 10 hectotherms = 1000 therms = . . . , thus having kilotherm, hectotherm, &c., suggestively corresponding to kilogramme, hectogramme, &c., in name as well as in nature.

"Therms and kilotherms, which would probably alone be required in practice, would thus take the place of 'thermal units, centrigrade', 'gramme-water-units', 'kilogramme units of heat', and others more or less lengthy and inexact at present to be found in writing, on Heat and Energy."

Postage on Printed Matter

THE Budget contains an announcement "of the greatest importance to men of science. The postage on printed matter not exceeding 2 oz., and on newspapers not exceeding 6 oz., is to be reduced to one halfpenny. We have waited a long time for this change : not too long, however, to welcome it warmly now it has come, for the tax on all authors of the postage of the scientific papers, copies of which they wish to distribute, has been very great."

AT the anniversary meeting of the Chemical Society held on March 30, the president, Dr. A. W. Williamson, announced in his address that Messrs. Johnstone and Matthey had offered the Society a donation of palladium to be used for the preparation of the first ten Faraday Medals.

THE honour of knighthood has been conferred on Mr. Ronalds for his early researches in telegraphy.

UNIVERSITY EVENTS

ABERDEEN.—On April 4, the honorary degree of LL.D. was conferred on Sir William Jameson, professor of public health, University of London, and Prof. F. A. Lindemann, professor of experimental philosophy, University of Oxford.

FORTHCOMING EVENTS

Monday, April 15

ROYAL SOCIETY OF ARTS, at 4 p.m.—Dr. L. H. Lampitt: "Science and Food" (Cantor Lectures. Succeeding Lectures on April 22 and April 29).

Tuesday, April 16

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts), at 5.15 p.m.—Prof. J. H. Jones: "The Report of the Royal Commission on the Distribution of the Industrial Population".

Wednesday, April 17

ROYAL SOCIETY OF ARTS, at 2.30 p.m.—H. V. Potter: "Plastics as Constructional and Engineering Material".

ROYAL MICROSCOPICAL SOCIETY, at 3.30 p.m.—Annual Meeting.

Dr. P. N. Bhaduri: "Improved Smear Methods for Rapid Double Staining".

ROYAL METEOROLOGICAL SOCIETY, at 4.30 p.m.—Prof. P. G. H. Boswell, F.R.S.: "Climates of the Past, a Review of the Geological Evidence" (G. J. Symons Memorial Lecture).

Thursday, April 18

CHEMICAL SOCIETY, at 6 p.m.—Prof. R. G. W. Norrish, F.R.S.: "Some Aspects of the Polymerisation of Vinyl Compounds".

Friday, April 19

EUGENICS SOCIETY (at the Linnean Society), at 5 p.m.—Mrs. Eva Hubback: "Family Allowances".

Saturday, April 20

ASSOCIATION OF SCIENTIFIC WORKERS (at the Guild of Undergraduates Union, Birmingham), at 3 p.m.—Conference of Industrial Scientists. (Speakers: J. S. Hunter: "Salaries, Cost-of-Living Adjustments, Overtime"; Dr. C. J. Milner: "Holidays and the Five-day Week"; J. Skeel: "The Problems of Assistants, (*a*) General and Economic Problems"; A. G. Ward: "The Problems of Assistants, (*b*) Problems of Technical Education"; Dr. R. E. Priestley: "Science as a Reserved Occupation".

SOCIETY OF GLASS TECHNOLOGY (Meeting at Sheffield), April 16–April 17.

April 17, at 2.30 p.m.—Annual General Meeting.

Prof. L. C. Martin: "The Possibilities of the Electron Microscope".

Dr. M. Benjamin: "An Electron Microscope".

APPOINTMENTS VACANT

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

LECTURER IN ELECTRICAL ENGINEERING at the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (April 16).

TEMPORARY LECTURER IN CHARGE OF THE DEPARTMENT OF PHYSICS—The Registrar, University College, Leicester (April 17).

A GRADUATE ASSISTANT TO TEACH MATHEMATICS AND GENERAL SCIENCE SUBJECTS, a GRADUATE ASSISTANT TO TEACH MECHANICAL SUBJECTS, and a GRADUATE ASSISTANT TO TEACH PHYSICS, at the West Hartlepool Technical College—The Chief Education Officer, Education Offices, Park Road, West Hartlepool (April 19).

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, Portsmouth Municipal College, Portsmouth (April 20).

ENGINEERING GRADUATE TO TEACH, PRINCIPALLY, MATHEMATICS, at the County Technical College, Dartford—F. L. Notley, 11 Essex Road, Dartford (April 20).

LECTURER IN AGRICULTURAL CHEMISTRY in the School of Agriculture near Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (quoting Lecturer, A.C.) (April 25).

HEAD OF THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Principal, Sir John Cass Technical Institute, Jewry Street, E.C.3 (April 27).

ASSISTANT INSPECTOR (man or woman) OF SCHOOLS IN WALES—The Secretary, Welsh Department, Board of Education, Alexandra House, Kingsway, W.C.2 (April 29).

H.M. INSPECTORS (men) OF TECHNICAL SCHOOLS AND COLLEGES—The Secretary, Board of Education, Alexandra House, Kingsway, W.C.2 (May 4).

ASSISTANT INSPECTOR (woman) IN DOMESTIC SCIENCE—The Secretary, Board of Education, Alexandra House, Kingsway, W.C.2 (May 4).

H.M. INSPECTOR (woman) OF PHYSICAL TRAINING—The Secretary, Board of Education, Alexandra House, Kingsway, W.C.2 (May 4).

IMPERIAL AGRICULTURIST at the Imperial Agricultural Research Institute, New Delhi—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting Appointment 9/1A) (May 4).

MEDICAL OFFICER (man or woman)—The Secretary, Board of Education, Alexandra House, Kingsway, W.C.2 (May 11).

HEAD OF THE DEPARTMENT OF CHEMISTRY—The Secretary, School of Metalliferous Mining, Camborne, Cornwall (May 15).

A SENIOR LECTURER IN CIVIL ENGINEERING, A LECTURER IN CIVIL AND MECHANICAL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING, at the Henry Lester Institute of Technical Education, Shanghai—Viney, Price and Goodyear, Empire House, St. Martin's-le-Grand, E.C.1 (May 18).

ENGINEER WITH GOOD KNOWLEDGE OF CHEMISTRY AND PHYSICS—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, N.W.4.

DRAUGHTSMEN (Ship-Constructional, Mechanical and General Engineering) by the Ministry of Supply—The Ministry of Supply (S.E.3b), Adelphi, W.C.2 (quoting Appts. 026/S.E.3b).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 45, Section B, No. 16: The Retardation of Chemical Reactions, 10: The Choice of Retarders in Liquid Phase Oxidations. By Kenneth C. Bailey. Pp. 373–412. 4*s*. Vol. 46, Section A, No. 1: A Characterisation of Algebraic Numbers. By Olga Taussky and John Todd. Pp. 8. Vol. 46, Section A, No. 2: A Method of Determining Quantum-Mechanical Eigenvalues and Eigenfunctions. By E. Schrödinger. Pp. 9–16. Vol. 46, Section A, No. 3: On Proving Certain Properties of the Primes by means of the Methods of Pure Number Theory. By T. S. Broderick. Pp. 17–24. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [213

The Higher School Certificate Examination: being the Report of the Panel of Investigators appointed by the Secondary School Examinations Council to enquire into the Eight Approved Higher School Certificate Examinations held in the Summer of 1937. Pp. 93. (London: H.M. Stationery Office.) 1*s*. 6*d*. net. [263

Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1938, with Report of the Geological Survey Board and Report of the Director. Pp. iv+108. (London: H.M. Stationery Office.) 2*s*. net. [263

The National Institute of Agricultural Botany. Twentieth Report and Accounts, 1938–39. Pp. 17. (Cambridge: National Institute of Agricultural Botany.) [273

Other Countries

New Zealand: Department of Scientific and Industrial Research. Meteorological Observations for 1938. Prepared in the Meteorological Office, Wellington. Pp. 38. (Wellington: Government Printer.) [193

Southern Rhodesia. Geological Survey Bulletin No. 36: The Geology of the Country around Gwanda. By R. Tyndale-Biscoe. Pp. viii+204+15 plates. (Salisbury: Government Stationery Office.) 6*s*. 6*d*. [203

Indian Association for the Cultivation of Science. Special Publication No. 8: Interatomic Forces. By Prof. J. E. Lennard-Jones. Pp. 44. (Calcutta: Indian Association for the Cultivation of Science.) 1.8 rupees: 2*s*. 3*d*. [203

Kungl. Svenska Vetenskapsakademien: Förhistoria, Grundläggning och Första Organisation. Av Bengt Hildebrand. Pp. xv+672. Noter, Bilagor M.M. Pp. v+673–886. (Stockholm: Kungl. Svenska Vetenskapsakademien.) [203

Annual Report of the American Telephone and Telegraph Company for 1939. Pp. 38. (New York: American Telephone and Telegraph Company.) [213

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Carnegie Institution of Washington Year Book No. 38, for the Year 1938–1939.) Pp. 57–106. (Washington, D.C.: Carnegie Institution.) [263

U.S. Department of the Interior: Geological Survey. Bulletin 874–D: Geology and Fuel Resources of the Southern Part of the Oklahoma Coal Field. Part 4: The Howe–Wilburton District, Latimer and Le Flore Counties. By Thomas A. Hendricks. Pp. iv+255–300+plates 27–35. 70 cents. Bulletin 890–A: Spirit Leveling in South Carolina. Part 1: Northern South Carolina, 1896–1938. Pp. ii+455+2 plates. 55 cents. Bulletin 898–E: Spirit Leveling in Missouri. Part 5: Southwestern Missouri, 1896–1937. Pp. x+581–735+xi–xiv. 20 cents. Bulletin 905: The Coal Resources of McCone County, Montana. By A. J. Collier and M. M. Knechtel. Pp. vii+80+16 plates. 75 cents. (Washington, D.C.: Government Printing Office.) [273

Carnegie Endowment for International Peace. Annual Report for 1939 of the Division of Intercourse and Education. By Nicholas Murray Butler. Pp. 64+7 plates. (Washington, D.C., and New York: Carnegie Endowment for International Peace.) [273

OFFICIAL ANNOUNCEMENTS

THE INSTITUTE of CHEMISTRY of GT. BRITAIN & IRELAND

(Founded 1177) (Incorporated by Royal Charter, 1885)

APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates and Senior Registered Students) who are available for appointments or who are seeking to improve their positions, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology. A list of Laboratory Assistants is also available.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to the Registrar.

All communications to be addressed to The Registrar, the Institute of Chemistry, 30 Russell Square, London, W.C.1.

GOVERNMENT OF INDIA

Applications are invited for the appointment of Imperial Agriculturist, Imperial Agricultural Research Institute, New Delhi.

Candidates must be British subjects or subjects of an Indian State and should not be more than 45 years of age. They should possess a high degree or diploma in agriculture or allied science, together with sound knowledge and experience of crop and animal husbandry problems, a working knowledge of modern methods of field experimental technique and interpretation of results; experience in power farming and general farm engineering and cattle breeding. They should have had at least ten years' experience of mixed farming and agronomical investigations.

Permanent appointment, subject to two years' probation.

Initial pay according to age, qualifications and experience in scale Rs.275, rising by increments of Rs.25 to Rupees 650, thence by increments of Rs.35 to Rupees 1,000 a calendar month, plus special pay of Rs.150 a month, plus Overseas Pay of £15, £25 or £30 a month according as officer is over 25, 30 or 35 years of age respectively (Rupee=1s. 6d. approximately). Free first-class passage to India and, if confirmed in appointment, further passages for leave purposes. (Overseas Pay and passages admissible only to candidate of non-Asiatic domicile recruited outside Asia.) Provident Fund, or, in the case of pensionable officers under Government, preservation of pensionary rights.

Further particulars and forms of application may be obtained, on application by postcard (quoting Appointment 9/1A) from the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2. Last date for receipt of applications, May 4, 1940.

GOVERNMENT OF BENGAL

Applications are invited for an appointment as Assistant Livestock Expert for Animal Husbandry work in Bengal.

Candidates must be natural-born British subjects, or subjects of an Indian State, and should be not less than 25 nor more than 35 years of age. They must possess a degree or diploma in Agriculture, or the qualification of M.R.C.V.S., and not less than three years' postgraduate training in Animal Husbandry, including dairying and knowledge of small stock and poultry. They must have had adequate practical experience in Animal Husbandry, including the breeding of stock and dairying.

Terms for candidates of Non-Asiatic domicile:

Appointment for five years in first instance. Pay scale Rs.550 a month, rising by biennial increments of Rs.100 a month to Rs.1,550 a month. Initial pay according to age, subject to maximum of Rs.750 a month at age 30 and upwards. (Rupee=1s. 6d. approx.) Provident Fund. Free passage to India and return passage on satisfactory completion of agreement.

Note.—Special terms, which will be supplied on application, will apply to an appointee of Asiatic domicile.

Further particulars and forms of application may be obtained, on application by post card (quoting Appointment 9/2 A), from the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2. Last date for receipt of applications April 27, 1940.

UNIVERSITY OF GLASGOW

LECTURESHIP IN ZOOLOGY

Applications are invited for the post of Lecturer (Grade III) in the Department of Zoology as from October 1, 1940. Salary scale £320—£380. Further particulars may be obtained from the undersigned, with whom applications (five copies), together with copies of not more than two recent testimonials and the names of referees, should be lodged not later than April 30, 1940.

ROBT. BROUGH,
Acting Secretary of University Court.

THE SIR JOHN CASS TECHNICAL INSTITUTE

JEWRY STREET, ALDGATE, LONDON, E.C.3.

The Governors of the Institute invite APPLICATIONS for the POST of the HEAD OF THE DEPARTMENT OF PHYSICS AND MATHEMATICS, which post will become vacant on the retirement of Dr. D. Owen, B.A. (Cantab.), D.Sc. (Lond.), F.Inst.P.

Salary in accordance with the London County Council Scale for Class II, Heads of Departments, namely, £580 per annum, rising by annual increments of £25 to £725.

Details of the duties and application form may be obtained from the undersigned.

Applications, with copies of not more than three recent testimonials, to be forwarded by SATURDAY, APRIL 27.

GEO. PATCHIN,
Principal.

SUDAN GOVERNMENT

Applications are invited for the appointment of a LECTURER IN AGRICULTURAL CHEMISTRY in the School of Agriculture near Khartoum.

Candidates should be between 23 and 27 years of age. They should possess an honours degree in Chemistry and a sound Agricultural background or a good degree in Agriculture with specialization in Chemistry. Teaching experience will be an additional recommendation. The post is pensionable after a two years' probationary period. The starting salary is £E.480 to £E.600 per annum according to age and qualifications, normally rising by biennial increments to a maximum of £E.1,080 after 18 years' service. (£E.1=£1 0s. 6d.)

Application forms and further particulars may be obtained from the Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1, to whom applications should be submitted not later than April 25, 1940. Envelopes should be marked "Lecturer, A.C."

UNIVERSITY OF GLASGOW

LECTURESHIP IN PHYSICS

Applications are invited for the post of Lecturer (Grade IIb) in the Department of Applied Physics as from October 1, 1940. Salary scale £400—£480. Further particulars may be obtained from the undersigned, with whom applications (five copies), together with copies of not more than two recent testimonials and the names of referees, should be lodged not later than April 30, 1940.

ROBT. BROUGH,
Acting Secretary of University Court.

COUNTY BOROUGH OF BURNLEY

EDUCATION COMMITTEE

BURNLEY MUNICIPAL COLLEGE

Applications are invited for the position of Principal of the Burnley Municipal College. Candidates will be required to possess a Good Honours Degree in Pure Science and have had good teaching experience and experience in the organization of Technical Education. Salary £750 to £800 per annum, according to qualifications and experience. The person appointed will be required to take up duties on September 1, 1940.

Further particulars, together with Application Form, will be forwarded (on receipt of a stamped addressed foolscap envelope) by the Director of Education, Education Offices, Burnley, to whom completed applications must be returned not later than Friday, April 26, 1940.

Canvassing either directly or indirectly will be deemed a disqualification.

ARCHIBALD GLEN,
Town Clerk and Clerk to the Local Education Authority.

Town Hall, Burnley.
April, 1940.

THE BRITISH BOOT, SHOE AND ALLIED TRADES RESEARCH ASSOCIATION

Technical Assistant and Instrument Maker required. Salary according to qualifications and experience. Applications with references and copies of testimonials to be sent to The Director of Research, 185 Park Road, Chiswick, London, W.4.

Librarian required for duties in Special Library

attached to Research Department of a firm of metal manufacturers. Candidates should apply to Box 704, T. G. Scott & Son, Ltd., 63 Ludgate Hill, E.C.4, giving particulars of qualifications in librarianship, linguistic abilities, scientific qualifications, age and salary required.

Wanted. Lamp for Zeiss Pulfrich Photometer.

—Box 705, T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4.

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN CO., 60-62 Fifth Avenue, New York—Saturday, April 13, 1940.