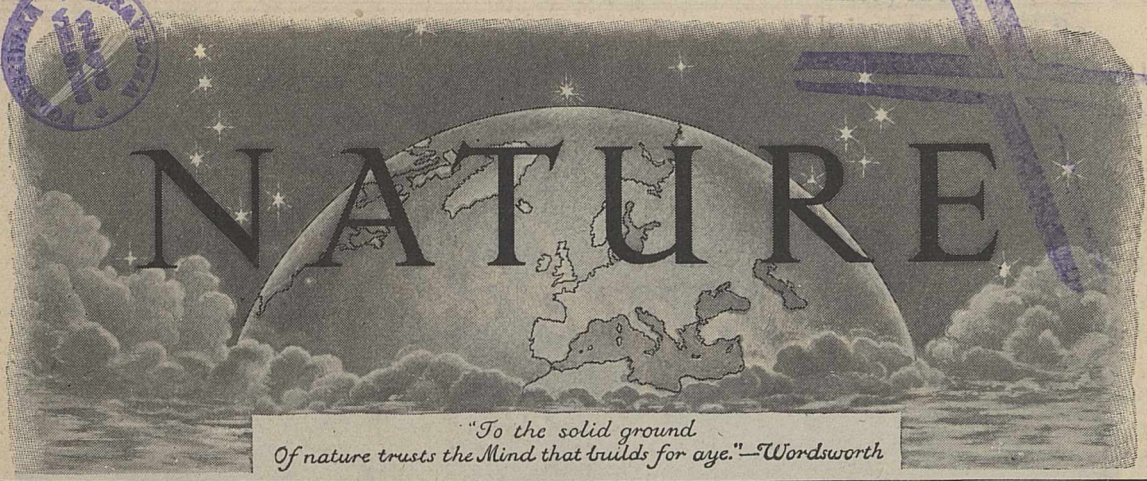

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NATURE

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PROGRESS TO PARTNERSHIP IN COLONIAL DEVELOPMENT

THE value of the Middle East Supply Centre and its potentialities have recently been discussed in these columns, and the contribution which regionalism might make to the solution of colonial problems in the field of welfare and economics appears to be gaining wider appreciation. Nevertheless, there has recently been disturbing evidence of unilateralism, and absence of forethought or of desire to co-ordinate American policy with that of Great Britain in the area which the Centre covers. The essential point is well made in an article entitled "Caribbean Laboratory" by Mr. J. M. Jones in the February issue of the American periodical *Fortune*. Colonial Powers, Mr. Jones observes, must now accept the increasing and legitimate interest of other nations in the welfare of dependent peoples; Americans must learn that helping other nations is not merely a matter of spending money and giving self-government, but also involves achieving trust and respect, the imparting of cultural standards and traditions, and the patient and self-sacrificing work of colonial servants over a long period of years. That is the basis of collaboration and of constructive criticism. Mr. Jones's review of British colonial policy in the West Indies and of Anglo-American co-operation in the Caribbean leads him to welcome and foreshadow, first the gradual extension of responsibility for dependent areas from the single Power exercising administration to the international society represented by regional commissions; secondly, the bringing together of dependent peoples themselves in regions where a community of need or interests exists to help each other in the attack on common problems.

Already it is clear that only an organization on the lines of the Middle East Supply Centre offers any prospect of securing the regional co-operation which is essential for effective development in that area. Unilateral action tends to provoke political difficulties even when it possesses the resources to achieve its limited purpose. The *Fortune* article may therefore be welcomed as evidence of a responsible point of view in the United States, and that at least some support will be forthcoming for the use for post-war purposes of effective instruments shaped primarily to serve war-time ends. The oil conference which began in Washington on April 16 may also promote confidence. The seconding of Dr. B. A. Keen and Dr. E. B. Worthington as joint scientific advisers to the Middle East Supply Centre to undertake a survey of scientific problems of the Middle East, from Libya to Persia and from Syria to the Sudan, indicates the importance attached by the British Government to the Centre as well as to scientific work overseas. The appointments should at least rouse further interest among scientific workers in these regional developments, the potentialities of which are as yet not widely appreciated.

It should not be thought, however, that obstacles to such developments are to be found in the United

States alone. Lord Cranborne, it is true, in a statement in the House of Lords, has indicated that the British Government would welcome collaborative and consultative machinery to facilitate the solution of problems which transcend the boundaries of political units in appropriate areas. This statement, which may well be an indirect reply to General Smuts' explosive thoughts on the new world last November, to some extent discounts the reluctance of the Government to commit itself in statements regarding the future of the Middle East Supply Centre. Moreover, there is nothing in the *Fortune* article which is at issue with the principle firmly maintained by Lord Hailey in his lectures at Princeton University in February 1943, which have now been published under the title "The Future of the Colonial Peoples" (Oxford University Press. Issued under the auspices of the Royal Institute of International Affairs. 1943. 3*s*. 6*d*.), that administrative responsibility must be undivided. The willingness or eagerness of the Colonial Power exercising administrative responsibility to govern and develop its dependent territories in accordance with the outlook and spirit of the international community does not, and should not, mean divided administrative responsibility.

It is not only in the Caribbean and in the Middle East that British colonial policy during the War has earned the sympathy and co-operation of the United States. "Mass Education in African Society", issued by the Advisory Committee on Education in the Colonies early this year (see NATURE, May 20, p. 606), indicates an outlook which is an immeasurable advance on the views of even two or three decades ago. Recognizing that the most formidable obstacle to development in Africa is illiteracy, the report argues that the problem must be attacked by the means, and on the scale, adopted in the U.S.S.R., China and Turkey. The evils and injustices which have to be overcome in Africa demand leadership, co-operation and an informed and intelligent public spirit. Co-operation, the active participation of Africans in the administration of their own country and the execution of great schemes of social reform are impossible if the community remains illiterate.

Education and social welfare must go hand in hand; and as Turkey has combined mass education with the organization of rural industries, so we may use it to meet the need, which Lord Hailey has emphasized, for greater specialization in African rural economy. By the measures indicated in the report, including the wide extension of schooling for children, with the goal of universal school within a measurable time, the spread of literacy among adults, together with the development of literature and libraries, the planning of mass education within the community as a movement of the community itself, involving the active support of the local community from the start, and the effective co-ordination of welfare plans and mass education plans so that they form a comprehensive and balanced whole, the report believes that proposals could be advanced for eliminating illiteracy within the next two or three decades.

With the details of the task ahead so ably delineated in the annexure to this report we are not concerned here, but the spirit and outlook of the whole document should compel tribute from even the severest critics of British Colonial policy. The note of urgency is rightly struck, for the next stage of partnership with the Colonial peoples cannot follow that of trusteeship unless and until those peoples are given every opportunity of equipping themselves to take their full place in the modern world. Moreover, this may well demand as generous provision of finance as schemes already under consideration for welfare and development. If mass education and welfare plans are in fact to be comprehensive, balanced and co-ordinated, there must be full understanding on the part of the citizens of Great Britain; for the responsibility of finding the necessary financial assistance will fall on them.

The case so ably argued in this report deserves to be made known as widely as possible, and it is the more important that public opinion in Great Britain should awake to the opportunity. The French Committee of National Liberation is considering a number of recommendations on French Colonial problems coming from a conference held at Brazzaville. These proposals also would handle public health and education in a large and generous spirit. They call, for example, for mass treatment of malaria and more preventive measures. A central school for medicine with a well-organized mobile service would demand an addition of 700 French and 1,800 African medical men.

Nor is it only in such fields as these that friendly emulation should arouse a wider and deeper public interest in Great Britain in Colonial affairs. When we are seeking with Lord Hailey to transform our relationship to the dependencies from that of trusteeship to that of partnership, it must be recognized that there are parts of the Empire where, in spite of specific pledges, the term trusteeship can scarcely be used to describe the spirit of our policy. Of these Kenya is a striking example, and uneasiness, not to say dissatisfaction, has repeatedly been expressed in both Houses of Parliament on this question. It is not too much to say that in Kenya the disparity in the treatment of the rights of the settlers and the rights of the indigenous population has become a matter of grave concern. That is attested by the studies in Lord Hailey's "African Survey" and by Sir Alan Pim's report on the financial position of Kenya quite as fully as in the less dispassionate publication of the Fabian Society, "Kenya: White Man's Country?" (Research Series No. 78). The Colonial Office is studying plans for remedying this neglect, which it is understood would provide for expenditure under the Colonial Development and Welfare Act on such objects as housing for Africans and the improvement of hospital and school accommodation. The Fabian Society paper welcomes such measures, but urges improvement both in the labour legislation and administration of the Colony—matters on which the recent International Labour Conference may be expected to have some beneficial effect.

There is substantial support for the view that white settlement in Kenya should never have been encouraged; but the termination of existing white settlement is rightly dismissed by the Fabian Society

report as not practical politics. On the other hand, the maintenance or extension, by fresh settlement, of the present privileged position of the European settlers is firmly opposed, and a programme for the political and economic advance of the population of Kenya as a whole is advocated as the most reasonable policy. This will involve various development schemes, as well as attention to the whole question of industrialization and the provision of transport, political representation of Africans and the abolition of all discrimination in favour of non-Africans regarding land occupation and tenure, backed up by vigorous attention to soil conservation, agricultural improvement and the like.

This report to the Fabian Colonial Bureau is a reminder that it will not always be possible to avoid political issues in dealing with Colonial problems. Much can be done, however, to make the political difficulties less acute by appropriate action in technical fields. Therein lies, in fact, one of the greatest hopes of a real contribution from such regional experiments as the Middle East Supply Centre to the solution of particular and dangerous political problems. The recent conferences organized by the Middle East Supply Centre, particularly the Agricultural Conference in Cairo, have shown, for example, that Jews and Arabs can come together to discuss schemes of regional development. Joint plans for raising the standard of living of Jew and Arab alike might go far to eliminate distrust and friction, while war-time experiments in the production of chemicals, plastics and rubber from industrial crops may stimulate the growth of a new technical and professional class in each community, with interests in common. This should still further assist participation in regional development schemes and provide wider possibilities of economic and political co-operation.

What is required is that the opportunities which are opened up for statesmanship should be realized and grasped. In Palestine, for example, there are possibilities of dealing with the difficult racial problem on wider lines in association with a Syrian Federation and with regional economic development in the Middle East. The West Indies Conference which opened at Barbados on March 13, when for the first time representatives of the Caribbean possessions of Britain and the United States met to discuss their common problems and work out a co-operative programme of action, has similarly indicated possibilities of Anglo-American co-operation which, if used with imagination and wisdom, may profoundly influence future world organization. Again, the present position affords us a great opportunity of putting Kenya on a sounder basis, both by large social reform and also by increasing African representation on governing and administrative bodies. There is much to be said for sending to East Africa a commission to do there what the Stockdale Commission did in the West Indies.

Whether or not such a measure be adopted, a report issued for consideration at the International Labour Conference entitled "Minimum Standards of Social Policy in Dependent Territories" will assuredly enforce reconsideration of British policy and administration in Kenya and elsewhere. No one document has put better than this report in its opening chapter the implications and possibilities of recent regional developments, and shown how successive steps such as the establishment of the Anglo-American Caribbean Commission, the Middle East Supply Centre and more recently the Agreement of January 21, 1944, between the Governments of Australia and New Zealand, envisaging the establishment of a South Seas Regional Commission, make one pattern.

The chief strands in this pattern are becoming clearer. They include a heightened conception of responsibility and an increased tempo in the development of self-government, closer relations between the dependencies and other interests in the different regions, and growing recognition that a main aim of policy should be the establishment of freedom from want; increasing co-ordination of economic and social programmes; a wider conception of social policy to include educational, public health and labour reforms; the establishment of new tropical industries and diversification of tropical agricultural production. The remoteness of tropical regions may well largely disappear through the development of air transport, but it is clear already that, apart from the world interest in security and welfare, these matters affect more than the Colonial Powers directly responsible for the administration of the separate territories.

It seems that, making allowances for local exceptions, the general economic foundations of social progress in dependent territories will be the development of the existing primary industries, supplemented by secondary industries concerned largely with processing primary products and providing elementary needs. Peasant development involves special difficulties, such as land tenure, where the spirit in which policy is administered is important. Again, there is the disputed question of compulsion for educational purposes or in the general interest of the country, and thirdly, the general problem of increasing the welfare of the peasant cultivator, not only by improving his methods but also by organizing the supplementary economic activities which he is not able to provide for himself.

Once again in this report we find the importance of education is stressed, particularly with reference to the evolution of self-reliance in social policy, the development of an individual and communal sense of informed responsibility, and of effective organs of consultation and collaboration. For the latter purpose the establishment of boards to deal with the co-ordination of social policy is suggested, and as a feature of regional technical collaboration the use of regional labour conferences. The main proposal of the report is that the appropriate authorities should examine the advisability of accepting certain fundamental principles of social policy in dependent territories and of providing for the extension and development of international minimum standards to such territories. A draft of such standards is included for submission by international agreement to the authorities concerned with a view to their application to dependent territories. These standards might also

serve as the principles subject to which the financing of developments in under-developed territories might operate.

In the territories where the present Colonial Powers retain direct control over labour and social policy, the fundamental principles formulated in this report should serve without difficulty as a basis of policy. If they are to apply to territories with wide and growing powers of self-government, the association of the immediate governments of those territories and their organized employers and workers will be required. Every effort must indeed be made to obtain the effective collaboration of peoples now dependent, in the amplification and execution of all measures on which their progress and well-being depend. That is a main purpose of the mass education programme, as it is part of the technique for executing that programme. Besides this, a large amount of technical and indeed scientific collaboration will be involved, and it behoves all whose services may be required in such duties to do their utmost to take the problems of development into an atmosphere of dispassionate inquiry and disinterested service. In so doing they best promote the participation of the American people with us and other trustees of Colonial peoples in the patient but expensive work of establishing the adequate basis in economics and education which is essential before politically immature peoples can stand alone. The cool critical spirit of scientific inquiry is an indispensable factor in the collaboration by which alone we can realize the immense possibilities inherent in regional developments, and build a new Colonial order in which freedom from want and from fear are assured to all without distinction of race.

VESALIANA

A Bio-Bibliography of Andreas Vesalius

By Harvey Cushing. (Publication No. 6, Historical Library, Yale University Library.) Pp. xxxviii+230 + 86 plates. (New York: Schuman's, 1943.) 15 dollars.

ONE of the most remarkable developments of exact learning in recent years is the growth of an interest in the history of medicine and science which has shot up in the United States of America. It started almost from nothing, and with bibliographical resources wholly inadequate for detailed and accurate studies. The two Americans who stand out before all others in this movement are William Osler and Harvey Cushing—the former, it is true, of Canadian birth, but none the less an adopted and loyal son of the United States. Both must have been born with the love of books in the blood, and, having achieved eminent success in an opulent profession, they were able to impart a new and sustained impetus to the steady flow from Europe to America of the rarest and most expensive books in medicine and science.

Both Osler and Cushing were gifted with an impelling and charming personality, and succeeded almost without effort in communicating to others their own enthusiasm for the old masters. Like Prince Florizel of Bohemia, they gained the affection of all by the seduction of their manner and by a well-considered generosity. When Osler found himself in possession of six exemplars of the first edition of the "Fabrica", besides those already in his library, he offered copies to two institutions which as it happened possessed much better ones *presented by himself*! To those who knew Cushing only in his mature years, it comes as a shock to learn of a time when there were "cobwebs in the purse", and when a new purchase had to be smuggled into the house by the back door. But in later years he never considered the cost when there was a prospect of closing a vital gap in the library, and if sometimes he was inveigled into paying £50 for a book which should have cost him 50*s*., he at all events got what he wanted. He was, however, by no means the only American intent on acquiring the classics of medicine and science. There were many other costly private libraries in the making, and, as they grew, so the work of American historical scholars reached a degree of excellence which it would be presumptuous to praise. In one respect, however, these activities are by no means grateful to their European brethren, since America is clearly answerable for the astronomical prices which booksellers are now demanding, and presumably getting, for the older literature. For example, in my younger days I paid 50*s*. for an excellent copy of the first folio edition of the Parisian Memoires, but to-day the same bookseller is asking £75 for it, and the first edition of Harvey on the circulation has progressed from 4*s*. 6*d*. to £800!

The methods adopted by Osler and Cushing in building up their famous libraries were similar and effective. The books were personally hunted down in the collections and bookshops of Europe, the booksellers of which quickly discovered what America needed and made it their business to supply it. As Osler remarked on one of these forays: "I have bagged two 1543 Fabricas. 'Tis not a work to be left on the shelves of a bookseller. . . . We cannot have too many copies in America." The Surgeon-General's Library at Washington is the most complete and best catalogued collection of books of its kind in the world, and if we add to it the numerous private and public scientific libraries, it will be evident that the American student of the history of medicine and science is, from a bibliographical point of view, in an exceedingly strong position. For example, the stately new library of Yale University now houses collections of the earlier literature of the highest importance and value.

As we learn from Prof. Fulton, Cushing spent the last year of his life in preparing the present work for the press. For more than forty years he had been interested in Vesalius, and for the last twenty he had been collecting material for his book, the writing of which was still claiming his unremitting attention until within a few days of his death. The introduction and first five chapters had been completed, two others were planned, but the last three were untouched. "Had he lived a few months longer, he would, no doubt, have finished the work to his own satisfaction." These finishing touches, however, have been faithfully supplied by Prof. J. F. Fulton, Dr. W. W. Francis and Dr. A. Castiglioni. In the completed work the introductory matter includes Cushing's delightful personal "Apologia", a short sketch of the time and circumstances which led to the composition of Vesalius's works, the relations between Vesalius and his illustrator Calcar, and Cardan's horoscope of Vesalius. Chapter 1 deals with

Vesalius's degree thesis—"The Paraphrase of the Ninth Book of Rhazes"; Chapter 2 with the "Tabulæ Sex"; Chapter 3 with Vesalius's edition of Guenther's "Institutiones Anatomicæ"; Chapter 4 with the venesection epistle; Chapter 5 with Vesalius's contribution to the "Opera Galeni"; Chapter 6 with the "Fabrica" and its sequelæ; Chapter 7 with the China-root epistle and the aftermath of the "Fabrica"; Chapter 8 with Vesalius as a consulting physician; and Chapter 9 with the Fallopius–Vesalius controversy. Chapter 10 is a valuable bibliography of Vesaliana, which is followed by an index of recorded copies, a chronology of editions, and an index of names.

Cushing's conception of what a bibliography should be was emphatically the right one. To him a book like the "Fabrica" of Vesalius was a living influence, and to dismiss it in arid records of dates and collations did violence to his artistic sense and penetrating imagination. Consequently he discusses the details and circumstances of its printing and illustration, the methods of publication and the wiles of publishers, the unblushing operations of the plagiarists, and above all the environment in which the book was conceived, and its influence on contemporary and posterior thought. He even tells us how, when, and at what cost he acquired his own copies. All this results in the production, not of a reference book which is promptly relegated to the shelves, but of a scholarly human treatise which can be read.

The most valuable sections of the work are the chapters on the few and rare fugitive sheets known as the "Tabulæ Sex", on the "Fabrica", and on the more popular "Epitome". It is doubtful whether any private or public library rivals Cushing's collection of Vesaliana, and he could hence pursue his studies at home with but occasional extraneous intervals. The bibliographical details which are given will be indispensable to students of Vesalius and librarians generally, not to mention the specialist booksellers. Cushing bequeathed his books to his old University, and Prof. Fulton has now added his own collection, so that Yale can offer almost unique facilities to those who wish to undertake historical researches in America. In this connexion two observations and an anecdote which are related by Cushing in this work may be recalled. History, he remarks, "has proved a solace for many of us in our later years"; and again, "the Fabrica has probably been more admired and less read than any publication of equal significance in the history of science". Now the anecdote: in 1914 Cushing and Streeter decided to celebrate the quatercentenary of the birth of Vesalius by an exhibit at the spring meeting of the American Medical Association. "For this purpose," he says, "we were allotted a booth and had a small pamphlet printed with a description of the books we had selected for display. It aroused little if any interest. We had arranged to alternate as showmen, Streeter in the morning hours, I in the afternoon. We met at lunch after the first morning and on my enquiring 'How did it go?' he replied, 'Well, only one old codger stopped long enough to read the sign VESALIAN EXHIBIT and said, 'Got any samples?' Streeter asked 'Samples of what?' He pointed to the sign and said, 'Samples of 'Vaseline', of course'. Sadder and wiser we returned to Boston with our 'samples' at the end of the week."

It only remains to add that this memorial to a great European is also a memorial to a distinguished and beloved American. It has been beautifully produced by the publisher, Henry Schuman.

F. J. COLE.

AMERICA A CENTURY AGO

Mirror for Americans

Likeness of the Eastern Seaboard, 1810. By Prof. Ralph H. Brown. (American Geographical Society Special Publication No. 27.) Pp. xxxii+312. (New York: American Geographical Society, 1943.)

THIS work is, in its author's words, "intended as a short cut to an understanding of American geography in 1810". It is compiled from a great variety of sources and is written in the style of the period it portrays. Its author is to be warmly congratulated on his skill and his imagination: the former has produced an admirable account of the historical geography of the eastern seaboard in or about the year 1810; the latter has invented a character, Thomas Pownall Keystone, who tells the story "which he might have written and illustrated" through the medium of Prof. Ralph H. Brown.

The work covers every field of activity and enables us to see, in their early stages, some of the fundamental questions that have been presented to the Republic. Was the climate changing and had it changed? Some, relying on earlier accounts of the country, said it had. Others, from scientific examination, argued that increasing cultivation led to less severe winters but "more inconstant, variable, and unsteady weather". One scientific worker maintained there had been no change. In a note Prof. Brown remarks: "the question of climatic change . . . pervades the entire literature of this period".

What population could this new country support? Some took the gloomy view, and put the limit at ten millions. Others optimistically predicted a population of eighty millions in 1876—a figure of thirty millions more than was attained. One writer foretold a population of 860 millions in 1946! These speculations were natural in view of the rapid growth of population at the beginning of the last century, largely through a great excess of births over deaths. But already the problems of this population were showing themselves. The Negroes were increasing both relatively and through the continued import of slaves and had already become a 'problem' in Virginia, where in parts there were "more blacks and even more slaves than free white persons". One Virginian contrasted this evil "which is now so thoroughly incorporated" with the happy state of New England, where the problem scarcely existed.

Much of this book is taken up with detailed accounts of means of communication, occupations, trade and industry and with regional accounts of various parts of the seaboard. Each chapter has its particular interest, too detailed for quotation in a short notice; such as coastal erosion at Cape Cod; the beginnings of the textile industry in the northern States; the spread of settlement westward in New York State; the commercial interest in Florida, then "little better than a wilderness" and still a Spanish possession; the industrial future of Pennsylvania, delayed only by "the difficulties of transportation and the prejudices of the people"; and the planning of the lay-out of some of the cities of the east. Dominating all is the story of the subjugation of a country by human enterprise shown in a great variety of ways. The continent was one of possibility: the population of the eastern seaboard was exploring and exploiting the immediate possibilities and, when tempted by land speculators or roused by curiosity, or even impelled by its growing numbers, was pressing westward to sample the wealth of an almost unknown

interior. This last region was, however, largely a blank on the maps in the mythical library of "Thomas P. Keystone, Esq." and is not discussed in this book.

This fascinating story is illustrated by a number of contemporary maps, plans and views, and Prof. Brown has added a select bibliography and many useful notes. The book is issued by the American Geographical Society and more than maintains the high standard of its publications.

J. N. L. BAKER.

PRACTICAL PHYSICAL CHEMISTRY

Physico-Chemical Methods

By Prof. Joseph Reilly and Prof. William Norman Rae. Fourth edition, revised. Vol. 1. Pp. ix+610. Vol. 2. Pp. vii+586. (London: Methuen and Co., Ltd., 1943.) 2 vols., 84*s*. net.

THE fact that another edition of "Reilly and Rae" has been called for after a lapse of only three years —abnormal years from the academic point of view—is adequate testimony to the usefulness of this comprehensive work on practical physical chemistry. A complete revision would have been impossible, but the authors have managed to prune out a good deal of material more suited to an introductory text than to an advanced treatise. Simultaneously they have introduced new matter by adding the necessary pages under a decimal system of pagination; the original pagination thereby being preserved. It is to be hoped that this war-time measure will disappear when conditions permit. The whole work tends to grow, for another volume is promised, dealing particularly with gas analysis, microanalysis and related topics.

Space prevents mention of all the additional matter, but the authors have lost no opportunity of introducing methods of recent origin; for example, in volume 1 Emmett's method for the determination of the specific surface of sub-microscopic particles, high-speed stirring equipment, data on the properties of laboratory glasses, the latest apparatus for hydrogenation and new photographic techniques and sensitive materials. Previous gaps have been filled by the inclusion of new sections on the graphical representation of three-component systems, thermocouples and thermopiles, and on the determination of the specific heats of liquids. Similarly, in volume 2 there are innumerable additions. Gas analysis is an ever-expanding technique, while distillation naturally assumes an important place with appropriate additions to an already complete chapter. There is an especially interesting and valuable section on microdiffusion in liquid systems. Brief mention is made of the technique of growing large crystals and of some of the applications. A few pages are devoted to the air-driven ultracentrifuge, but the oil-driven type is only mentioned in passing. Although some small additions are made to the chapter on adsorption, the necessary expanded treatment is reserved for the third volume. A similar arrangement is made for the electron microscope. The glass electrode and the measurement of the dielectric properties of solids both come in for some revision. There is only a small point of criticism. A few of the diagrams could be better drawn in order to be worthy of the work as a whole.

In a comprehensive book of this character, it is presumed that every topic having a bearing on physical chemistry must be described. To follow such a presumption leads to difficulties, for in some directions the techniques have become so highly specialized as to be unsuitable for inclusion in this kind of manual. They require to be treated by a specialist in a separate monograph; for example, the ultracentrifuge, electron microscope, infra-red spectroscopy, X-ray crystal analysis and radioactive technique come into this category. While the omission of these topics might leave the impression of incompleteness, no physical chemist would reasonably object, since standard works on these subjects exist. The real function of the volumes under review is to bring together all the multiplicity of techniques, methods and appliances used in modern physical chemistry, but often unknown to, or undiscovered by, those practising the subject. "Reilly and Rae" already fulfils this function, and it is hoped will continue to do so in an even greater measure with the promised appearance of a third volume to complete the work.

H. W. MELVILLE.

THE EXTRUSION OF METALS

The Extrusion of Metals

By Claude E. Pearson. Pp. viii+205+37 plates. (London: Chapman and Hall, Ltd., 1944.) 18*s*. net.

IT is not a little surprising that an important industrial process, well over a hundred years old, should have had to wait until now for an author. Particularly is this the case where the process is one which has shown such marked advances as has extrusion during the past twenty or thirty years. Starting as a means of forming lead pipes, it is now a method of working metals which is of first-rate importance, and its potentialities, so far from being exhausted, may result in its serious incursion in the comparatively near future from the realm of non-ferrous metallurgy into that of the steels.

In this little volume the author gives a general survey of the whole field, theoretical as well as practical. The treatment is well balanced, and the information, collected from many sources, is clearly and impartially discussed. It is, however, more or less of an introduction to the study of extrusion, and to those already familiar with the process and the materials to which it is applicable, there will not be much which is unknown.

How much now remains to be investigated is shown by the wide gaps which still exist in our knowledge of the nature of the flow of the metal and the stresses required to effect it. The shape and contour of the die, for example, a matter to which the wire-drawer has for long devoted most careful consideration, receives only the most general treatment, although it must have a profound influence upon the ease with which the process is carried out. In this connexion, too, it may be pointed out that equation (8) on p. 125, in which the die angle is introduced, is similar to one proposed for wire-drawing, where its predictions are by no means entirely in accord with experimental results.

As a general introduction to its subject, this book is good; in its implications of the large field of work still demanding attention, it will be of real service to the research worker, but one puts it down with the impression that a process of such immediate importance and with such immense possibilities of expansion deserves a more comprehensive and detailed treatment than it has yet received.

F. C. THOMPSON.

Elementary Morphology and Physiology for Medical Students

A Guide for the First Year and a Stepping-stone to the Second. By Dr. J. H. Woodger. Third edition. Pp. xvi+522. (London: Oxford University Press, 1943.) 15*s*. net.

FIRST published in 1924 this text-book has now passed into its third edition, a fact which testifies to its usefulness. The book has been thoroughly revised and an additional chapter on insects, with *Periplaneta americana* chosen as the type, has been included. The revision has been well carried out on the whole, and this has involved some of the illustrations as well as the text, but it is a pity that the account of mitosis was not more completely rewritten and not simply left as the traditional account with a note that it requires modification in the light of recent observations.

The book differs from many of the text-books for medical students in that it assumes the use of other practical texts for the acquisition of factual knowledge; the author rightly observes that no book can replace personal observation. This does not imply that the treatment of morphological facts is omitted; they are indeed well treated, but the emphasis laid upon them is not so marked, and more attention is paid to what, for the want of a better term, may be called theoretical aspects. In order to do this satisfactorily the author has found it necessary to go outside the actual types laid down in the examination syllabus; for example, the interesting chapter on the primitive Amphibia and the reptiles, to give an idea of the history of the origin of the mammals. The result is that the reader will obtain a rather wider outlook on matters zoological. Perhaps one of the most important sections from this point of view is the chapter on theoretical biology and the methods of science, and the student would be well advised to read this carefully and consider its applications to all his work. The text and illustrations are well done, and the volume is deserving of commendation.

Ultra-fine Structure of Coals and Coke

Proceedings of a Conference held at the Royal Institution, London, June 24th and 25th, 1943, by the British Coal Utilisation Research Association. Pp. 366. (London: H. K. Lewis and Co., Ltd., 1944.) 25*s*. net.

A CONFERENCE on the structure of coal was held in London on June 24–25, 1943, and the present volume is an account of its proceedings. It comprises a set of scientific papers together with discussions of their contents and forms a valuable book of reference for those who study coals and cokes.

It can scarcely, however, be regarded as a book of reference for facts, since the general impression given is of the lack of knowledge about the subject. This is evidenced by the number of theories put forward by the various investigators and by the, at times, rather impatient tone of the discussion. While this state of mind is probably inevitable at the beginning of a new subject—as the scientific study of coal undoubtedly is—one feels that more receptive states of mind would be a happier augury for the future.

On the other hand, the promoters of research are to be congratulated on their breadth of vision in applying new research tools. These include X-ray diffraction, electron microscopy, the measurement of the heat evolved in wetting by certain organic liquids, the measurement of magnetic anisotropy and infra-red spectroscopy. While none of the methods employed has given a complete answer to any of the problems raised, the integration of the results they are producing is bound to be informative. If, therefore, the present volume is regarded as a 'clearing house' for ideas it will have served its purpose. It would be interesting to see what a corresponding volume would contain if it were produced in, say, twenty years time. H. L.

The Biotic Provinces of North America

By Lee R. Dice. Pp. viii+78. (Ann Arbor, Mich.: University of Michigan Press, 1943.) 1·75 dollars.

BY recognizing a series of floras associated with definite areas in North America in 1830, C. Pickering laid the foundation of the biogeography of that area. This was added to in 1843 by R. B. Hinds but established on more or less modern lines in 1859 by J. G. Cooper, who recognized a series of regions to which geographical names were applied. Since that time a great deal of attention has been paid to this topic both in the broad sense of dividing North America as a whole and in the more detailed analysis of limited areas from the points of view of the distribution of plants or animals or the effects of climate.

Lee R. Dice has made the most recent contribution to this subject in the book under review, in which twenty-nine biotic provinces are recognized and a map showing them is provided. By biotic province the author means a continuous area of reasonable size that is characterized by one or more ecological associations that differ sufficiently from those of adjacent provinces to constitute an entity. In the absence of some striking geographical barrier it is obvious that one province may pass over into the next and so the position of the actual dividing line may be a matter of convenience or opinion. In view of their different natures, plants can be utilized more readily for such a purpose than the more mobile or even migratory animals. The author, whose contributions to the zoogeography of vertebrates are well known, has considered fully the previous work and so far as possible utilized in his terminology names that have been applied already, with the necessary redefinitions. It would be unfair to leave the impression that the book is merely a résumé of the work of others. He has himself studied the ecological associations and conditions in nearly all the provinces, and it is in his critical evaluation of these factors that the main value of this well-produced volume lies.

The American Land

Its History and its Uses. By William R. Van Dersal. Pp. xvi+215+65 plates. (London, New York and Toronto: Oxford University Press, 1943.) 21*s*. 6*d*. net.

IF a book can be classed as good when it fulfils a predefined object, then this book is good. The author has been fully impressed by the wealth and greatness of his own country, and in simple but logical diction has painted a canvas of distinction. Corn, wheat, barley, fruit, cotton, vegetables and subsidiaries are all there in detail, which is surprising, considering the simple terms used; and a series of excellent photographs makes for a well-balanced whole. As learning increases, so man's ability to absorb the whole of it decreases. The consequent era of specialization has created gaps in human knowledge which appear impossible of closure, and in a sense these gaps may be accounted a serious detriment. The real value of this book is as a stepping-stone across the break. D. CARPENTER.

HUMAN LIMITS IN FLIGHT*

By DR. BRYAN H. C. MATTHEWS, F.R.S.
R.A.F. Physiological Laboratory

A MODERN aircraft will climb in a few minutes to heights at which the air is so thin that it will no longer support life. It can turn and manœuvre so fast that the pilot may easily be rendered unconscious from the mechanical forces which it can impose on his body, and in an aircraft which is moving rapidly in three planes of space the pilot can be subjected to stresses beyond the limits which the human body can stand.

The adaptation of which the human body is capable to new surroundings and conditions can play a considerable part in fitting man to these new conditions; for example, airsickness which many suffer on first flying in rough air or doing aerobatics, in most people soon passes off and they become adapted to motions which at first perplex and incapacitate them; though a few never become completely adapted. But there are several stresses placed on man in aircraft that cannot be met by any unconscious adaptation, which require equipment specially designed to meet them. Some of the necessities are obvious, such as windscreens to protect the man from the enormous wind pressures at high speed and a heat supply from the engine and special clothing to keep him warm in the arctic cold of the stratosphere. His senses must be extended by a set of blind-flying instruments so that he may know his altitude and movement in space when in clouds or at night. He must learn to believe the instruments against his senses, for these are no longer a reliable guide when he may be moving at varying speeds in any direction—in fact, they will often be wrong. The human limit of visual range by day and especially by night is of paramount importance in flying.

But besides the stresses from wind pressure, cold, vibration and noise, the pilot's body must also be protected from other less obvious stresses, and here I propose dealing particularly with the two greatest stresses which an aircraft puts upon the pilot: those due to acceleration or rapid change of motion and those due to high flying in the rarefied air of the upper atmosphere.

In the last hundred years man has increased the speed at which he can travel more than tenfold, but there is no reason to suppose he is approaching any human limit in speed for, provided that he is protected from wind pressure by a closed cockpit and that the motion does not change rapidly in direction, there is no more mechanical stress on the pilot than if he were sitting on the ground.

If the human body is moving uniformly there is no force acting on it other than that due to gravity, recognized as weight. But when the motion changes in either magnitude or direction, large forces come into play; for example, while launching an aeroplane by catapult. During this linear acceleration, the pilot has the sensation of being driven backwards against his seat by forces equalling several times his own weight. This is seen in the retracting of the skin of his face, which bares the teeth like a snarling dog. In this case, the acceleration acts transversely on the body and lasts only a few seconds, and in this direction the pilot can easily withstand many times the acceleration of gravity provided his head and shoulders are well supported.

When a fast-moving aeroplane changes its direction and turns, aeroplane and pilot are both subjected to very large forces. The phenomenon known as blacking-out came into prominence in the Schneider Trophy races; pilots found that in turning at high speed their vision became blurred and that for a few seconds in the turn they frequently became blind. This is now a common event in aircraft and is well understood by fighter pilots.

When an aeroplane travels in a curved path in turning or pulling out of a dive, a large centrifugal force tends to force the aeroplane and pilot away from the centre of the circle. The magnitude of this force increases with the square of the speed and decreases as the radius increases. Subjectively, a pilot experiences a great increase in weight of all parts of his body as the centrifugal force tries to drive his body out through the bottom of the aeroplane. The magnitude of the acceleration acting on the pilot is expressed in terms of g, the force due to gravity normally acting on the body which causes it to have its normal weight. Thus in a turn producing $4g$ or four times the force of gravity, if the pilot's seat were fixed to a spring balance it would register four times his normal weight and the pilot and all parts of his body become extremely heavy. This is seen in the sagging of the soft part of the face which occurs in a tight turn (Figs. 1*a* and *b*). A turn at 300 miles per hour and 1,000 feet radius produces $6g$, and a pilot in effect weighs about half a ton and his blood virtually becomes as heavy as molten iron. The blood is normally being pumped to the pilot's head by his heart, but as its virtual weight increases, the heart has difficulty in maintaining the blood supply to the head. The brain and the eyes can only function for a few seconds without their normal blood supply, and loss of vision in blacking-out is due to failure of the circulation in the retina of the eye. If the acceleration is still greater, the whole blood supply of the brain fails and the pilot becomes unconscious.

Blacking-out is a warning that the blood pressure in the cerebral arteries is getting low. If the control column is eased forward, the aeroplane straightens out, the centrifugal force ceases and within a few seconds the circulation returns to normal. While this happens in the head the deficit of blood tends to gravitate to the legs, and the phenomenon can be regarded as the head losing blood to the feet.

This draining of the blood from the head takes time. The greater the acceleration the less the time that the pilot can retain his sight.

Many measures have been taken to reduce the effect of centrifugal force on the pilot; much may be done by posture and seating. If the pilot's attitude is crouched with his legs raised, the distance through which the heart has to raise the blood to his head can be reduced, and the loss of it to his feet is again less if the feet are high. Another method of lessening the effect of this force which may be mentioned is to place the pilot in the prone position. The heart and head are then nearly at the same height and a man in this position can withstand some $10g$, but this posture is a very fatiguing and inconvenient one for the control of an aircraft, though it is reminiscent of the very earliest aeroplanes in which the pilot frequently lay prone. The effect of posture on blacking-out is shown diagrammatically in Fig. 2.

The engineer has produced machines that are so strong and manœuvrable that they can subject the

* Friday evening discourse at the Royal Institution, delivered on June 11, 1943.

pilot to forces beyond his tolerance, and the useful limit in design for manœuvrability at high speed changes from being an engineering limit to being a human limit. It would be useless for the aircraft designer to produce an aeroplane so strong and manœuvrable that it could turn with a centrifugal acceleration of 20*g*, because the pilot would not be conscious to control it under these conditions; the ability to out-turn the enemy has an important tactical advantage in 'dog-fighting', but to achieve this it is now necessary to look to the man rather than the machine. Fig. 3 illustrates how the human limit makes it impossible for a fast aeroplane to follow a slow one in a tight turn; both pilots are subjected to 5*g*.

The most important stress, however, to which man is subjected in aircraft is that resulting from the thinness of the air at great altitudes. The air pressure at ground-level is 14·7 lb./sq. in. (Fig. 4), it has fallen to one half at 18,000 ft. and to less than one fifth, about $2\frac{3}{4}$ lb./sq. in., at 40,000 ft. The effects of altitude on man are those resulting from the lowered atmospheric pressure.

The disabilities which a man suffers at lowered pressure first came into prominence on the surface of the earth as 'mountain sickness'. Later the term 'balloon sickness' was given to the troubles experienced in high balloon ascents at the beginning of the last century; long before aeroplanes had become practical flying machines, the problems of high altitudes had been encountered, because early balloon ascents carried the balloonists to heights at which the air would scarcely support life, and at that time their knowledge of how to overcome this was lacking.

It is necessary to emphasize the difference between rapid ascent from ground-level, as in an aeroplane, and slow ascent in climbing mountains. In the latter case, weeks are spent at 15–18,000 ft. to become acclimatized to the thin air. Great changes occur throughout the climber's bodily processes which enable him to live at altitudes which are fatal to a 'sea-level' man. Acclimatization is soon lost on return to ground-level, so it is not possible to make much use of this in flying.

Climbers have reached 28,000 ft. on Mount Everest, but in contrast to this the first serious high-altitude accident occurred in 1875 when Tissandier with two companions went up in the hydrogen balloon *Zenith*. The balloon ascended to about 26,000 ft. and the occupants became unconscious; although they carried bags of oxygen they failed to make use of them. They became conscious again when the balloon descended to 20,000 ft. but then threw out ballast and the balloon rapidly ascended to about 28,000 ft. All became unconscious, and when Tissandier regained consciousness the balloon was at about 19,000 ft., descending rapidly, but his two companions were dead. This accident focused a great deal of attention on the physiological problems of altitude, and to investigate these Paul Bert constructed a steel chamber from which the air could be removed by a pump to simulate altitude conditions at ground-level. Since then a great deal of research has been carried out in such decompression chambers, on mountains, and in aircraft, on the nature of altitude sickness and the ways of overcoming it.

The R.A.F. Medical Service uses decompression chambers in which a man can be taken to a pressure equal to that at 30,000 ft. in less than a minute, and are capable of producing pressures down to a small fraction of a pound to the square inch.

For life, man needs food, water and air. He can live without food for weeks, without water for days,

Fig. 1*a*. MAN DURING STRAIGHT AND LEVEL FLIGHT.

Fig. 1*b*. IN A TIGHT TURN PRODUCING ACCELERATION OF $4\frac{1}{2}g$ 15 SECONDS LATER.

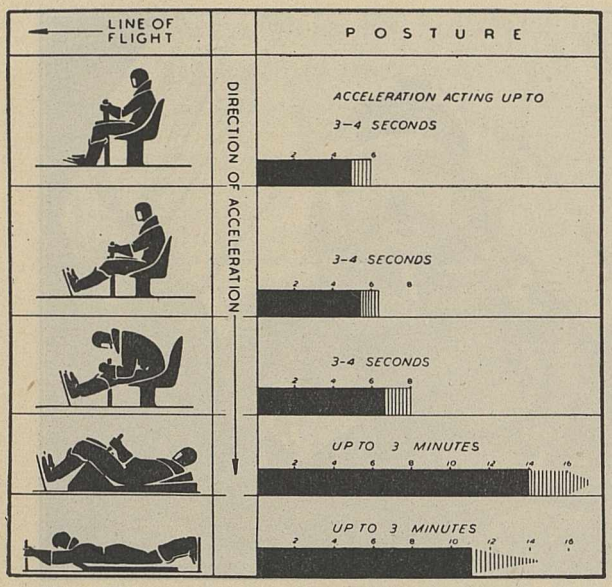

Fig. 2. EFFECT OF POSTURE ON THE TOLERANCE OF ACCELERATION. (DATA FROM RUFF.)

but without air he can survive only a few minutes.

At increasing altitudes, although the proportion of oxygen in the air remains one fifth, the density of the mixture becomes less, and a certain pressure of oxygen is essential for living cells to function normally. At an altitude of 42,000 ft., if the lungs are filled with air they contain less than one sixth of the normal quantity of oxygen, and this is insufficient to support life. Much of the Battle of Britain was carried out in an atmosphere in which a pilot unassisted with breathing apparatus would be dead in a few minutes. However, long before this height is reached, oxygen-lack makes its presence felt in the impaired intelligence and mental performance of the pilot. As oxygen-want comes on, judgment is lost, gross errors are made, intelligence fails, muscular control is lost and this may be followed by unconsciousness and death if the anoxia is severe. Moreover, oxygen-want is very insidious because the sufferer is often almost unaware of it. At 20,000 ft. a man without oxygen may do irrational things; oxygen-want resembles drunkenness both in its symptoms and in that the sufferer is confident that he is normal and much resents any suggestion to the contrary.

It would clearly be dangerous to send an aircraft up to 25,000 ft. unless it was ensured that the crew were protected from oxygen-want. Much research on the practical protection of flying personnel from the effects of altitude has been carried out by the R.A.F., particularly by the Medical Branch, which directs research in this very important side of the pilot's welfare. The importance of this is emphasized by the following true story of an incident which occurred over Germany. A pilot's breathing apparatus became disconnected, and the pilot thereupon told the crew that he was going to land. He put down his wheels and tried to land on a cloudbank at about 18,000 ft. He then told the crew over his intercommunication system that they were below ground-level and he was going to get out, whereupon the navigator, realizing what had happened, was in time to stop him climbing out of the machine, take over the controls and re-connect the pilot's breathing apparatus. It is easy to see that such an incident might not always have a happy ending. The effects of oxygen-want may often be extremely amusing, but clearly there is no place for such events in the dangerous and difficult work of high-altitude flying.

There are two ways in which altitude effects can be overcome. The first is to increase the amount of oxygen in the air which the pilot breathes by mixing oxygen from gas cylinders with it, thus giving the pilot a mixture rich in oxygen or even pure oxygen to breathe. In this way when the pressure is one quarter of an atmosphere at 33,000 ft., if his lungs are filled with pure oxygen he will not suffer from any symptoms of oxygen-lack. To this end the pilot always wears an oxygen mask, which also carries a microphone for his communication with the crew or ground.

The second alternative is to increase the amount of oxygen in the pilot's lungs by compressing the air in them. In an engine the loss of power from oxygen-lack is overcome by compressing the thin air with a supercharger; but it is not possible to supercharge the lungs so easily, as the pressures required would burst them. The pilot must therefore be completely surrounded by air at increased pressure. This can be done either with a pressure-suit something like a diving dress, or by sealing the cabin and making it strong enough to withstand a raised air pressure produced by a pump attached to the engine. The air around the pilot can then be kept at 14 lb./sq. in. and the atmosphere he breathes can be exactly like that at ground-level. However, it is clear that for military use such a pressure-cabin is very vulnerable, though for civil use it is the ideal method in high flying because the passenger is not inconvenienced by a mask on his face and need not be aware, by any change in the air pressure, that he has left the ground. Both alternatives are in use in civil airlines. The pressure-cabin has other advantages over the oxygen mask besides preventing lack of oxygen. At heights up to 36,000 ft. a man can avoid oxygen-lack by breathing pure oxygen, but above 44,000 ft., even breathing pure oxygen, he would become unconscious. Moreover, the vapour pressure of blood equals the atmospheric pressure at 63,000 ft., so if a man could reach this pressure his blood would boil and his lungs be filled with steam. At heights above 40,000 ft. it becomes necessary not only to breathe pure oxygen but also to increase the

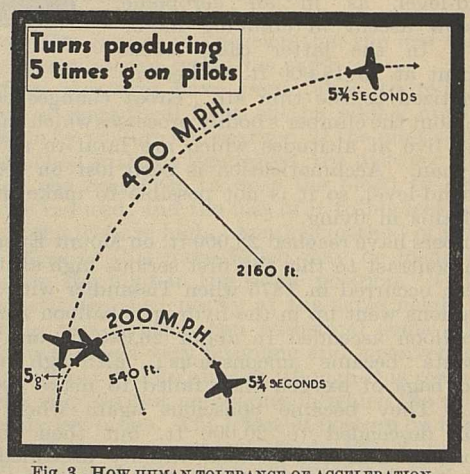

Fig. 3. HOW HUMAN TOLERANCE OF ACCELERATION MAKES IT IMPOSSIBLE FOR A FAST AEROPLANE TO FOLLOW A SLOW ONE IN A TIGHT TURN.

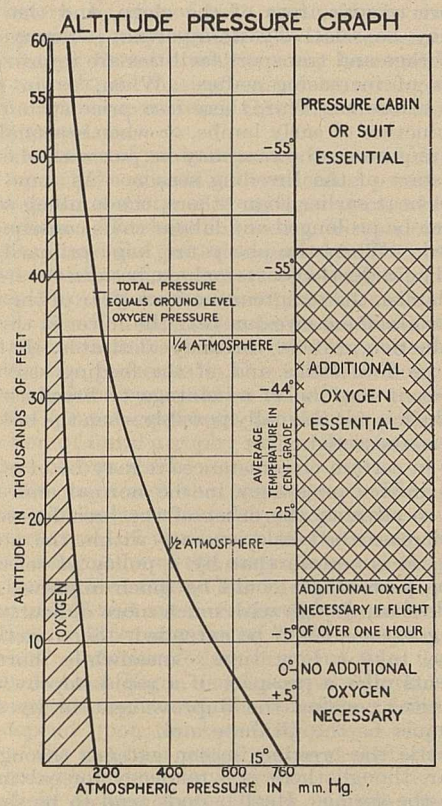

Fig. 4. RELATIONSHIP BETWEEN ALTITUDE AND ATMOSPHERIC PRESSURE (I.C.A.N. SCALE).

pressure acting on man. When Flight-Lieut. Adam broke the world's altitude record by reaching 54,000 ft. in 1937, he wore a pressure-suit which was blown up to some 2½ lb./sq. in. pressure and filled with pure oxygen. In it man could survive even in a vacuum. Thus the effects of oxygen-want can be completely overcome up to altitudes of some eight miles by breathing pure oxygen, and this is done in military aircraft of all nations. Above this height, pressure must be applied in addition. In the altitude record balloon ascents by Prof. Piccard and by the U.S. Army, closed gondolas at raised pressure were used.

Fig. 5 illustrates the time elapsing between cutting off the oxygen supply to a man and his becoming unconscious at various heights. From this it will be realized how quickly a pilot must act should his oxygen supply fail at high altitudes.

The physiological abnormalities at altitude are not entirely solved by breathing oxygen, as there are effects on the body at low pressure in addition to oxygen-lack. At ground-level the air pressure drives nitrogen into the blood which dissolves in appreciable quantity. If now the pressure on the man is rapidly reduced before this nitrogen can escape, it will form bubbles in his blood vessels and stop the circulation.

The possibility that bubbles might occur in animals at low pressures was envisaged in 1670 by Robert Boyle, who placed a viper under a bell-jar and pumped out the air; when the pressure was reduced he saw a bubble within the eye of the viper. Bubbles forming in the body fluids have long been a difficulty in deep diving where men have been subjected to much increased pressures of air. The body fluids then dissolve a large quantity of nitrogen, and if the diver comes to the surface too rapidly it cannot escape from his lungs in time to prevent bubbles forming, and he gets decompression sickness or 'bends' (caisson disease, compressed air illness), with severe pain, cramps, occasionally unconsciousness and even death. A diver can get severe bends coming up from a depth where the pressure is 4 atmospheres, to the surface where it is only 1 atmosphere, but fortunately an airman does not get into such serious difficulties if he goes from ground-level to one quarter ground-level pressure at 33,000 ft. Bends as they occur in the air are rarely experienced at altitudes below 25,000 ft. They come on slowly and are rarely of a serious nature. Unconsciousness can result if the warning symptoms of pain in the joints are neglected. The pains are cured almost instantly if descent is made to about 25,000 ft., where the air pressure compresses the bubbles sufficiently to drive them back into solution in the blood.

Much research has been carried out on men in decompression chambers to find ways of alleviating these effects. One method is to breathe pure oxygen before ascent so as to replace the nitrogen in the blood with oxygen. The oxygen is then used up in the tissues before it can form bubbles. This method has long been used to displace nitrogen from the blood while ascending from deep dives.

There are other disturbances to man with rapid changes of altitude resulting from the change in air pressure. The middle ear communicates through the eustachian canal with the throat and it is necessary for air to leave and enter it with ascent and descent lest the ear-drum be collapsed. The canal to the throat will normally open on swallowing, and in a dive a pilot clears his ears almost unconsciously; but should he fail to do so or have severe catarrh, he may damage his ear-drums. Enclosed gas elsewhere in the body, as in the sinuses surrounding the nose, has to equalize its pressure as the altitude changes or severe pain may result. Again, the gas normally present in the intestines expands to a larger and larger volume as the outside pressure falls when climbing, but this is rarely a serious practical problem.

Thus the human safety limit in height is some 10–16,000 ft. breathing air and 40–42,000 ft. breathing oxygen; heights much in excess of the latter are only achieved by enclosing the pilot in an artificial atmosphere.

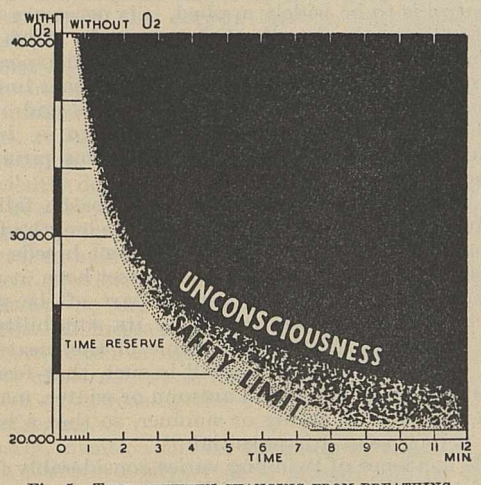

Fig. 5. TIME BETWEEN CHANGING FROM BREATHING OXYGEN TO BREATHING AIR AND THE OCCURRENCE OF UNCONSCIOUSNESS. (AFTER RUFF.)

It is clear that, starting with fit pilots on the ground, much must be done to keep them efficient in the air, and the efficiency of the man may often be of even greater importance than that of the machine.

In the Battle of Britain quality in men and machines overcame weight of numbers, and although always greatly outnumbered, the R.A.F. by efficiency and courage were able to rout the Luftwaffe. To maintain that efficiency in the air and at high altitudes is no mean problem. That it is done is the result of scientific research during the last seventy years into life at great altitudes, and the successful application of what has been discovered to the particular problems of the pilot. I should like this lecture to be considered a tribute to all those scientific men, from Paul Bert onwards, and to many officers of the R.A.F. who have contributed so much to the solution of high-altitude flying, and in particular to those medical officers who have lost their lives in this War in flying experiments.

CONTROL OF OVULATION IN FARM ANIMALS

By JOHN HAMMOND, JUN.
School of Agriculture, Cambridge

WHEN Cole and Miller[1] obtained ovulation in anœstrous sheep there was initiated a series of studies upon the application of gonadotrophins to the improvement of animal husbandry. It is the purpose of this article to sketch out the practical problems and the progress which has been made in overcoming them. It is not practicable to quote extensively, but many of the references to experimental work, upon which this account is based, are to be found in three papers in the *Journal of Agricultural Science*[2,3,4].

The nature of the control over ovulation which it may be desirable to exercise varies with the species and the economic circumstances. The problem may be to obtain matings outside the normal breeding season, or to improve fertility by increasing the number of ova shed at a normal heat, to regulate the interval between mating and ovulation, or to treat sterility due to cystic ovarian follicles. If a method of control is to be widely applied, it is necessary that the treatment be based upon materials which are available in large amounts and which are inexpensive to produce. Such preparations are at present limited to mare serum gonadotrophin, stilbœstrol and other synthetic œstrogens, and (available to a lesser extent) chorionic gonadotrophin and some pituitary extracts.

In the sheep, the natural breeding season falls in the autumn and winter months, but the length of the season varies considerably with different breeds, and in some, notably the merino and Dorset horn, it may extend over the whole or greater part of the year. The breed kept is determined by its suitability to local conditions, the relative value of the meat and wool crops, and, where rainfall is such that feeding conditions are good only in autumn or winter, mating has to be done in spring or summer, so that a breed with a long season is essential.

The incidence of twinning varies considerably from breed to breed; more especially it is low in the wool breeds. Specialized wool breeds are kept mainly in the more remote areas of the globe, and the lamb crop may be relatively unimportant; however, as meat storage and transport facilities are improved, it becomes of increasing value. When, as in Great Britain before the War, there is a price stimulus to the production of early lambs, or when seasonal conditions require it, the ram may be put with the ewes at the start of the breeding season. As some ewes come on heat earlier than others, the lambing season may then be prolonged and labour costs consequently increased. When the sheep are kept primarily for meat, the production costs include, besides the feeding of the lambs, the maintenance for a year of the ewes. The more lambs a ewe can rear the lower is the cost of production; it is certainly desirable that she should produce twins and, if the feeding stuffs are available, it may be of advantage to breed twice a year, which is not normally possible when the breeding season is restricted.

Thus in certain circumstances it may be of advantage to induce pregnancy in the normal anœstrous period, to advance the onset of the breeding season or to increase the ovulation rate within the normal season. It is certain that by a policy of selection, twinning percentages could be much improved, and probable that, though with much more difficulty, the breeding seasons could be extended. Such methods, however, take a long time; meanwhile, hormone treatments offer a prospect of a rapid improvement in practice, pending the improvement in livestock which must be the ultimate aim.

In cattle the breeding season extends throughout the year, though there is a tendency for calving to shift to the spring. Heat periods tend to be shorter and less well marked in the winter, and there are two types of anœstrus. In the first, ovulatory cycles continue, but heat is not manifested; in the second, a true anœstrus, ovulation ceases and only small follicles are present in the ovaries; the latter state is almost entirely restricted to young animals in the winter months and under hard feeding conditions. The incidence of twinning is low, on the average well under 2 per cent, and is much lower in beef than in dairy breeds.

For milk production, calvings have to be spread over the year, and to maintain the winter supply a larger proportion must calve in the autumn months. This implies service in winter, when the anœstrous condition is liable to develop. Sterility also causes large losses to the dairy industry, and a proportion of this is due to the formation of follicular cysts. Because in cattle the female twin to a male is usually a freemartin (imperfectly developed and sterile) twinning does not increase the number of animals which can be kept for breeding. In dairy cattle twins are not wanted, but in beef breeds they would be valuable for the same reason that applies to the mutton breeds of sheep. In areas where both beef and dairy cattle are kept, it is common for an extra calf to be bought for the cow to rear; however, the dairy-bred calf is a less efficient converter of feeding stuffs. In exclusively beef-producing areas there are, of course, no extra calves to buy.

The breeding season of the mare falls in spring and summer; persistence of anœstrus causes some difficulty, and some sterility is due to development of cystic follicles, which may be associated with spiteful behaviour. The most important feature is, however, the low proportion of services which are fertile; this is attributable to the length of œstrus relative to the survival time of sperm. Ovulation occurs about a

day before the end of heat, and early in the season heat periods may sometimes last several weeks. With heavy horses a stallion may be available only once a week, so mating cannot be arranged at the optimum time even when the time of ovulation can be estimated.

The number of goats kept has increased during the War; partly because of milk rationing, partly because of the great variety of roughages upon which they will subsist. The breeding season is restricted, as in the sheep, and the gestation period is five months, so the peak of lactation cannot, with normal mating, be arranged to fall in winter when the milk ration is lowest. Mention must also be made of the pig. No work appears to have been done on the control of reproductive processes in this species. A method of increasing fertility would be valuable in some breeds, but the proper approach to this is probably the reduction of fœtal atrophy rather than increasing the number of ova shed.

In the mare and the cow, the condition of the ovaries can be ascertained by palpation per rectum. The structure of the ovary in the mare does not permit recognition of the corpus luteum, except in its early formative stages; but in the cow it is easily distinguished and can be removed by pressure without difficulty. After expression of the corpus luteum, heat and ovulation follow in about four days, and the cycle thus begun is of normal length. In the other species mentioned, the condition of the ovaries will depend upon the breed, age, time of year and time of the last heat period; it is probable also that nutritive conditions considerably affect the amount of follicle development. There is little precise information on these points. Year-old sheep (Suffolk and Suffolk crosses) killed in Cambridge are usually found to have well-developed follicles at all times in anœstrus; isolated ovulations are occasionally observed. The state of the ovaries during lactation is not known.

Mare serum gonadotrophin and follicle-stimulating pituitary extracts will cause follicle growth, followed by ovulation, in anœstrous sheep. The first ovulation of the breeding season in sheep is not normally accompanied by heat, and this also applies to gonadotrophin-induced ovulation. Injection of mare serum gonadotrophin combined with artificial insemination may lead to pregnancy; but as yet this has been achieved in only a small proportion of the treated animals. The number of ovulations is normal and seems, except possibly for very high doses, to be unrelated to the amount of gonadotrophin given. Treatment with stilbœstrol and other œstrogens will cause heat, and in some cases, probably those animals with larger follicles, also leads to ovulation. When stilbœstrol and mare serum gonadotrophin are given together it appears the œstrogen may sometimes inhibit the ovulation which would be obtained with the gonadotrophin alone; often with œstrogen the time relationships of œstrus and ovulation have been such as to render fertilization improbable.

If a second follicle-stimulating treatment is given after an interval of about sixteen days (the normal cycle-length in sheep), heat and fertile service often follow. An induced ovulation is sometimes followed, a cycle later, by spontaneous ovulation together with heat. The difficulty may be encountered in the summer that the ram is not at all keen. The numbers coming on heat after a double treatment have, in trials, varied greatly from flock to flock and year to year; the proportion of services fertile is lower than in the breeding season. Results tend to be best with fifteen-month-old animals and poorest with suckling ewes. Much remains to be done before commercial application is possible.

The goat appears to differ from the sheep in that about half come on heat a few days after a single injection of mare serum gonadotrophin[5]; the proportion of services which are fertile is lower than in the breeding season. In anœstrous heifers, only small follicles are present in the ovary, and stilbœstrol does not induce ovulation, though, of course, it produces signs of heat. Mare serum gonadotrophin and horse pituitary have been found to cause follicle growth followed by ovulation in the majority of animals, though a small proportion fail to respond. Heat is not always shown and tends to be short and not well marked; in those served, the frequency of conception seems to approach the normal figure. In the mare, it is noteworthy that mare serum gonadotrophin, characteristically follicle-stimulating, has no apparent effect on the anœstrous ovary[6], and at present there is no practicable and effective treatment.

In the breeding season, the presence and influence of the corpus luteum may be responsible for a different response to treatment from that found in anœstrus. In sheep and cattle, the luteal phase occupies nearly the whole of the cycle. Stilbœstrol given in mid-cycle will produce signs of heat, but usually without willingness to accept the male, and the rhythm of the cycle is unaffected. Chorionic gonadotrophin will cause ovulation in the presence of a corpus luteum, follicle-stimulating preparations may sometimes do so, but not generally. Usually the cycle rhythm is unaltered; the corpus luteum formed when ovulation is induced in mid-cycle persists only as long as that already present in the ovary. If gonadotrophin is given shortly before the corpus luteum degenerates, the follicles developed, but previously restrained from ovulating, do so at the next heat period. In this way an increased ovulation-rate is obtained. In sheep, this has been confirmed by several workers, and multiple pregnancies have been so produced; practical trials have, however, given very disappointing results.

In the cow, multiple ovulations and calvings have been obtained in this way with mare serum gonadotrophin. They may also be obtained by injection of this gonadotrophin earlier in the cycle, followed by expression of the corpus luteum, the number of ovulations varying with the dosage and the interval between injection and removal of the corpus luteum. Little has yet been done to determine how closely the number of ova shed can be controlled, but it seems, at least when a single injection is given, that the corpus luteum removal method may be not sufficiently dependable, and the end of cycle injection may be satisfactory if the time for treatment can be properly judged. The former method requires only a rectal examination, the latter that the cow be seen on heat previously; with beef cattle it is usual for the bull to be run with the herd, and heat is not well marked. An increased frequency of double ovulations has been noted in cattle after treatment with stilbœstrol implants[7], so it may be possible to evolve a method of increasing the ovulation-rate by the use of œstrogens.

Lastly, mention should be made of conditions in which there is a large follicle present and no active corpus luteum. After rupture of a cystic follicle in the cow, a follicle usually matures but, failing to

ovulate, also degenerates into a cyst. If this follicle is ruptured early, it undergoes luteinization and the normal cycle is resumed. Chorionic gonadotrophin, at least in some cases, will cause ovulation of such follicles[6]; this treatment may be useful because it can be given by one without the necessary skill in rectal examination. Chorionic gonadotrophin given to œstrous mares having a large follicle induces ovulation within about twenty-four hours; prolonged œstrous periods are thereby terminated and matings can be arranged accordingly.

In this short account, it has been convenient to give only a few references, mostly English; it is therefore well to point out that much work in this field, particularly early attempts at application to sheep breeding, has been Russian, most of the remainder being done in the United States and Great Britain.

[1] Cole, H. H., and Miller, R. F., *Amer. J. Physiol.*, **104**, 165 (1933).
[2] (Mare) Day, F. T., *J. Agric. Sci.*, **30**, 244 (1940).
[3] (Sheep) Hammond, jun., J., Hammond, J., and Parkes, A. S., *J. Agric. Sci.*, **32**, 308 (1942).
[4] (Cow) Hammond, jun., J., and Bhattacharya, P., *J. Agric Sci.*, **34**, 1 (1944).
[5] Williams-Ellis, C., personal communication.
[6] Day, F. T., personal communications.
Hammond, jun., J., and Day, F. T., *Endocrinol.* (in the Press).

THE STATISTICAL LAW IN NATURE

By Prof. ERWIN SCHRÖDINGER
Dublin Institute for Advanced Studies

LUDWIG BOLTZMANN was born in Vienna in 1844. Of the Austrian tetrad of brilliant physicists (Loschmidt, Stefan, Mach, Boltzmann) he duly gained widest fame. I could begin by telling of the splendid, at that time daring, proof he gave of the fundamental law of radiation, by imagining a pintful of nothing to undergo a sequence of compressions and dilatations—a so-called Carnot cycle. I could tell of his grinding a crystal of sulphur to the shape of a neat marble, that was to serve him in an experimental confirmation of Maxwell's theory of electricity, of which he was one of the foremost champions on the Continent. But to indicate what he really meant to the development of human thought, I must start from a wider basis.

In the course of the last sixty or eighty years, statistical methods and the calculus of probability have entered one branch of science after another. Independently, to all appearance, they acquired more or less rapidly a central position in biology, physics, chemistry, meteorology, astronomy, let alone such political sciences as national economy, etc. At first, that may have seemed incidental: a new theoretical device had become available and was used wherever it could be helpful, just as the microscope, the electric current, X-rays or integral equations. But in the case of statistics, it was more than this kind of coincidence.

On its first appearance the new weapon was mostly accompanied by an excuse: it was only to remedy our shortcoming, our ignorance of details or our inability to cope with vast observational material. In the study of heredity we might prefer to be able to record the individual processes of meiosis, and thus to know how the hereditary treasure of a particular individual is composed from those of its grandparents. In text-books on gas-theory it has become a stock phrase, that statistical methods are imposed on us by our ignorance of the initial co-ordinates and velocities of the single atoms—and by the unsurmountable intricacy of integrating 10^{23} simultaneous differential equations, even if we knew the initial values.

But inadvertently, as it were, the attitude changes. It dawns upon us that the individual case is entirely devoid of interest, whether detailed information about it is obtainable or not, whether the mathematical problem it sets can be coped with or not. We realize that even if it could be done, we should have to follow up thousands of individual cases and could eventually make no better use of them than compound them into one statistical enunciation. The working of the statistical mechanism itself is what we are really interested in. It adds nothing to our outlook to know whether a particular (male) fly owes a specified portion of its X-chromosome to its mother's father or to its mother's mother. The relevant fact is, that one or the other must be the case and that one is as likely as the other.

I dare say the first scientific man aware of the vital role of statistics was Charles Darwin. His theory hinges on the law of big numbers. He had not to resort to heavy mathematics; common sense is sometimes an admirable substitute. It will be remembered how untiringly Darwin emphasizes again and again the enormous geometrical progression of virtual offspring and the enormous destruction of actual offspring that must be inferred therefrom. This, indeed, is the statistical mechanism which makes practically and safely operative the very small increase in chance of survival that a small favourable variation entails.

More drastically than any other science, physics has promoted the statistical aspect from an ancillary service to the domineering role of indicating the goals and pointing out the pathways. It was a revolutionary step, affecting virtually the whole house of science, inasmuch as it is ultimately based on physics. The names of L. Boltzmann and W. Gibbs are representative of that discovery. Only five years in age separated these two men, of whom Gibbs was the older; but the Atlantic lay between them, and I do not know that they ever met. Yet so parallel ran their thought, that to us it almost coalesces. It involved a new outlook on the nature of the laws of Nature; namely, that they are not rigorous laws at all, but 'only' statistical regularities, based on the law of great numbers, just as Darwin's theory is*.

Among the laws of physics *one* has quite a unique standing, the so-called Second Law of Thermodynamics. By enunciating (in a sense not to be detailed here) the *perpetual increase of entropy*, it safeguards a one-way traffic of physical events. Nothing could ever happen in exactly the opposite way it does happen, because that would involve a decrease of entropy. No substantial part of the world can ever be made to run backwards, as you could do with an ideal, purely mechanical clock-work (which, of course, does not exist). The Second Law embodies the unidirectional trend, the irreversibility in the course of Nature.

It would scarcely be satisfactory to account for this remarkable fact by inventing some special device, to be attributed as a common feature to all the

* If the nineteenth century is going to be named after any one man, said Boltzmann in 1886, it will be called the century of Darwin.

multifarious 'mechanisms' in Nature. According to Boltzmann, this is not necessary. The Second Law rests on—nay, it *is*—statistics; it is the pure embodiment of the statistical law itself, nothing else. Events move in the direction in which they are most likely to move. Heat flows in the direction of temperature fall, because it is billions of billions times less likely to do anything else.

The philosophical implication can scarcely be overrated. Forces, charges, potentials, collisions—the whole armoury of detailed mechanisms we invent—are apt to retain, in spite of all our striving for the contrary, a slightly mystic tinge or at least much arbitrariness. Boltzmann's discovery, though it cannot entirely dispense with this armoury, assigns to it the rank of an auxiliary device. Our true understanding of what happens is reduced to reasoning about *whole numbers*. We are able to predict the course of events, because we are able to count: one, two, three four, . . . so we can count the eventualities of every thinkable turn and find out the one that is overwhelmingly likely.

That the probability is, as a rule, next to certainty—in other words, that the laws of Nature are next to infallible—is due to the enormous number of single atoms or single microscopic events that co-operate. Whenever this number is not 'enormous', deviations must be expected. From the very year of Boltzmann's tragic death (1906) experimental evidence about these 'thermodynamic fluctuations' began to spring up abundantly, confirming quantitatively the conclusions from his theory, none of which has ever failed.

In the long run, even very improbable things are bound to happen. Given an infinity of time, a physical system would return occasionally even to a very improbable state. Strangely enough, the overwhelmingly most probable manner of accomplishing the—in itself extremely improbable—return is by an *exact* reversal in time of a common process, one following the ordinary laws of physics as we know them. In a word, *sub specie æternitatis*, past and future become equivalent—there is no 'arrow of time'. Future may mean nothing more than just that one of the two directions of time in which entropy does increase—in our time and for some time before and after. This curious result, of which a momentous effect on our world-picture may still be in store, is the inevitable outcome of sober mathematics, not a wilful day-dream.

While many a page in Boltzmann's books and scientific papers is witness to his unusual, slightly capricious, but very lovable human personality, the most attractive means of reconstructing it is offered by the slim volume of his popular writings[1]. I wish I could use up another column or two in quoting from these enjoyable essays. "A German Professor's Voyage to the Eldorado"—describing a visit to California—is a gem in light literature (the use of "German" in the purely cultural connotation was, of course, current in Vienna). The new topic of aeronautics, the objective existence of the world around us, controversies on the ill-famed German 'energetics', Beethoven's symphonies, America's university life and queer temperance laws, and scores of other subjects are dealt with in this volume in a pleasing conversational tone by one who was a man, take him for all in all—with a candid soul, a sincere and interesting mind, whatever else he might have been.

[1] Boltzmann, L., "Populäre Schriften" (Leipzig: J. A. Barth, 1905).

OBITUARIES

Mr. H. N. Dixon

HUGH NEVILLE DIXON was born at Wickham Bishops, Essex, on April 20, 1861, and died at Northampton on May 9, 1944. He was educated at Christ's College, Cambridge, where he studied classics, taking a first in the Classical Tripos in 1883; he later obtained a London M.A. On leaving Cambridge he went to assist the Rev. Thomas Arnold, who had a school for the deaf at Northampton, which his brother attended; he succeeded as head of the school in 1884, retiring in 1914. He was an active Congregationalist serving on many committees, and was a director of the London Missionary Society.

In 1886, Dixon became secretary of the Northamptonshire Naturalists' Society and Field Club and took an active part in its affairs until his death, continuing as secretary until 1931. An all-round naturalist, he was mainly interested in mosses. His first paper, "Northamptonshire Mosses", appeared in the *Journal of Botany* for 1884, and was preceded by a note on "New Localities for Rare Mosses" which gave evidence that his interest dated from his Cambridge days. Then, until the end, there was a steady stream of papers, first on British and European mosses, and then those of various expeditions to different parts of the world until he became, and was regarded as, one of the foremost authorities on the group. He is best known to students by his excellent "The Student's Handbook of British Mosses", which was published in 1896, with further editions in 1904 and 1924. This was illustrated with drawings by the Rev. H. G. Jameson, who also drew up keys to the genera and species. This is the standard Flora and is likely long to remain so. His only other book is "Studies in the Bryology of New Zealand", which appeared in parts during 1913–29 and has "special reference to the herbarium of Robert Brown", the shoemaker bryologist of Christchurch.

With so many calls on his knowledge Dixon might well have pleaded inability to give assistance to those struggling with identifications of common British mosses; but it was characteristic of him that he always gave unstinted assistance and encouragement. He joined the Moss Exchange Club on its formation in 1896, and when it was converted into the British Bryological Society in 1923, he was appropriately elected as the first president: he had produced a "handbook" catalogue of British mosses for use of members in 1897.

H. N. Dixon was quiet and unassuming, of wide learning and, except where his principles were offended, a man of peace. He was fond of sketching, and wrote quite pleasing verse. Few, until they knew him well, realized his store of energy; he was an adept at skating, played hockey until he was more than fifty, climbed Snowdon three times in one day, and Skiddaw on his eightieth birthday—with alpine climbs to his credit; and walked from Northampton to Leamington, Kenilworth and Coventry—55 miles in one day.

Dixon's health did not begin to fail until this year. So late as March he read a short paper before the Linnean Society on "The Phytogeographic Relations of Sumatran and other Alpine Mosses"—and was engaged on naming some British Museum collections when he became ill. Thus for sixty years H. N. Dixon published a long series of important papers on the taxonomy of mosses, and his name is writ large in

the annals of bryology. He served on the Council of the Linnean Society during 1925–29, and was vice-president in 1928. He was honorary member of several natural history societies, but none of the recognized honours came his way. Perhaps it was because taxonomy, not being in the fashion, is not 'original research'—perhaps it was because he was over-modest. He has bequeathed his British collection to the Kew Herbarium and his foreign collection to the British Museum (Natural History). J. RAMSBOTTOM.

WE regret to announce the following deaths:

Prof. J. G. Duncan, lecturer in chemistry in the Royal Technical College, Glasgow, and professor of chemistry at the Veterinary College, Glasgow, on May 1.

Prof. Chancey Juday, emeritus professor of limnology and director of the Limnological Laboratory at the University of Wisconsin, president in 1927 of the Ecological Society of America, on March 29, aged seventy-two.

NEWS and VIEWS

University Chair of Geography: Birkbeck College

Prof. E. G. R. Taylor

THE retirement of Prof. Eva G. R. Taylor from the University chair of geography at Birkbeck College, London, marks the departure from active academic life of one of the most vigorous personalities in geography. After graduating in natural sciences in London, she became personal assistant to Prof. A. J. Herbertson at Oxford at a time when he and his contemporaries—including Halford Mackinder and H. R. Mill—were laying the firm foundations of the modern concept of geography. A period of lecturing in London teachers' training colleges followed by ten years association (1921–31) with Prof. J. F. Unstead at Birkbeck College gave opportunities, both through lively teaching and lecturing and the well-known series of Unstead and Taylor text-books, for disseminating the new ideas in the minds of successive generations of prospective teachers. Prof. Taylor preferred always to work under her maiden name, but geographical work had to be combined in these years with the urgent needs of a young family; nevertheless she found time for a thoughtful little book on "Oceans and Rivers", and in her own text-books developed the now universally familiar idea of the 'sketch-map'—more adequately described as a cartogram in which certain salient or related features are selected for diagrammatic representation on an outline map.

Prof. Taylor's appointment in 1931 to succeed Prof. Unstead gave opportunities for a wider sphere of work. Earlier years of patient research in historical geography led to the successive publication of a study of Barlow's "Brief Summe of Geographie", comprehensive works on Tudor geography and on Late Tudor and Early Stuart geography and on the writings of the Hakluyts. Papers on old maps and instruments appeared in the *Mariners Mirror* and many other journals. In 1937 came the great opportunity to bring before a wider public the geographical concept of the influence of environmental factors in the life of man. The Royal Geographical Society was asked to prepare evidence for the Royal Commission on the Geographical Location of the Industrial Population (the Barlow Commission) and Prof. Taylor acted as chairman of the committee which, by a large series of maps and diagrams yet to be incorporated in the proposed National Atlas, succeeded in demonstrating both the strength and permanence of such localizing factors as accessibility, relief of the land, distribution of minerals, soil, rainfall, temperature, fog and a host of others on the distribution of industry and the movement of the population. She showed the dangers of the growing concentration of industry and population in a central coffin-shaped area stretching from Lancashire to Greater London—with the consequent creation of peripheral depressed areas. With Dr. Dudley Stamp she represented the Society and gave verbal evidence to the Commission the influence of which is apparent in both the Barlow Report and the subsequent Scott Report, as well as in what is now current day-to-day practice in town and country planning. It is greatly to be hoped that Prof. Taylor's retirement will in reality mean greater leisure for continuance of constructive work.

Prof. S. W. Wooldridge

DR. S. W. WOOLDRIDGE, who has been appointed to succeed Prof. Taylor, was trained as a geologist. He took as his special field the minor structures and glacial history of the London Basin, to which much of his published work relates. The climatic implications of glaciation drew him to a study of meteorology under the stimulating guidance of Sir Napier Shaw, and, thus equipped, it was natural that he should be invited to lecture on the physical basis of geography to the newly formed Honours School of Geography at King's College and the London School of Economics. Dr. Wooldridge's attention was thus turned to human geography, concerning which its critics said that its conclusions were either trivial or fallacious. To test this view, he examined the archæological and historical material relating to the entry phase of the Anglo-Saxon settlement in the light of his geomorphological researches, and was able to demonstrate, *inter alia*, the important influence of the loam terrains. His published papers on this theme strengthen the view that the weakness of human geography has arisen rather from the insufficient refinement of the analysis of physical conditions than from the unimportance of the geographical factor. At Birkbeck College Dr. Wooldridge will find a considerable body of postgraduate students, many of whom are at work on geographical aspects of regional and national planning. The importance of a close scrutiny of the terrain in this connexion needs no emphasis.

Ardaseer Cursetjee (Wadia), F.R.S.

FEW men of science in Great Britain know that an Indian, Ardaseer Cursetjee (Wadia), was admitted into the fellowship of the Royal Society so early as 1841. The following information was given to Prof. A. V. Hill, biological secretary of the Royal Society, by Colonel S. L. Bhatia, of the Indian Medical Service, who obtained details from Sir R. P. Masani of Bombay. In the *Journal of the Royal Asiatic Society* of 1865 he appears as "Ardeseer Cursetjee, Esquire, of Bombay" and as the first Indian elected a fellow of

the Royal Society in the records of that Society. There is corroboration in "History of the Lodge Rising Star of Western India" by D. F. Wadia. "It was at the very meeting (of the Lodge) held at the Town Hall on 15 December 1843, that four gentlemen were proposed for initiation to be ballotted for at the next meeting. They were Mr. Ardeseer Cursetjee Wadia (the first native gentleman admitted a Fellow of the Royal Society, who had a great engineering reputation and was at this time Chief Engineer in the Government Dockyard) and Messrs. Mirza Ali Mahomed Shoostry, Hajee Hasham Ishphanee and Mahomed Jaffer, who were leading Mogul Mahomedan merchants of the day."

In 1822 Ardaseer Cursetjee (Wadia) served under his father in the Government Dockyard and became assistant builder. In 1833 he built a small steamer, the *Indus*, in the Mazagon Dock and personally fitted up all machinery. He is reported to have made experiments in connexion with gas lighting and to have fixed up all pipes and gas machinery in his bungalow at Mazagon, Bombay; and it is recorded in Parsi annals that the Earl of Clare, Governor of Bombay, inspected the installation on March 10, 1834, and gave him a 'Dress of Honour'. In 1836 he was appointed non-resident member of the Royal Asiatic Society of Great Britain and Ireland. In 1839 Ardaseer Cursetjee (Wadia) went to England for further studies in mechanical engineering. There his services were engaged by the court of directors of the East India Company in the workshop of Messrs. Wards and Keppel. The chronicles further state that he was presented to Queen Victoria on July 1, 1840, and that he thereafter published a book of his notes regarding his travels in England. He returned to Bombay in 1841 and was appointed chief engineer of the Steam Factory and Foundry. In 1849 he was elected vice-president of the Mechanics Institute. He went to England for the second time in 1851; was made a Justice of the Peace in 1855, and retired on pension on August 1, 1857. In 1859 he went to England for the third time; and in 1861 he was appointed chief resident engineer of the Indus Flotilla Company at Karachi, and there he built three or four steamers navigating the Indus. In 1864 he went to England for the fourth time and remained there until his death on November 16, 1877, at the age of seventy.

'Marfanil'

LITTLE has been gleaned, according to the *Lancet* (635, May 13, 1944), from a close watch on German medical publications and practice during this War; but an exception is 'Marfanil', formerly known as 'Mesudin', which is 4-amino-methyl-benzene sulphonamide. It differs from the other common sulphonamides in having the amino group separated from the benzene ring by a methyl group. It is now extensively used in the German army for local application to wounds, being issued as a powder; the powder is used either alone or diluted with nine parts of sulphanilamide. Tablets of equal parts of 'Marfanil' and sulphanilamide are also used. A quantity of the drug captured in North Africa has been tested clinically by three R.A.M.C. officers, Lieut.-Colonel G. A. G. Mitchell, Captain W. S. Rees and Captain C. N. Robinson, who give their results in the same issue of the *Lancet*. They say that no other substance that they have tested has given better results, except penicillin; and they suggest that penicillin used in conjunction with 'Marfanil' may give better results than penicillin mixed with sulphanilamide or sulphathiazole. The anti-bacterial action of 'Marfanil' is not inhibited by pus or other wound discharges. It is almost non-irritating, and is no more toxic than sulphanilamide. It does not destroy epithelium or prevent its growth. It is evident from the other features of this drug discussed by the *Lancet* that further study of it would be profitable. It is, unfortunately, largely inactivated in the blood and is therefore not suitable for systemic administration; but it should not be beyond the skill of chemists to overcome its other drawback, namely, the difficulty of producing it in quantity.

Herbs and Medicinal Plants

DURING the past year, the *Brooklyn Botanic Garden Record* (32, Nos. 1 and 3) included two attractive Guides (Nos. 15 and 16) to the Herb and Medicinal Garden which was opened in 1938. The provision of a medical plant garden was considered justified in view of the large number of plant drugs in use in spite of the recent increase in the number of 'chemical' and 'biological' substances utilized in medical practice. Guide No. 16 includes a survey by A. H. Graves of the use of plants in medicine from Greek times up to the present day, which illustrates the growth of our knowledge from the relatively advanced outlook of the Greeks, through the period clouded by superstitions of the early Middle Ages, finally to the very marked advances of modern times. This survey is written in a style to attract the interest of general and scientific readers, and is illustrated by numerous woodcuts of the activities of the early herbalists. The historical survey is followed by an account by Prof. C. W. Ballard of Columbia University, and collaborators, of the medical uses of the species commonly regarded as drug plants. In the case of some of those officially recognized in the United States Pharmacopeia or the National Formulary, such as *Aloe vera*, *Ephedra equisetina*, *Atropa belladonna*, etc., some indication of the amount used annually and the possibilities of home cultivation within the United States receive comment. In the case of some imported plant drugs, the shortage caused by the present crisis has indicated clearly that the encouragement of home cultivation of the plants and their study with a view to possible synthesis of the medicinal constituents is a matter worthy of serious consideration.

Vesalius and the Struggle for Intellectual Freedom

IN an address delivered before the Washington Academy of Sciences on November 18, 1943, on the occasion of the four hundredth anniversary of the publication of Vesalius's "De humani corporis Fabrica" (*J. Wash. Acad. Sci.*, **34**, 1; 1944), Prof. Howard W. Haggard, of Yale University, sees the great classic of human anatomy as less important for its merely technical contents than for its significance in the struggle for intellectual freedom, for the liberty of scientific thought against tradition and authority. Reviewing the progress of medical knowledge through the centuries, he shows that the authority of Galen had helped to blind even competent observers to the facts revealed on the dissecting table until Vesalius published his great book in 1543. Prof. Haggard deals also with the main facts and incidents in the life of Vesalius, and his tragic death from an unknown disease when shipwrecked on the island of Zante on returning from a pilgrimage

to the Holy Land and on his way to resume his old chair of anatomy in Padua. There is also a reference to another tragedy, that of Servetus, "who, for a theological quibble, was burned at the stake by order of Calvin and whose books were burned with him"—a crime of bad faith that still sends a cold shudder through the sensitive reader.

New World Prehistory

A PAMPHLET entitled "Cross Sections of New World Prehistory: a Brief Report on the Work of the Institute of Andean Research, 1941–42", by Wm. Duncan Strong, professor of anthropology at Columbia University, has been issued (*Smithsonian Misc. Collections*, 104, No. 2). The fields covered by the various investigators include eastern and western Mexico, El Salvador, Venezuela and the West Indies, Colombia, Ecuador, various districts in Peru and the northern coast of Chile. Naturally the information from such a wide area of the Americas that can be given in some 42 pages accompanied by 33 plates is not very extensive; but a general survey like this is of value, and the large relative chronological chart from A.D. 100 to A.D. 1500 will doubtless prove useful to students more interested in the general prehistory of Central and South America than in its details. There is also a map showing the general location of the excavations undertaken by the Institute.

Remote Switching by Superimposed Currents

A PAPER was read on this subject in London recently before the Institution of Electrical Engineers by J. L. Carr, in which the author briefly reviewed the methods employed for the centralized control of switching operations on distribution networks, by the injection into the distribution system of currents the frequencies of which differ from that of the main supply. The superimposition of ultra-audio frequencies for limited and specific purposes, such as the protection or the remote switching of a transmission line, has not, so far, been employed to any large extent in Great Britain, and is therefore not considered. Several devices employed to respond to injection currents are briefly described, and the probable applications of this method of control are outlined. Particulars of the development of remote signalling over the network of a large electricity supply undertaking are given, together with reasons for the final adoption of the method selected. Data of the components of the equipment are given, and the power required is analysed for two frequencies.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has found the epicentres of three recent earthquakes. On January 10 at 20h. 10·0m. G.M.T., an earthquake had its epicentre in Mexico near lat. 18·1° N., long. 100·6° W. It was recorded throughout America and as far north as Sitka in Alaska. On January 15 at 23h. 49·4m. G.M.T., an earthquake had its epicentre in the Argentine near lat. 31·5° S., long. 68° W. It was recorded throughout America as far north as Alaska and at Honolulu. On February 3 at 12h. 15·2m. G.M.T., an earthquake had its epicentre in south-eastern Alaska near lat. 59·3° N., long. 138·0° W. This was recorded by seismographs at Buffalo, Burlington, Chicago, Fordham, Georgetown, Honolulu, Pasadena, Philadelphia, Sitka and Tucson.

Lunar Eclipses and the Earth's Atmosphere

Sky and Telescope of January 1944 has a short notice with the above title, which describes the photometric results of the lunar eclipse on March 2–3, 1942. These results were obtained in France by Daniel Barbier, Daniel Chalonge and Ernest Vigroux, and indicated, in accordance with the theoretical predictions by Link, a relationship between the intensity of the ozone bands and the distance from the centre of the shadow. Future spectrophotometric studies of lunar eclipses may yield new information on the earth's upper atmosphere.

Physical Society

AT the annual general meeting of the Physical Society held on May 24 the following were elected or re-elected for 1944–45: *President*, Prof. E. N. da C. Andrade; *New Vice-President*, Sir Edward Appleton; *Hon. Secretaries*, Mr. J. H. Awbery (Papers) and Dr. W. Jevons (Business); *Hon. Treasurer*, Dr. C. C. Paterson; *New Members of Council*, Prof. S. Chapman, Mr. C. H. Collie and Prof. H. R. Robinson. At an extraordinary general meeting held on the same day A. F. Joffe was elected an honorary fellow of the Society. The officers of the Colour Group for 1944–45 are: *Chairman*, Mr. J. Guild; *Hon. Secretary*, Dr. W. D. Wright. The officers of the Optical Group for 1944–45 are: *Chairman*, Prof. A. O. Rankine; *Hon. Secretary*, Prof. L. C. Martin.

Announcements

PROF. A. V. HILL, biological secretary of the Royal Society, has been awarded the Joykissen Mookerjee Gold Medal for 1944 of the Indian Association for the Cultivation of Science.

SIR ARDESHIR DALAL, director in charge of the Tata Iron and Steel Co., Ltd., has been appointed a member of the Executive Council of the Governor-General of India, and will be in charge of a newly formed Department of Planning and Development.

Dr. B. A. Keen and Dr. E. B. Worthington, the two British members of the Scientific Advisory Mission to the Middle East Supply Centre, who have been travelling extensively in the Middle East territories for the past seven months, have returned to England for consultations at the Ministry of War Transport in connexion with their draft report and recommendations.

THE American Association for the Advancement of Science will hold its annual meeting for 1944 at Cleveland, Ohio, during September 11–16. Two previous annual meetings have been cancelled at the request of the U.S. Office of Defense Transportation.

AT the annual general meeting of the Institute of Physics held on May 22 the following were elected to take office on October 1: *President*, Sir Frank Smith; *Hon. Treasurer*, Major C. E. S. Phillips; *Hon. Secretary*, Prof. J. A. Crowther.

THE Summer School in Social Biology arranged by the British Social Hygiene Council to be held in Bangor (see NATURE, March 25, p. 373) has been cancelled.

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

THE ROYAL INSTITUTE of CHEMISTRY of GT. BRITAIN & IRELAND

(Founded 1877)
(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 position, 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 Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

ESSEX EDUCATION COMMITTEE

South-East Essex Technical College and School of Art, Longbridge Road, Dagenham.

Applications are invited for the permanent post of SENIOR LECTURER IN BIOLOGY as from September 1, 1944. Candidates should possess high academic qualifications and have had teaching experience. Some teaching of Physiology to B.Sc. General Standard would be an additional qualification. Research experience desirable.

Salary: Burnham (Provincial) Scale plus £40 for post of responsibility.

Further particulars and forms of application are obtainable, on receipt of a stamped addressed envelope, from the Clerk to the Governors at the College, to whom applications with copies of two recent testimonials should be sent by June 12, 1944.

B. E. LAWRENCE,
Chief Education Officer.

County Offices, Chelmsford.

UNIVERSITY COLLEGE NOTTINGHAM

Applications are invited for the following appointments to fill two vacancies and five posts newly established to meet College developments:

Professor of BOTANY. Salary £900 per annum.

Assistant Lecturers in ECONOMIC HISTORY, GEOGRAPHY, BOTANY, and ZOOLOGY. Salary in each case £300 per annum.

ADULT EDUCATION: (*a*) ORGANIZING TUTOR for Derbyshire, (*b*) TUTOR IN PSYCHOLOGY, who will be required to undertake also some internal teaching duties. Salary in each case £400 per annum.

The conditions of these appointments and forms of application, which must be returned by Wednesday, June 14, may be obtained from The Registrar, University College, Nottingham.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as HEAD of the DEPARTMENT OF PHYSICS in the College vacant upon the appointment of Dr. J. P. Andrews as Assistant Professor of Physics at Queen Mary College (University of London).

The scale of salary attached to this appointment will be £600 to £700 per annum. A war bonus of £52 per annum is, at present, also paid.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College not later than Saturday, June 17, 1944.

THOS. BOYCE,
Director of Education.

OXFORD AND CAMBRIDGE SCHOOLS EXAMINATION BOARD

The Oxford Delegacy for the Inspection and Examination of Schools proposes to appoint an Assistant Secretary to act under Mr. Wilkinson. The post would be full-time and the salary offered is £600 a year. In view of possible post-war rearrangements the appointment will be temporary, terminable by six months' notice from either party. Applications should be sent before the end of July to the Chairman of the Delegacy (St. Catherine's Building, St. Aldate's, Oxford) from whom any further particulars may be obtained. It is hoped that the Assistant Secretary will be able to start his duties in October.

KING'S COLLEGE NEWCASTLE UPON TYNE

(IN THE UNIVERSITY OF DURHAM)

Applications are invited for the post of Lecturer in Electrical Machinery in the Department of Electrical Engineering. Salary from £500 per annum, according to qualifications and experience. Further particulars may be obtained from the undersigned, to whom four copies of applications, together with the name of not more than three persons to whom reference may be made, should be sent not later than Saturday, June 24, 1944.

G. R. HANSON,
Registrar of King's College.

KING'S COLLEGE NEWCASTLE UPON TYNE

(IN THE UNIVERSITY OF DURHAM)

Applications are invited for the post of Temporary Lecturer in Mathematics. Duties to commence October 1, 1944. Salary from £350 per annum, according to qualifications and experience. Further particulars may be obtained from the Registrar, King's College, Newcastle upon Tyne, 2, by whom four copies of applications, with the names of not more than three persons to whom reference may be made, must be received not later than June 26, 1944.

G. R. HANSON,
Registrar of King's College.

UNIVERSITY OF LIVERPOOL

The Council invites applications for the post of Assistant Lecturer (Grade III) in the Department of Organic Chemistry at an initial salary of £350 per annum. If engaged in National Service the person selected will not be required to take up the appointment until released from his present duties.—Applications, with the names of three referees, should be sent to the undersigned as soon as possible.

STANLEY DUMBELL,
Registrar.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(University of London.)

8 Hunter Street, Brunswick Square, W.C.1.

Applications are invited from men or women for the post of DEMONSTRATOR IN THE CHEMISTRY DEPARTMENT from October 1, 1944, at an initial salary of £250 per annum, with superannuation benefits, and war allowance of £30 per annum.

Further particulars may be obtained from the Warden and Secretary, to whom applications should be sent by June 23, 1944.

May 31, 1944.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER or SENIOR LECTURER IN GEOGRAPHY, according to the qualifications and experience of the candidates. Minimum stipends: Lecturer, £400; Senior Lecturer, £600 per annum. Duties to commence September 29, 1944. Applications should be sent not later than July 10, 1944, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER IN GEOGRAPHY. Stipend £350 per annum. Duties to commence September 29, 1944. Applications should be sent not later than July 10, 1944, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY OF MANCHESTER.

Applications are invited for the post of ASSISTANT LECTURER IN ENGINEERING. Stipend £350 per annum. Duties to commence September 29, 1944. Applications must be sent, not later than July 1, 1944, to the Registrar, The University, Manchester 13, from whom further particulars may be obtained.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER IN MATHEMATICS. Duties to commence September 29, 1944. Stipend £350 per annum. Qualifications in Pure Mathematics desirable.—Applications not later than June 26, 1944, to the Registrar, University, Manchester 13, from whom further particulars may be obtained.

Required by London Paint Manufacturers (Scheduled under Essential Work Order). (*a*) Technical Chemist. Must be capable organizer able to take full chemical control of production and organize all laboratory testing and formulating against current specifications. Commencing salary £700-£750 per annum, according to experience. The position is permanent and progressive. (Ref. F2012XA). (*b*) Laboratory Assistant. Some experience in the testing of paint products preferred but not essential. Commencing salary £350-£450 per annum, depending on experience and qualifications. A permanent and progressive post. (Ref. F2503XA). Applicants should write, quoting the reference number for the post desired, to the Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed, on or before July 8, 1944.

Applications invited for the post of technical adviser on crop diseases in connection with fungicides and insecticides by a leading London manufacturer. Applicants must hold an agricultural degree, with specialized knowledge of plant pathology; some experience of advisory and demonstration work amongst farmers and growers is advisable; salary according to qualifications; all travelling expenses paid by the company. Write, giving age, full details of education and experience, with copies of two testimonials.—Box 198, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Biochemist, 38, British, M.Sc., Ph.D., F.R.I.C., reserved, desires Research post in Public Health, Agriculture or Industry. Long experience in hospital and factories (including control of staff); training in bacteriology, microrespirometry; wide linguistic knowledge.—Write, Box 194, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Graduate in Science or Arts with knowledge of German or a Latin language other than French. Salary £290 per annum, inclusive, with increments.—Apply Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge.

Wanted by a large industrial firm in the North of England, two mycologists, preferably male, and with experience in large-scale mould fermentations.—Reply, with full particulars, to Box 196, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist (Ph.D.), research and practical experience, free to take responsible post.—Box 195, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Research Fellow (Biochemist) required. Applications, with full particulars, to Secretary, Research Institute, 117 Grove Street, Liverpool 7.

Export: Managing Director established New Zealand distributors, visiting England shortly, desires contact Manufacturers binoculars and Cameras and Associated lines. Buying Agencies required now. Substantial orders can be placed immediately manufacturing facilities available.—Write Sawell, 4 Ludgate Circus, London, E.C.4. Central 4353.

Microscopical work. Industrial, Biological, Metallurgical invited, Photomicrography, etc.—Box 197, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp.—Chards, Microscope Specialists, Forest Hill, S.E.23.

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LETTERS TO THE EDITORS

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

Relaxation Processes in Statistical Systems

THE difficulties besetting the so-called 'foundation of statistics', that is, the establishment of the connexion between statistics and mechanics, reduce, as is well known, to two fundamental points of an entirely different nature.

The first difficulty is connected with the introduction into mechanics of probability conceptions, which constitute the essential feature of statistical physics, for example, of its fundamental assertion, the H theorem. The second difficulty consists in the mechanical specification of those systems to which the results of statistical mechanics can be applied.

To the first group belong all the problems of a mechanical interpretation of irreversibility, all the well-known objections against Boltzman's treatment of the H-theorem. To the second group belong the investigation of ergodical properties, which have met with but very meagre success in reaching the goal set by statistical mechanics. In spite of a number of accessory results—eventually extremely important ones—obtained in the attempts to overcome these two difficulties, the problem of establishing the connexion between statistics and mechanics must be considered as wholly unsolved thus far.

In fact, all these points of view, which were based on classical mechanics (Boltzmann, Ehrenfest, Mises, Rosenthal and others), are in principle incapable of overcoming the first of the above difficulties: all attempts to introduce into the classical mechanics the probability concept lead to inner contradictions. This circumstance is expressed by the fact that the mechanical process cannot be subjected to the probability scheme of Markoff's chains (Hadamard). (In particular, the interpretation of the H-theorem with the help of Boltzmann's famous saw-like curve proves to be self-contradictory.) On the other hand, investigations based on classical mechanics (numerous investigations of mechanical ergodicity carried out in recent years) have led to problems of unsurmountable complexity in the way of removing the second difficulty; in the first place, it turns out that mechanical ergodicity is quite insufficient for statistical purposes—and, in particular, for the definition of the fundamental notion of relaxation; in the second place, the results of investigations on ergodicity did not enable one to specify those systems to which the corresponding mathematical definitions should be applicable.

At the same time, attempts to solve the question based on quantum mechanics (Neumann, Klein, Pauli, Fierz and others) left the second difficulty altogether aside, referring to the model of irreducibility only. But even in this respect they could not reach their goal: the connexion between the microscopic and the macroscopic notions, indicated by them, remained unsatisfactory. Investigations based both on the classical and on the quantum point of view thus could not introduce the notion of the relaxation of a system, which is the fundamental notion of statistical physics: they not only did not give—even in principle—a method for a quantitative determination of the relaxation time, but left the notion of relaxation devoid even of a qualitative definition through the mechanical characteristics of the system. They were, accordingly, quite unsatisfactory.

In the present investigation, the notion of ergodicity is ignored. I reject the ergodical hypothesis completely: it is both insufficient and unnecessary for statistics. I use, as starting point, the notion of motions of the mixing type, and show that the essential mechanical condition for the applicability of statistics consists in the requirement that in the phase space of the system all the regions with a sufficiently large size should vary in the course of time in such a way that while their volume remains constant—according to Liouville's theorem—their parts should be distributed over the whole phase space (more exactly over the layer, corresponding to given values of the single-valued integrals of the motion) with a steadily increasing degree of uniformity.

It is possible to state the general condition which must be satisfied by the potential energy of the system for the latter to belong to the mixing type. The main part of this condition consists in the requirement that the curvature R of the Riemann space of Jacobi's variational principle, corresponding to the mechanical problem and expressed by the formula

$$R = -\frac{1}{hw^2}\Delta w - \left(\frac{1}{4} - \frac{3}{2h}\right)\frac{1}{w^3}\,\mathrm{grad}^2\, w,$$

where $w = A\,(\varepsilon_0 - u)$, ε_0 is the total energy of the system, u its potential energy, A a certain constant, n the number of degrees of freedom, Δ and grad being defined in the n-dimensional configuration space[1], should be negative; or, more exactly, that the regions with a positive curvature should be sufficiently small. This condition is actually fulfilled in all the practically important cases of the application of statistical physics.

The main condition of mixing, which ensures the fulfilment of this condition, is a sufficiently rapid divergence of the geodetic lines of this Riemann space (that is, of the paths of the system in the n-dimensional configuration space), namely, an exponential divergence (cf. Nopf[1]).

Measurements of macroscopical systems, considered in statistical mechanics, refer to a region of phase space with a volume $A^n \gg h^n$ (this is due, besides the quantum character of the measurements, to the macroscopic character of the systems). The notion of probability penetrating all the statements of statistical mechanics arises as a result of the impossibility of specifying the state of the system as a point in the phase space. The change of the distribution function of the system is determined by the law of spreading of the points of the initial region over the whole surface of the given values of the single-valued integrals of the motion: the probability of finding the system at a time t after the initial experiment in a certain macroscopic state is defined by the fraction of the points of the initial region, which at the instant t are situated within the region, corresponding to this macroscopic state. In the presence of mixing, this circumstance ensures the fulfilment of all the probability requirements of statistical physics (of the H-theorem, of Schrödinger's reversibility of the macroscopic equations with respect to the time, etc.). The relaxation process can be visualized as the process of the mixing—the mixing of the initial region, corresponding to the original

non-equilibrium state, over the whole surface of given values of the single-value integrals of the motion. The relaxation time is defined as the time of this mixing, that is, the time during which a mixing with such a degree of uniformity is reached as corresponds to the type of the control macroscopic measurement, that is, to the accuracy of the experiment checking the establishment of equilibrium. The relaxation time depends, in general, on the type of the original fluctuation. The largest value of the relaxation time can be defined as the time of mixing of an initial region with a volume A^n, when $A \sim h$.

It turns out that the relaxation time possesses over a very wide range the property of being insensitive with respect to the size of the initial region A^n, tending, however, to infinity in the limit $A \to 0$, corresponding to a transition to the classical mechanics. From this insensitivity it can be concluded that with increase of the fluctuation the relaxation time increases very slowly, tending rapidly to the limit, corresponding to the minimum value of the region A^n (for $A \sim h$). In the case of an ideal gas, this limiting value of the relaxation time with respect to the velocities is given by the formula :

$$t = \frac{\frac{3}{2}\tau}{\ln \lambda/r_0}\left\{\ln \frac{2\pi}{(\Delta p/p_0)}\right\},$$

where τ and λ are the duration and length of the mean free path, r_0 is the radius of a molecule, $p_0 = \sqrt{mkT}$, $\Delta p = A/L$, L is the linear dimensions of the system, and $A \sim h$; it thus proves to be of the order of a few τ. In a transition to the classical case, $A \to 0$ and $t \to \infty$. Under the condition $A \sim h$, the relaxation time can, however, depend on the choice of the initial region of this size. Since the space of 'initial regions', that is, of the results of the most complete experiments, is compact, it can be shown that the relaxation time for different initial regions of the same minimum size A^n possesses an upper boundary.

I wish to express my sincerest gratitude to Academician V. Fock for his participation in the discussion of certain above-mentioned questions.

N. KRYLOV.

[Received from Prof. J. Frenkel,
Academy of Sciences of the U.S.S.R.,
Moscow.
Oct. 10, 1943.]

[1] Nopf, *Ber. Ann. Wiss. Leipzig*, **3** (1932).

The Four-Colour Problem

THE correctness of the statement that any plane map may always be tinted with four colours in such a way that two areas meeting on the same boundary never have the same colour has always been admitted since Möbius mentioned it in 1840, although no mathematical proof of this theorem has yet been firmly established. I think I have found a rigorous and general proof of it. First, I have a theoretical proof of the common enunciation ; secondly, I suggest a practical method of colouring. The complete paper is being submitted for publication elsewhere.

(1) Any plane map can be represented schematically as follows. Each area is figured by a point, and every contact between two contiguous areas is represented by a line connecting the figuring points. It is not difficult to show that any map, however complicated, can be reduced to a system of connected triangles externally limited by a unique triangle.

Then, using the method of general induction, I have shown that if it is always possible to colour a net of n vertices by means of four tints, the property remains true for a net of $n + 1$ vertices. In order to make this clear, I have used a theorem which is enunciated as follows : If a net R consisting entirely of triangles and of one—and one only—quadrilateral is colourable, then the net R^1 obtained by adding one supplementary diagonal in the quadrilateral is also colourable.

The evidence that a simple net consisting of a single triangle is colourable leads by induction to the complete demonstration.

(2) The foregoing statement is the basis on which the practical method of colouring rests.

A net already coloured with the four tints, 1, 2, 3, 4, might be coloured otherwise in black and white, making, for example, 1 and 2 white, and 3 and 4 black, in such a way that every polygonal black or white chain is open or when closed involves always an even number of vertices. The reciprocal proposition is true.

On the other hand, it is always possible to classify the vertices of any given net to be coloured in three groups, α, A, B, with two exceptional vertices, and to number the vertices: 1, 2, 3, . . . n, during the process of classification.

By definition, a vertex belonging to group α is directly connected with two and only two vertices, the number of either being lower than its own number. In the same way, a vertex A is connected with three, and a vertex B with four vertices. Nevertheless, it might happen that a vertex is connected with five preceding vertices, belonging then to a new type C. In this case, owing to a definite diagonal mutation of chosen sides of the net, such a vertex enters the group B.

All vertices being numbered and classified in types α, A, B, excepting the two vertices numbered 1 and 2, a general rule can be given for marking the vertices of the net in black and white in such way as to avoid any closed chain, black or white, involving an odd number of vertices.

After that the net can be coloured in the four tints 1, 2, 3, 4.

If any alteration has been made owing to eventual diagonal mutations, it is possible to return to the previous structure of the net, basing the necessary modifications of marking and colouring on the fundamental theorem enunciated in (1).

Bibliography. A short account of the history and bibliography is given in Rouse Ball's "Mathematical Recreations and Essays" (London: Macmillan and Co., Ltd., 1905, pp. 51–54), from which it appears that the problem was mentioned by Möbius in 1840 ; Francis Guthrie communicated it to De Morgan about 1850 ; although familiar to practical map-makers, Cayley redirected attention to it in 1878, but did not know of any rigorous proof of it ; in 1880 Tait published a solution (*Proc. Roy. Soc. Edinburgh*, **10**, 729 ; 1880) but it would seem to involve a fallacy (see J. Peterson, of Copenhagen: *L'Intermédiaire des Mathematiciens*, **5**, 225 ; 1898 ; **6**, 36 ; 1899).

S. M. DE BACKER.

Oakfield, Vine Road,
East Molesey, Surrey.
Feb. 1.

Distribution of Nucleic Acids

A QUESTION of great interest has been raised by Gulland, Barker and Jordan when they object to a nucleic acid terminology proposed by us[1]. We suggested that the terms 'chromonucleic' and 'plasmonucleic acid' be used as synonyms for 'desoxyribose' and 'ribose nucleic acid' respectively[2]. The latter terms are useful because they clearly denote an essential difference in *chemical* composition of the two known types of nucleic acid; the former terms would be useful because they describe the striking *biological* distribution of the two nucleic acids.

In recent years it has been shown, contrary to what had been believed previously, that both types of nucleic acid are present in both plant and animal cells. There is indeed a profound difference in the distribution of the two types of nucleic acid; but the difference is discernible within each plant and animal cell. In all plant and animal cells on which careful observations have been made, one type of nucleic acid has been detected in the chromatin only, and we have accordingly suggested the name 'chromonucleic acid' for this type. The other type of nucleic acid, 'plasmonucleic', occurs in the cytoplasm, in the plasmosome (nucleolus) and possibly in minute quantities in the chromatin[3,4]. The distribution of the two nucleic acids provides a biochemical basis for the now classical cytological distinction between chromatin and other constituents of the cell. 'Chromonucleic' and 'plasmonucleic acid' are terms that epitomize the point of view of the cyto-geneticist, much as the term ascorbic acid does the point of view of another group of biologists—better than does the chemical term 2,3-enediol-*l*-gulono-1,4-lactone! Gulland, Barker and Jordan object to the terms we have suggested because nucleic acids are present in viruses and bacteria as well as in cells with clearly defined nuclei. 'Chromonucleic' and 'plasmonucleic' are terms based on a distribution of the two acids within cells in which certain morphological features are visible. The presence of nucleic acids in viruses and bacteria is regarded by Gulland, Barker and Jordan as an "exception" to this distribution. This, in our opinion, is altogether too narrow a view to take, and it becomes apparent at once when we consider the presence of 'chromonucleic (desoxyribose) nucleic acid' in bacteria.

The existence of nuclei in bacteria has been a moot question for years. In the nuclei of many animal and plant cells, chromatin forms by far the bulk of the nuclear substance, and in some nuclei more than 90 per cent of the chromatin consists of desoxyribose nucleoprotein (chromonucleoprotein)[5]. The presence of desoxyribose nucleic acid in bacteria[6,7] and the preparation from bacteria of a desoxyribose nucleoprotein strikingly similar to those prepared from all nuclei[5] indicates that the chemical equivalent of chromatin is present in bacteria; and whether or not this chromatin is organized in a morphologically distinct nucleus becomes, in a sense, a secondary matter. The discovery that a chromonucleoprotein, like that present in the nuclei and not in the cytoplasm of animal and plant cells, and forming the bulk of their chromatin, also exists in bacteria, is surely not so much an exception to the statement that such nucleoproteins exist in the nuclei of cells of higher animals and plants as an indication that bacteria contain chromatin.

It appears fruitful at present to compare the viruses with the self-duplicating bodies known to be present within the cells of plants and animals. Some viruses (vaccinia, bacteriophage) contain desoxyribose nucleic acid; others (the tobacco mosaic virus, for example) contain ribose nucleic acid[3]. The suggestion arises at once that some viruses may be related to those self-duplicating bodies, the genes, that are so closely associated with the chromonucleoproteins (desoxyribose nucleoproteins) of chromatin and that other viruses may be related to self-duplicating bodies in the cytoplasm, such as the chloroplasts, which contain plasmonucleoproteins (ribose nucleoproteins).

The nucleic acid terminology which we have proposed does not ignore the presence of nucleic acids in bacteria and viruses; on the contrary, this terminology implies that the distribution of nucleic acids has a profound biological significance.

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Hospital of the Rockefeller Institute
for Medical Research,
New York.

[1] Gulland, J. M., Barker, G. R., and Jordan, D. O., NATURE, **153**, 194 (1944).
[2] Pollister, A. W., and Mirsky, A. E., NATURE, **152**, 692 (1943).
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[6] Sevag, M. G., Smolens, J., and Lackman, D. B., *J. Biol. Chem.*, **134**, 523 (1940).
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Carbonic Anhydrase

IN a recent letter in NATURE[1], Keilin and Mann question the zinc content of carbonic anhydrase reported by us. The facts seem to be that they have obtained an enzyme preparation (which they believe is highly purified) having a zinc content of 0·3–0·33 per cent[2], and we have obtained a preparation (which we likewise feel we have shown to be highly purified) having a zinc content of 0·2–0·23 per cent[3]. Realizing that criticism can be directed against the determination of any low zinc content, whether the method used be the dithizone method employed by Keilin and Mann or the method of Sahyun and Feldkamp used by us, we conducted preliminary experiments and reported[4] that "Before zinc estimations were conducted on the enzyme, analyses were made on a sample of zinc-insulin crystals with the same technique as was used in estimating the zinc in the enzyme. Duplicate results agree within 4 per cent. Moreover, these results were in good agreement with the metal content of the crystals as calculated from ash determinations. Along with each estimation of the zinc content of an unknown sample it was routine procedure to determine likewise the zinc content of a standard zinc solution". In all our estimations of the zinc content of the enzyme preparations, care was taken that a reasonable quantity of material was used. Recently Prof. Thode of McMaster University made polarographic determinations of the zinc content of our enzyme preparation and found it to be 0·22 per cent. We feel that the comparatively low zinc values reported by us are not attributable to the method of determination used in our work.

Keilin and Mann direct attention to the fact that the carbonic anhydrase content of ox blood as determined in our laboratory[5] was approximately twice that reported by them for washed ox red blood

corpuscles[2]. In view of the fact that "in any one species there is a two- to four-fold variation or more"[6] in the enzyme content of blood, it could be expected that there might be a difference in the enzyme values reported from the two laboratories. However, the primary object of our communication[5] was to direct attention to the marked instability of dilute solutions of highly purified preparations of the enzyme. This instability is so great that we believe it is impossible to determine accurately the potency of dilute aqueous solutions of the enzyme by the unmodified glass boat method used by Keilin and Mann. Our work showed that the addition of a very small amount of peptone or of certain other substances (themselves free from enzyme activity) rendered solutions of carbonic anhydrase stable and made assay possible. Such stabilized solutions of the purified enzyme had activity double that obtained for similar aqueous solutions of the enzyme when attempts were made to assay these immediately after the solutions were prepared for assay. It would be a matter of interest to determine the potency of the highly active preparation of Keilin and Mann in the presence of a small amount of peptone, to ascertain whether under these stable conditions their preparation would indicate an activity as great as that which we have reported.

Keilin and Mann state that the crystalline compounds of carbonic anhydrase with piperidine, *iso*-amylamine and *n*-amylamine described by us have "no relationship to the enzyme". Evidently they have not understood our use of these compounds. Of course these *dried* crystalline preparations are "devoid of catalytic activity", as are the dried crystalline preparations of the enzyme obtained from ammoniacal acetone and as are dried crystalline preparations of certain other enzymes. In the case of the hormone insulin, the crystalline base-insulin preparation *retains* activity after drying[3,7] even though the potency of insulin is ordinarily readily destroyed in the presence of a base. Since a substance so labile as insulin retains potency under these conditions, it seems that an explanation other than alkalinity must be found for loss in potency during drying of a crystalline preparation of a substance so remarkably stable to base (*p*H 12) as is carbonic anhydrase[6]. If consideration is given to the drying of the crystals, it seems not unlikely that water may be concerned. This is further suggested by the marked instability of the enzyme in dilute aqueous solutions, and by the fact that crystalline preparations of the enzyme obtained from ammoniacal acetone are inactive after drying.

Keilin and Mann also object to the use of these liquid bases because they form crystalline compounds with other proteins. As a matter of fact, there are few chemicals which are specific for the crystallization of only one protein. It was a matter of much interest to us to learn that Keilin and Mann had often observed thin plates during precipitation of the purified enzyme.

D. A. SCOTT.
A. M. FISHER.

Connaught Laboratories,
University of Toronto.

[1] Keilin, D., and Mann, T., NATURE, **153**, 107 (1944).
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Antibacterial Action of Arsenic

Voegtlin[1] and Eagle[2] have produced convincing, even if partly circumstantial, evidence that organic arsenicals act on trypanosomes and spirochætes by combining with –SH (thiol) groups in enzyme systems essential for the metabolism of these organisms. These workers showed that arsenobenzenes act in this way only after oxidation to the corresponding arsenoxides, and likewise pentavalent arsenicals become active only after reduction to their arsenoxides.

More recently, Fildes[3] has produced evidence that mercurial antiseptics acted on bacteria by combining with –SH groups in enzymes essential for bacterial metabolism. Accordingly one of us (J. E. F.) pointed out[4] that arsenoxides should act as antiseptics towards a wide range of bacteria, as mercurials do. Should arsenoxides prove ineffective against a variety of bacteria *in vitro*, a vital inconsistency between the Voegtlin theory of the action of arsenicals on trypanosomes and spirochætes and the Fildes theory of the action of mercurials as antiseptics would be revealed.

Curiously enough, no reference earlier than 1942 to the successful action of arsenicals in significant dilution against common pathogenic bacteria (that is, other than the atypical spirochætes and bartonellæ) could be found. Hirsch[5] showed that atoxyl (*p*-aminophenylarsonic acid) has a sulphonamide-like action on *B. coli*. But here it is not acting as an arsenical but through its structural resemblance to *p*-aminobenzoic acid. Indeed Peters[6] has shown that other pentavalent arsenicals not having this resemblance, such as acetarsol (*p*-hydroxy-*m*-acetylaminophenylarsonic acid) and tryparsamide (N-phenylglycineamide-*p*-arsonic acid), are inactive towards this organism. Peters noted, however, that *m*-amino-*p*-hydroxyphenyl-arsenoxide was highly active against *B. coli* and was not antagonized by *p*-aminobenzoic acid. Osgood[7] had shown that neoarsphenamine (an arsenobenzene) was effective against *Streptococcus viridans* in bone-marrow culture if left for 2–3 days, but believed that the mechanism was different in this case from that obtaining with trypanosomes.

To assist the clarification of this rather confused picture, we have submitted arsenical drugs typical of each of the three possible levels of oxidation to a bacteriostatic analysis. The technique followed has been previously described[8], and the same pathogenic strains were used as heretofore. The medium used has been found to contain enough *p*-aminobenzoic acid completely to counter any sulphanilamide-like drug activity. The arsenoxide was used in the form of 'Mapharsen N.N.R.' (synonyms: 'Mapharside', 'Neohalarsine', arsphenoxide), due allowance being made for the diluent present. The acetarsol was dissolved in an equivalent of sodium hydroxide, the proflavine in an equivalent of hydrochloric acid and the other substances in water. The results are given in the accompanying table.

Discussion. The table demonstrates that arsenoxide behaves towards a wide range of bacteria as a potent antibacterial of the same order of activity as the acridines and the mercurials, and it is as easily inactivated by a typical thiol compound as mercurials are. The pentavalent arsenical (acetarsol) was quite inactive and the arsenobenzene (neoarsphenamine), which was tested under hydrogen to secure conditions unfavourable to its oxidation, showed only slight and limited activity.

It is concluded that at least one organic arsenical

HIGHEST DILUTIONS COMPLETELY INHIBITING GROWTH IN 48 HOURS AT 37° C. (MEDIUM: PEPTONE-BROTH CONTAINING 10 PER CENT SERUM; *p*H 7·2.)

Substance	*Cl. welchii*	*Strept. haem* A.	*Staph. aureus*	*B. coli*	*Proteus vulgaris*
Arsenoxide (*m*-amino-*p*-hydroxyphenylarsenoxide)	1:160,000	1: 80,000	1:160,000	1:10,000	1:10,000
Acetarsol B.P. (*m*-acetylamino-*p*-hydroxyphenylarsonic acid)	*	*	*	*	*
Neoarsphenamine B.P. (N-methylenesulphoxylate of *m*-amino-*p*-hydroxy-arsenobenzene	1: 10,000	1: 10,000	1: 10,000	*	*
Arsenoxide in 0·1 per cent thioglycollate broth	1: 5,000	1: 10,000	*	*	*
Proflavine (2 : 8-diaminoacridine)	1:320,000	1:160,000	1: 20,000	1:20,000	1:10,000
Mercuric chloride	1: 40,000	1:160,000	1: 40,000	1:80,000	1:80,000

* Signifies not inhibitory at 1 : 5,000.

at the arsenoxide level of oxidation is a potent antibacterial acting after the fashion of the mercurials, whereas closely related arsenicals at both higher and lower levels of oxidation are inactive. Hence the Voegtlin and the Fildes hypotheses are more closely linked than heretofore. This hitherto unsuspected antistaphylococcal action of arsenoxide is, in our experience, inferior only to that of penicillin, ethyl mercurithiosalicylate ('Merthiolate') and crystal violet. In view of the widespread experience of the use of this drug in syphilis, it should not be a difficult matter to determine whether it is clinically useful in staphylococcal infections.

We wish to thank Miss J. Stone for valuable assistance in performing these tests.

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[1] Voegtlin, C., *Physiol. Rev.*, **5**, 63 (1925).
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Cataphoretic Velocities of Pure Copper Ferrocyanide Sol

THE cataphoretic velocities of the sols formed from the precipitates from potassium ferrocyanide and copper sulphate solutions peptized with water after washing by centrifugalization were measured by the microcataphoretic method[1].

In the pure sol of copper ferrocyanide, the cataphoretic velocities of particles of different sizes vary from $-16{\cdot}5 \times 10^{-5}$ to $-56{\cdot}8 \times 10^{-5}$ cm. per sec. per volt/cm. It is found that the larger particles move with a higher velocity and smaller particles with a lower velocity. Therefore the velocity we actually get after calculation is the average of all the velocities of all the particles.

The cataphoretic velocities of centrifuged sols are less than those of the non-centrifuged sols[2]. The cataphoretic velocities of a sol increase with time. If the non-centrifuged sol be kept for a month and then centrifuged, it is found that the centrifuged sol has a higher velocity than the non-centrifuged sol.

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[1] Freundlich and Abramson, *Z. physikal. Chem.*, **133**, 51 (1928).
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A Method for Collecting Sporozoites of *Plasmodium gallinaceum* by Feeding Infected *Aedes aegypti* through Animal Membranes

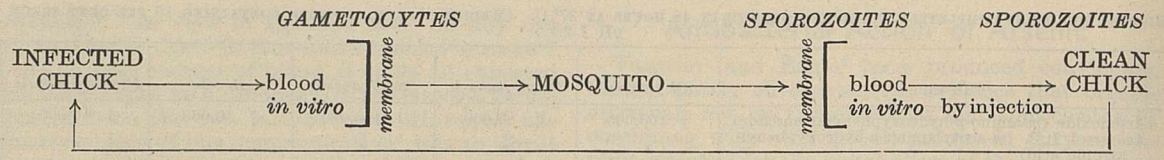
THE well-known difference between the resistance of blood-inoculated and mosquito-induced malaria indicates that sporozoites, or the stages arising immediately from them, are very resistant to the action of the known anti-malarial drugs. Since a true prophylactic drug, that is, one which will prevent sporozoite-induced infections, is the most urgent requirement in the chemotherapy of malaria, a method for testing drugs directly on sporozoites is of great importance. Hitherto the only method of doing this was to obtain sporozoites by the dissection of salivary glands from infected mosquitoes, which is both laborious and unsatisfactory, as the sporozoites are always mixed with and may be protected by fragments of the salivary gland cells. Thus it is difficult to obtain them in uniform suspension and to be sure that they are all exposed equally to the action of the admixed drugs being tested.

In order to overcome these difficulties, we began to work upon the possibility of obtaining sporozoites free from gland tissue by feeding infected mosquitoes (*Aedes ægypti*) through animal membranes. Gordon[1] had shown that mosquitoes would feed through a fresh animal membrane, and Yoeli[2] had infected *Anopheles elutus* with *Plasmodium falciparum* by inducing the mosquitoes to gorge upon infected blood through a prepared rabbit-skin membrane.

The type of membrane which we have found to be the most successful is one made of chicken skin. We prepared it by soaking the skin of a 1–3 week old chick in absolute alcohol for at least 30 minutes, washing it in running tap water and stretching it over a piece of glass tubing 2·5 cm. × 6 cm., and keeping it in place, until dry, by a thin rubber band. On drying, the skin is thin and parchment-like and adheres firmly round the glass tubing, making a water-tight seal.

The highest rates of gorging are obtained when the blood in the membrane (1·5–3 c.c. of heparinized chick blood) is warmed to 41–42° C. and kept warm by a surrounding water-jacket filled with water at that temperature. Moistening the outer side of the membrane, that is, that presented to the mosquitoes, with saliva also increases the rate of gorging as compared with a dry surface. The apparatus is placed upon the mosquito-netted top of a jar containing *Aedes ægypti* so that the surface of the membrane rests upon the netting. Gorging is effected in the dark in an incubator at 28° C., in a moist atmosphere.

We have infected *Aedes ægypti* with *Plasmodium gallinaceum* by feeding mosquitoes through a mem-



INFECTIVE CYCLE OF *Plasmodium gallinaceum*, BY *Aedes ægypti*, THROUGH ANIMAL MEMBRANES.

brane upon heparinized chick blood heavily infected with gametocytes. The rate and intensity of infection, as assessed by oocyst counts on the fourth day, were equal to those obtained from mosquitoes of the same age-group gorged on the same chicken immediately prior to drawing the blood for the membrane experiment.

What is, however, more important for our work, is that we have been able to demonstrate that infected mosquitoes, when they gorge through a membrane, extrude sporozoites into the blood, and that these sporozoites are viable, since the blood containing them when injected into clean young chicks produces infections typical of mosquito transmission.

Mosquitoes, which became infected as a result of gorging through a membrane upon blood containing gametocytes of *P. gallinaceum*, have ejected sporozoites through a membrane into uninfected chick blood, and this blood has proved infective when injected into a clean chick. The cycle of development as shown in the accompanying chart has, therefore, been completed.

In obtaining sporozoites from infected *Aedes ægypti* only batches of mosquitoes which have been proved, by oocyst count on the fourth–fifth day, to be heavily infected are used. The rate of gorging through a membrane of infected mosquitoes (that is, mosquitoes which had already had one, the infective, blood-meal) is generally not so high as when mosquitoes gorge for the first time, but usually at least 50 per cent gorge, and in certain batches the rate has been as high as 90 per cent.

Our practice is to allow the mosquitoes thirty minutes in which to gorge upon 1·5–3 c.c. of heparinized blood from clean chicks, and then to pipette out the blood from the membrane and shake it well to ensure that the sporozoites are evenly distributed. The blood (0·4–0·5 c.c. per bird) is injected intravenously into 5–10 day old chicks. Groups of three or four chicks injected with blood from membranes through which batches of 35–53 mosquitoes had gorged showed parasites in their peripheral blood on the sixth–seventh day. This incubation period is, in our experience, similar to that in chicks bitten by two to four heavily infected mosquitoes. In one experiment, blood from which forty-five mosquitoes had gorged produced infections of such intensity in six chicks that five died on the seventh day, post-mortem examination revealing enormous numbers of exoerythrocytic schizonts in the capillaries of the brain.

Infected Aedes remain infective after gorging through a membrane and can be induced to eject their sporozoites by this method on more than one occasion. Thus a batch of thirty-nine infected mosquitoes ejected sporozoites through a membrane into clean blood on the ninth day after infection. From this blood five chicks were infected. Six days later, the twenty-one Aedes surviving gorged again through a membrane upon clean blood, and the blood in the membrane proved infective to the two chicks inoculated with it, parasites being found in the peripheral blood of each chick on the sixth day.

Experiments are now being made upon the applicability of this method for testing the action of antimalarial drugs directly upon sporozoites and the developmental stages arising from them, and the results will be reported later.

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[1] Gordon, R. M., *Ann. Trop. Med. Parasitol.*, **16**, 424 (1922).
[2] Yoeli, M., *Riv. Malariolog.*, **17**, 62 (1938).

Action of Inert Dusts on Insects

IN his recent letter Dr. Wigglesworth[1] has explained the desiccating action of inert dusts on insects by the abrasion and perhaps adsorption of waxy substances forming a thin layer on the cuticle. The following results, which appear to confirm his conclusions, were obtained while comparing the dust resistances of various races and species of Drosophila, and spraying dust on some other animals. Of the various dusts tested, the loss of water was most accelerated by shaking the insects with charcoal of plant or animal origin. At 25° C. and 40–50 per cent relative humidity, *Drosophila melanogaster* flies were dead after eleven minutes, and *D. subobscura* after nine minutes, whereas in an atmosphere saturated with moisture, they survived for many hours. Mosquitoes, house-flies and house-spiders dusted with charcoal and kept in a centrally heated room died in less than an hour, and a young newt died in about two hours. Earthworms and slugs, on the other hand, were not killed by the dusts.

Pupæ of *D. melanogaster* did not die in charcoal, but the flies emerging from them soon did; larvæ survived for several hours. Drosophila flies which were narcotized in carbon dioxide, shaken and kept with charcoal in an atmosphere sufficiently rich in carbon dioxide to keep them immobilized, survived in this condition for several hours, and died only ten minutes after they had recovered in air and had been running. Similarly, at 5° C. and about 70 per cent relative humidity, Drosophila flies survived in charcoal for several hours. If immobilized by carbon dioxide or chill after they had been crawling in charcoal for two to three minutes, Drosophila flies dried up and did not recover.

The dependence of the desiccating effect on movement was also evident in the first instars of Dixippus. Cataleptic individuals survived much longer when dusted with charcoal than did active animals. In the cottonstainer Dysdercus sp., the abrasive effect of charcoal could be observed directly under the binocular microscope without using a dye. If a later instar of this bug was dusted with charcoal and turned on its back, white scratches, looking as if paraffin

wax were scratched with a needle, could be observed on the cuticle of the abdomen where the femora had rubbed it. If the legs were cut before dusting, no scratching could of course occur, and the nymph survived much longer.

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[1] Wigglesworth, V. B., NATURE, **153**, 493 (1944).

A System of Notation for Petroleum Hydrocarbons

I SHOULD like to invite attention to a system of notation I am using for petroleum hydrocarbons. In recent years the tendency to invent trade names (such as 'triptane' for 2,2,3-trimethyl butane) is understandable, but is to be deplored as a retrograde step away from unification and systematization. There is no need to depart from the international system of nomenclature if some simple system of notation is used for groups of atoms. The accompanying table contains a list which I have found suitable. It applies generally to hydrocarbons boiling in the gasoline range and a few simple substituted derivatives.

NOTATION FOR THE SYSTEMATIC NAMES OF HYDROCARBONS.

Abbreviation	Group or meaning	Abbreviation	Group or meaning
M	methyl	X	xylenes
E	ethyl	i	*iso*-
P	propyl	s	secondary
Ph	phenyl	t	tertiary
b	butyl	c	cyclo
a	amyl	Δ	double bonds
4	butane		(positions indicated by
5	pentane		following figures)
6	hexane	δ	triple bonds
7	heptane		(positions indicated by
8	octane		following figures)
9	nonane		
10	decane	Substituents	
B	benzene	F	fluoro
T	toluene	C	chloro
oX	*o*-xylene	Br	bromo
mX	*m*-xylene	I	iodo
pX	*p*-xylene	N	nitro
		A	amino

Only the necessary minimum number of symbols is used, as there is no need to include the total number of alkyl groups in the name. For example, 2,2,3-trimethylpentane becomes 223M5; *iso*-octane is written i8, and 2,2,4-trimethylpentane becomes 224M5. *Iso*-pentane can be written i5, though the purist would prefer 22M3. In the naphthene series *cyclo*pentane becomes c5, and 1-methyl-3-*iso*propyl *cyclo*hexane becomes 1M3iPc6. Among the aromatic hydrocarbons we have EB for ethyl benzene and 135MB for mesitylene. The olefine butadiene becomes 4Δ13 and 2-methyl-3-ethyl pentadiene Δ2–4 becomes 2M3E5Δ24. Acetylene is 2δ. I have no experience of using this notation for the substituted hydrocarbons, and the extension to the list is offered without experience to stimulate criticism or extension of the notation.

Similar notations are probably in use in other laboratories, but in these days when the detailed analysis of fuels is occupying so many chemists on both sides of the Atlantic, a simple, uniform notation for the international nomenclature for labelling samples and for use on graph or in tables would be of considerable value, particularly as so much of this information has to be exchanged.

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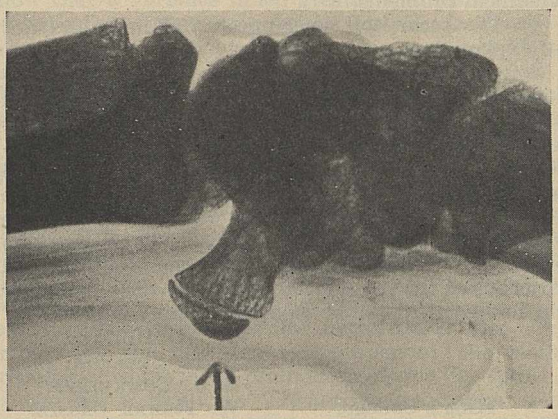
The Pisiform Bone

THE pisiform bone is often dismissed by the human anatomist as an insignificant sesamoid bone in the tendon of the flexor carpi ulnaris muscle, notwithstanding its articulation with the os triquetrum (os ulnare of comparative anatomy).

An extensive analysis of radiographs of the carpus in various mammals has shown that this minisculum is a canonical carpal bone, for in all young primates examined, with the exception of man, it presents a secondary bony centre with a well-marked epiphysial growth cartilage. The bony epiphysis is clearly shown in the accompanying lateral radiograph of the wrist of a young *Macacus rhesus*.



LATERAL RADIOGRAPH OF THE WRIST OF A YOUNG *Macacus rhesus*. (× 3.) THE ARROW POINTS TO THE BONY EPIPHYSIS OF THE PISIFORM BONE.

The pisiform is now, for the first time, shown to be analogous to the os calcis, which alone among the bones of the tarsus has a secondary centre of ossification in all primates, including man.

The hitherto unsuspected existence of this epiphysis in the pisiform bone makes it necessary to revise for all vertebrate forms the present views on the morphology of the carpus and tarsus. No mention of the epiphysis is found in the book on the hand by Wood Jones[1], in the anatomy of the rhesus monkey by Hartman and Straus[2], or in the extensive monographs by Schreiber[3] and Schwartz[4]. The same is true of the various papers by Broom and Watson on fossil forms.

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[1] Wood Jones, F., "The Principles of Anatomy, as seen in the Hand", 2nd Edit. (London, 1941).

[2] Hartman, C. G., and Straus, W. L., jun., "The Anatomy of the Rhesus Monkey" (London, 1933).

[3] Schreiber, H., *Anat. Anz.*, **78**, 369 (1934); *Gegen. Morph. Jahr.*, **77**, 22 (1936).

[4] Schwartz, W., *Gegen. Morph. Jahr.*, **81**, 187 (1938).

Geostatics

RECENTLY, at King's College, Newcastle upon Tyne, more than seventy engineers and architects studied the subject of 'soil mechanics'. A week of lectures and drawing office practice under the direction of Mr. A. W. Skempton, of the Building Research Station, resulted in considerable discussion of the various aspects of the problems involved. In such discussions, the name given to this rapidly developing science was the subject of criticism on the following lines :

(1) The word 'soil' has, for centuries, signified that extreme upper layer of the earth's crust which can support plant life. In 'soil mechanics' the word is forced out of its usual connotation to include any of the unconsolidated or partially consolidated geological sediments existing to any depth likely to be of interest to the engineer or architect

(2) Even if the meaning of 'soil' be extended to include sands, gravels, silts, and clays of any depth, it cannot, logically, be applied to harder materials such as shales, to which the methods of 'soil mechanics' do apply.

(3) The term 'mechanics' is misleading and covers a field which is too wide to identify the specialized statical problems involved. The methods of 'soil mechanics' are not, for example, extended to include dynamical problems.

(4) The term 'soil mechanics' is clumsy, and not self-explanatory.

'Soil mechanics' is the science of applying the methods of statics to data deduced from the measured properties of geological sediments. The results obtained indicate the static forces involved in earthworks or in foundation design. For this reason, and since there is no collective term to indicate the loose sediments of the earth's crust, we suggest that the term 'Geostatics' should be employed. This suggestion forms a constructive reply to the well-founded criticisms of the present name, and covers adequately and neatly all possible aspects of 'soil mechanics'.

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Wordsworth and Science

THE important question is surely not whether Wordsworth should now and again have scoffed at men of science with or without provocation, but whether the poems as a whole suggest that he felt at heart that it were incumbent upon poets to give recognition to scientific knowledge. Now I submit and, indeed, tried to show in an article published in NATURE of November 28, 1942, that the very strength of Wordsworth's unique Nature mysticism depends on the tacit acceptance of science in principle discernible in the poems. This must be precisely why the forerunners of this journal so wisely selected a now time-honoured Wordsworthian motto, and why ever to discard it would be a most foolish blunder.

I should like to quote a few lines from "The Excursion" as exemplifying with peculiarly solemn power the depth of this great poet's philosophical outlook upon Nature :

"He, many an evening, to his distant home
In solitude returning, saw the hills
Grow larger in the darkness ; all alone
Beheld the stars come out above his head,
And travelled through the wood, with no one near
To whom he might confess the things he saw."

That lad returning from school over the wild Perthshire hills shows himself a "visionary of the first water"—of the finest calibre with the making both of a man of science and a poet ; for he is seeking to peer behind the natural scene and to capture a hidden meaning in the grand and impressive phenomena of the landscape. Here we certainly have flights of poetical imagination properly disciplined by scientific caution and faith in the "solid ground of nature". Such great moments as were vouchsafed to the Wanderer will repeatedly and often unexpectedly come to everybody who cultivates the requisite outlook.

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Patent Law and Procedure in Austria

IN view of the present interest in the reform of the patent law and procedure in Great Britain (see NATURE, May 6, p. 553), it may be worth while to refer briefly to the manner in which the Austrian Patent Act, 1925, has tried to cope with one of the most intricate problems concerned, namely, the treatment of the scientific worker in his quality as inventor. Under this Act—which seems to be the most progressive legislation in this field of law—the employee is considered the owner of his inventions, even if they had been made in the course of his employment. He may assign his invention and the patent applied or granted therefor to his employer or may grant him a licence, and is bound to do so if agreed upon in either an individual or collective agreement ; but he is entitled to claim an adequate compensation for such assignment or grant of licence, a right which he cannot validly waive in advance. Failing an agreement between employer and employee, the Court has to assess the compensation, taking into consideration the importance of the invention, the possibilities of utilizing the same and the part which facilities provided by the employer and his experience have played in arriving at the invention. Such a decision may be altered by the Court on application of either side if circumstances have essentially changed.

Experience has shown in Austria that the question of compensation has nearly always been solved by agreement, so that resort to the Court was necessary only in very few exceptional cases.

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Petrological Microscopes

A SMALL committee has been formed, including representatives of the Mineralogical and Geological Societies, with the object of furthering the manufacture of petrological microscopes in Great Britain. The committee would welcome comments from any persons interested with whom they are not already in touch, to be addressed to the Secretary, Petrological Microscope Committee, Geological Survey Office, Exhibition Road, S.W.7.

A. BROUGHTON EDGE.
A. F. HALLIMOND.
(Acting Secretaries.)

RESEARCH ITEMS

Putrescine in the Biosynthesis of Hyoscyamine

In plants of *Atropa belladonna* and *Datura stramonium*, growing normally, hyoscyamine appears to be formed principally in the root, with putrescine as an intermediate metabolite, and then moves upwards through the vessels into the stem, leaves, fruit and seeds (B. T. Cromwell, *Biochem. J.*, **37**, 717 and 722; 1943). The author's previous work on the biosynthesis of berberine and hyoscyamine had led to the conclusion that these alkaloids are synthesized from products of carbohydrate and protein breakdown. Work on the nature of the intermediate reactions leading to the formation of hyoscyamine, by experiments on exudates of cut stems, grafting and slow injections of various substances into stem stumps or branches of *Atropa belladonna* and *Datura stramonium*, showed the root as the probable locus of synthesis, and demonstrated the stimulating effect of arginine, hexamine, formamol and especially putrescine. This is compared with results of other workers (for example, Dawson, *Science*, **94**, 396; 1941), who concluded that nicotine is synthesized mainly in the root of the tobacco plant and that the alkaloid moves from the root system via the xylem to the leaves. It was of interest to determine the manner in which putrescine provided its contribution to the hyoscyamine molecule. Bearing in mind the use of succinaldehyde in the synthesis of tropinone, it might be concluded that putrescine gives rise to succinaldehyde by oxidation. The occurrence of an enzyme system bringing about the oxidative deamination of putrescine with formation of ammonia and an aldehyde in roots and etiolated shoots, and the isolation of small amounts of putrescine from leaves and upper stems of *Atropa belladonna* and *Datura stramonium*, add weight to these considerations.

Biology of the Albacore

Vernon E. Brock has discussed ("Contribution to the Biology of the Albacore (*Germo alalunga*) of the Oregon Coast and other Parts of the North Pacific". *Stanford Ichthyological Bulletin*, **2**, No. 6; Dec. 1943. Contrib. No. 10, Department of Research, Fish. Commission of Oregon) the albacore fishery in connexion with the probable causes of the sudden reduction in abundance off the coasts of California. This is the result of the first four years study and describes certain biological features in the albacore populations of the Pacific coast with emphasis on those of Oregon, and presents a review of all available material on the species from other parts of the North Pacific in so far as the material bears on the fishery problems. Fish with ripening ova are not present in the Oregon fishery and have never been recorded from the Californian fishery. It is probable that those forming the fishery have never spawned. The available evidence strongly suggests that only a few year-classes are present in the temperate-water fisheries for this species and that these are immature. This may, at least in part, account for the history of instability shown by the Californian fishery and may cause a similar instability in the Oregon fishery. The populations exploited by the North Pacific albacore fisheries may represent three different stocks or races which centre off the coasts of North America, Hawaii and Japan. The existence of albacore in mid-Pacific at positions roughly midway between these localities makes it appear possible that a certain amount of mingling may occur. It is not known if those fish occurring offshore represent wholesale migratory movements, but if so, the study and conservation of this species would cover the entire North Pacific Basin.

Mutations in Bacteria

The nature of variation in bacteria is a theme upon which disagreement exists. G. Luria and M. Delbruck (*Genetics*, **28**, 491; 1943) have discovered some important facts regarding this problem. *Escherichia coli* B. in culture with bacterial virus 9 first shows complete lysis and then, after a few hours, secondary cultures make their appearance. These consist of cells which breed true to resistance to attack by the virus. The distribution of resistant bacteria in the various cultures of sensitive bacteria was ascertained. The fluctuation in the number of resistant bacteria was considerably higher than could be accounted for by sampling error. On the theory that the resistance is due to acquired immunity, there will either be a binomial distribution or a Poisson series if the numbers are small. On the mutation theory the assumption is that there is a fixed chance of change per unit time, which is measured in cycles of bacterial division. The authors show that a variance much greater than unity is to be expected. In every case, the experimental results accord with the calculations on this theory, with a discrepancy of even higher variability than expected. The mutation-rate was determined experimentally to be $2{\cdot}45 \times 10^{-8}$ per bacterium per division cycle.

New Species of Aquatic Fungi

Two papers recently published by C. F. Ingold (*Trans. Brit. Mycol. Soc.*, **26**, Pts. 3 and 4, 104 and 148; Dec. 1943) describe four new species of aquatic Hyphomycetes. *Dendrospora erecta* and *Piricularia anomalum* were found on decaying submerged oak leaves. The former species necessitated also the creation of the new genus Dendrospora, the main criterion of which is the production of tree-like spores, as the name implies. *Tricladium anomalum* was found growing on decaying submerged leaves of *Typha latifolia*, while *Triscelophorus monosporus* inhabited leaves at a later stage of decay, too rotted for identification. Triscelophorus is also a new genus. It seems possible that aquatic Hyphomycetes are of fairly wide distribution. Dr. Ingold has recorded several species upon decaying sweet chestnut and hawthorn leaves in addition to oak and alder leaves as described in an earlier paper.

Continental Drift and Fossil Floras

In a study entitled "Continental Drift and Plant Distribution" (privately printed, 1943), Prof. D. H. Campbell, of Stanford University, California, argues that, from a comparison of the existing and fossil floras of the northern and southern hemispheres, it is clear that the two areas were completely separated up to the end of the Mesozoic period, and that North America and Eurasia have always been more or less intimately connected. The relations between the genera and even species of New Zealand and Chile, and West Africa and Brazil, are so close that former land connexions must be assumed. Most of the common forms could not have been transported by ocean or air currents. The almost complete absence from the southern continent of the characteristic

boreal trees, such as Pinaceæ, Fagaceæ, Salicaceæ, Magnoliaceæ and others, and the absence in the northern hemisphere of many austral families, like the Myrtaceæ and Proteaceæ and the coniferous Araucaria and Podocarpus, is evidence of the complete separation of boreal and austral land masses from late Palæozoic to late Mesozoic times, and confirms Du Toit's theory of two original land masses of Laurasia and Gondwana rather than Wegener's theory of Pangæa. When the first connexions between the two were established is not certain. The paper contains a great deal of closely reasoned evidence.

Meteorites and an Earth-Model

UNDER this title R. A. Daly discusses the old hypothesis that the materials of the substratum and core of the earth are likely to be closely similar to those of average meteorites (*Bull. Geol. Soc. Amer.*, 54, 401 ; 1943). The paper summarizes the principal observed facts about the nature of meteoritic stones and irons, and the reasons for supposing them to be fragments of a disrupted parental planet. After comparison between the latter and the earth itself, the hypothetical evolution of the earth is tested by reference to the terrestrial discontinuities revealed by seismic evidence, and to mean density, moment of inertia, radioactivity and plasticity. Rough estimates of the temperatures and the degrees of strength of the materials in depth are deduced. The author assumes the earth to have been initially gaseous with a temperature well above the boiling point of iron (about 3,000° C.) and traces the probable effects of condensation and differentiation. The suggested course of development leads to an earth-model which has the following succession from surface to centre : a crust or lithosphere ; a thicker vitreous asthenospheric (weak) shell ; a still thicker crystallized mesospheric shell ; and a nickel-iron core, probably fluid and possibly behaving much like a gas. It is frankly confessed that the processes envisaged fail to account satisfactorily for the existence of a sharply defined radioactive layer. Moreover, no attempt is made to apply tests of a dynamical character, that is, to confront the model with the geological facts of mountain-building and vulcanism. Nevertheless, quite apart from its conclusions, some of which are necessarily highly speculative, the paper is extremely valuable as a compendium of all the relevant data by which such speculations must be guided.

Reaction Kinetics in Solution

IN the Tilden Lecture to the Chemical Society (*J. Chem. Soc.*, 629 ; 1943) R. P. Bell gave an account of some attempts to calculate velocity coefficients on the basis of activation energy. The fundamental equation was proposed by Arrhenius, and for bimolecular reactions is $k = Ae^{-E/RT}$, where E is the activation energy, having values from 7 to 40 k.cal. per mol. The values of A vary considerably ($10^2 - 10^{19}$) and, although the values are distributed over the whole range, smaller values apply to reactions between uncharged molecules and larger values to reactions between ions. The A values have been interpreted either as giving the product of the collision frequency Z and a so-called probability factor P, namely, $A = ZP$, and also on what is called a transition state theory, in which the equilibrium constant K for a state X through which the reacting molecules pass during reaction ($A + B \rightleftharpoons X$) and the thermal velocity v, which does not vary greatly from one reaction to another, are connected by the equation $k = Kv$. It appears that in solution Z is not greater than four times its value for the reaction in the gaseous state. The question of solvation is an important one, and is dealt with rather fully in the lecture. In a series of solvents A and E are found to change in a parallel manner. The lecture gives a concise yet comprehensive survey of the subject with which it deals.

Boundary Lubrication and Heat of Absorption

FOLLOWING an earlier investigation of the effect of temperature on the boundary lubrication of mild steel surfaces by a number of pure long-chain compounds, J. J. Frewing has now published a study correlating the results with heat of absorption (*Proc. Roy. Soc.*, A, 182, 270 ; 1944). The frictional behaviour between mild steel surfaces lubricated with solutions in white oil of long-chain halides and other compounds was studied under high loads at low speeds. For all compounds a transition from smooth sliding to stick-slips occurs at a temperature characteristic of the particular solution used. The transition temperature increases with the concentration. Each solution builds up, and is in equilibrium with, an absorbed and oriented film of the polar compound on the surface. By assuming that the transition occurs when the surface concentration of this film decreases to a certain value which, for any one material, is independent of temperature, an equation was deduced relating the concentration and transition temperature with the heat of absorption (U). The equation fits the experimental results well. From the values of U it appears that these long-chain polar compounds are adsorbed by the interaction of their dipoles with the atoms in the metal surface and not by any chemical reaction. The results also suggest that the esters are similarly oriented at metal and at aqueous surfaces.

Polarization in Fraunhofer Lines at the Sun's Limb

DR. ZANSTRA showed in 1941 that if atoms in the solar atmosphere acted like classical oscillators, light within Fraunhofer lines should be polarized near the sun's limb (*Mon. Not. Roy. Astro. Soc.*, 101 ; 1941). R. O. Redman examined the solar spectrum at $\sin \theta = 0{\cdot}985$, and was able to obtain only a small amount of polarization in the line 4227, Ca I, the observed effect being only about one tenth of that predicted by theory. Zanstra showed later that collision damping would reduce the predicted polarization very considerably, and Redman has suggested recently that the polarization would be weakened by the roughness of the sun's surface (*Mon. Not. Roy. Astro. Soc.*, 103, 173 ; 1943). Fresh observations have now been made by Redman at the Radcliffe Observatory, using an improved method (*Mon. Not. Roy. Astro. Soc.*, 103, 6 ; 1943). A description of the apparatus is given. By suitable arrangements the observations are much more accurate than those previously obtained. In addition to certain precautions, check photographs were made at the centre of the sun's disk, where there should be no polarization, these being taken immediately after the limb photographs. The results confirm the previous conclusion that polarization in the Fraunhofer lines is much smaller than was predicted by Zanstra's original theory.

PHOTOGRAPHY IN AGRICULTURAL RESEARCH

ON April 29, the Association for Scientific Photography held a meeting at Caxton Hall, London, to discuss "Photography as a Tool in Agricultural Research". Papers were read by Dr. E. M. Crook and Mr. V. Stansfield, of Rothamsted Experimental Station, and by Mr. J. C. Hawkins and Mr. R. H. Broome, of the National Institute of Agricultural Engineering, Askham Bryan, and illustrated by lantern slides and cine films.

The word 'tool' was included in the title in order to emphasize the fact that the centre of interest should be no radically new departure in the use of photographic materials in agricultural research, but simply the day-to-day use of well-known and well-tested techniques such as can be depended upon to yield results with a minimum of trouble and incidental research.

A large proportion of the photographic work of both institutes, as indeed is true of all photography applied to science, arises as a result of the need for an adequate means of preserving a detailed and easily comprehended record of very complex situations and phenomena. A single photograph will often record experimental results more adequately than several pages of written notes; in addition, it often preserves for future reference effects which were quite unnoticed at the time the experiment was made. Similar considerations apply to the use of photographs for passing on instructions for assembling or adjusting an agricultural implement or recognizing a certain plant disease. The photographic record, being objective, is also a valuable means of establishing beyond dispute the results of tests such as the Institute of Agricultural Engineering continually carries out on articles submitted by manufacturers.

Many records are enhanced in value, and in dramatic effect, by the use of colour. This is especially true of the recording of plant disease symptoms and the results of manurial trials such as make up a considerable proportion of the work at Rothamsted. On the other hand, where relative positions and the demonstration of movements are important, as at Askham Bryan, colour does not present any particular advantage. Other special techniques include the use of infra-red plates to record satisfactorily the lesions in the streak diseases of potato.

Recording does not, of course, cease with macroscopic objects, so far as Rothamsted is concerned. Illustrations were shown of records of the life-cycles of two soil organisms, crystals of plant viruses and of the lesions caused by such viruses, all of which involve photomicrography. The electron microscope now available at Rothamsted allows these records to be extended right down to the actual particles of virus and particles of clay (Fig. 1) at magnifications of 20–30 thousand diameters.

At the other end of the scale comes the use of aerial photographs (Fig. 2) for observing crops, the first of which were taken in 1925 by the R.A.F., at the request of Rothamsted. As is well known, aerial photographs show up differences completely invisible from the ground, and make possible the recording on a single plate of such differences in crops covering many acres.

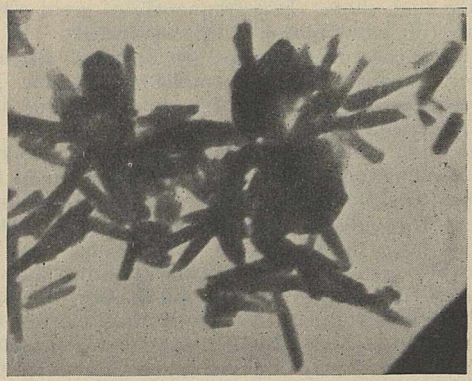

Fig. 1. THE CLAY MINERAL, HALLOYSITE. ELECTRON-MICROGRAPH TAKEN AT ROTHAMSTED BY DR. F. M. L. SHEFFIELD. × 20,000.

Most of this 'still' recording work (except electron micrographs and aerial photographs) is done with modern small cameras; the Leitz Leica using 35 mm. film at Rothamsted, or the Zeiss Super Ikonta, giving $2\frac{1}{4}$ in. × $3\frac{1}{4}$ in. pictures at Askham Bryan. The former can be easily adapted for photomicrography by means of the 'Ibso' attachment, or by extension tubes and the sliding copy device, and both are in use at Rothamsted, as well as the Leitz 'Makam' camera, all of which are attached directly to a standard microscope.

Cinematography also finds a valuable place in this work. At Rothamsted, a comprehensive study has been made of the formation of cell inclusions in plants infected with virus, and several stills from this film were shown at the meeting. This film was made using exposures twelve times as long as normal, and when run at the normal rate gives a speeded-up effect which makes possible the detection of many movements which occur too slowly to be seen by direct observation. At Askham Bryan even more use is made of cinematography, partly for educational work and partly for studying the performance of machines. It has been found that the use of the 'aerial' shot is of great advantage in illustrating the movement of farm machinery; a special portable tower 20 ft. high, mounted on a lorry, is used for

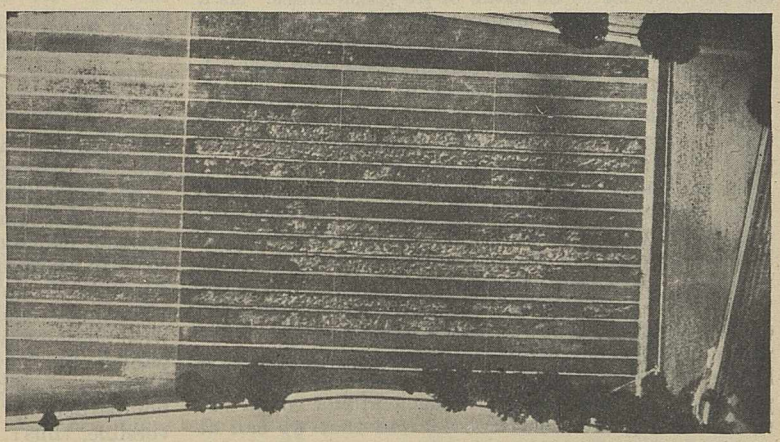

Fig. 2. BROADBALK FIELD, ROTHAMSTED. AERIAL PHOTOGRAPH BY R.A.F. IN 1930. THE DIFFERENTLY MANURED STRIPS, SOME WITH MUCH LODGING, STAND OUT PLAINLY. THE DIFFERENCES BETWEEN FALLOW (RIGHT) AND CROP (LEFT) DURING THE PRECEDING YEAR CAN ALSO BE SEEN.

making such shots. It is frequently of great advantage to run slow-motion films backwards. In such circumstances many points are obvious which can scarcely be noticed in a normal forward run. Illustrative excerpts of films of a potato digger and a disk-plough in action were shown.

The 'high light' of the afternoon was a speeded-up film of ploughing, made at Askham Bryan, to teach the best methods of laying out and ploughing a field so that idle running of plough and tractor is reduced to a minimum. A suitable field on Tees-side overlooked by a cliff was the site, and the whole operation of setting out and ploughing was photographed from the top of the cliff, one picture being taken every second. In this way it was possible to compress two days ploughing into a film which could be shown at the normal rate in 40 minutes. The effect, as well as being very instructive, was amusing, as the tractor and plough appeared to move at about 50 m.p.h.

In addition to these direct methods of employing photography, two uses of the photographic emulsion at Rothamsted were touched upon: spectrographic analysis, both qualitative and quantitative, and X-ray diffraction work on clay minerals, in both of which the sensitive emulsion is used as a recording medium. Standard equipment is used for both—a Hilger medium quartz spectrograph and a Cambridge cylindrical powder camera of 28 mm. radius.

The spectrographic work includes the analysis of soils and plants for such elements as calcium, potassium, sodium, manganese and magnesium, and the detection and estimation of trace elements such as copper and boron and, in one or two recent instances, zinc, lead and chromium in toxic soils. Elements of the first group are estimated from lines excited in the Lundegärdh burner, and calibration curves are plotted with the ratio of line density to background density as ordinate and logarithms of the concentration as abscissæ. Elements of the second group are estimated from lines excited in the carbon and copper arc, using suitable internal standards; for example, tin for boron, the intensity of the tin line at 2496 A. being compared with the boron line at 2498 A.

The X-ray work is indispensable for the identification of minerals found in soil colloids and clays. The electron microscope will undoubtedly help greatly in this work, but as yet, insufficient data are available for the best use to be made of its possibilities. As a general rule, powder diagrams of clay minerals are poor because of the large scattering near the central beam, and aggregate diagrams must be used instead. However, the newer technique of replacing the air in the camera by hydrogen so cuts down the scattering as to make the former more valuable, particularly when obtained from an aggregate.

In the short discussion following the papers, Prof. Yule Bogue raised the question of the limitation of the electron microscope for the examination of biological material by the necessity for working in a vacuum. Dr. Crook, replying, pointed out that the vacuum is only one of the limitations, since the electron-scattering power of the oxygen atoms of the water which constitutes so large a proportion of living material is much greater than the scattering power of the carbon and nitrogen atoms which are the chief 'organic' constituents, and that we can at best hope for an image rather like a radiograph if it becomes possible to use wet material (say, by a freezing technique).

NUCLEAR ENERGY-LEVELS

THE following is a summary of a paper by P. Comparat* which came into the writer's hands by an unorthodox but topical procedure. Printed at Lyons in 1942, it was brought from France by an officer of the Free French forces in 1943. It then found its way into the hands of Prof. D. Saurat, of the French Department of King's College, London, who presented it to the College library. The work described therein was carried out at the Faculty of Sciences, Lyons, initially under the direction of Prof. J. Thibaud. The research occupied a period of four years, full time being devoted to the problem.

Introduction. The first demonstration of the transmutation of nitrogen by rapid neutrons was that of Feather in 1932, using a cloud expansion chamber. The suggested reaction was

$$^{14}N + n \rightarrow {}^{4}He + {}^{11}B + Q,$$

where Q was negative, thus corresponding to an endo-energetic reaction. Subsequent workers, for example, Chadwick and Goldhaber, showed in 1935 with an ionization chamber and a linear amplifier that exo-energetic disintegration also occurred in this reaction. About the same time, Kurie demonstrated that an alternative reaction occurred in which protons were emitted instead of α-particles.

The aim of Comparat's research was to measure the number of disintegrations at various energies of disintegration and to see if the magnitude and distribution of the energy-levels agreed with the current theory. By 1936 the discord between theory and experiment was considerable; the existing theory,

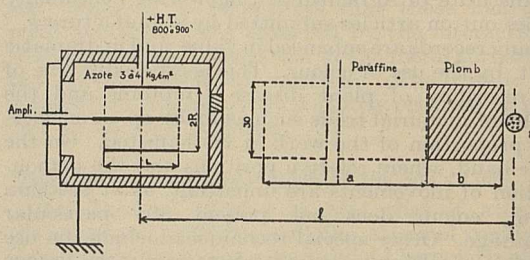

FIG. 1.

based on the two-body concept of the interaction of the incident neutron with the ^{14}N nucleus, predicted a few nuclear levels of considerable width. On the contrary, experiment showed numerous sharp levels. Again, theory predicted identical values for the diffusion and capture cross-sections of slow neutrons, whereas experiment showed a large ratio.

At about this time, Bohr introduced the concept of nuclear transmutation according to which the incident neutron amalgamates with the entire nucleus to form an intermediate nucleus (in this case ^{15}N) of appreciable duration. The intermediate nucleus afterwards disintegrates, for it is in an excited state, with the emission of a heavy particle, often accompanied by γ-radiation. In the special case of nitrogen bombarded by neutrons and boron bombarded by α-particles, the whole process is reversible, thus:

* "Disintegration of Nitrogen by Fast Neutrons; Distribution of the Energy Levels of N^{15}". By P. Comparat. Pp. 96. (Lyon, 1942.)

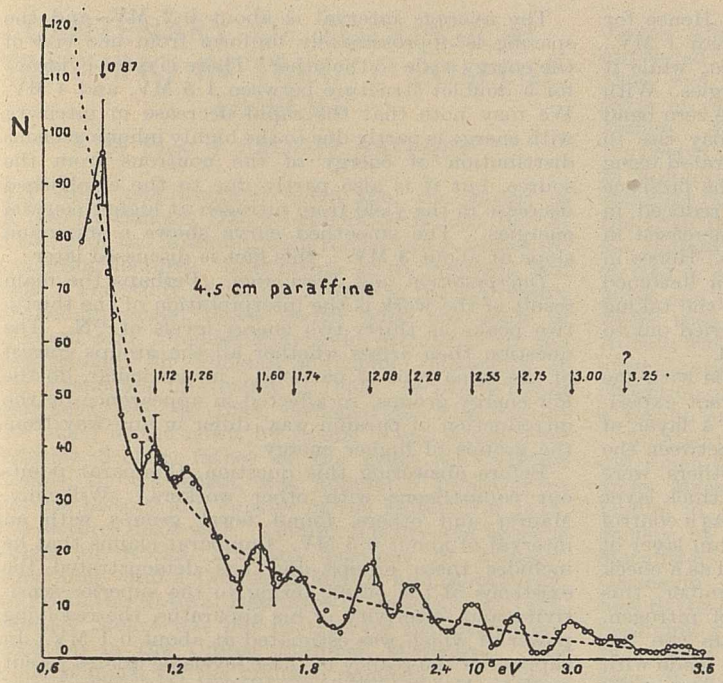

FIG. 2.

$$^{14}N + {}^{1}n \rightarrow {}^{15}N \rightarrow {}^{11}B + {}^{4}He \qquad (1)$$

and also

$$^{11}B + {}^{4}He \rightarrow {}^{15}N \rightarrow {}^{14}N + {}^{1}n \qquad (2)$$

Hence the same resonance levels of ^{15}N should be registered in both cases, although the ^{15}N has been prepared by two quite different processes.

By 1937, several determinations had been made of the values of the excited levels of ^{15}N. Wilhelmy had demonstrated the existence of at least five distinct levels for reaction (1), while Maurer had recorded eight levels for reaction (2). Agreement was found between the two workers with four of the energy values. Of the remainder, two further values were assigned to ^{15}N, but the other two were attributed to the excited isotope ^{14}N, formed from the boron isotope ^{10}B, which was present in the experiment. Szalay confirmed Maurer's six levels for ^{15}N and added one more. Finally, Ortner and Protowinsky found a total of twelve groups of particles emitted by ^{15}N in the energy range 1–7 MV.

Experimental arrangement. A diagram of the experimental arrangement is shown in Fig. 1. The principle of the method consists in the use of a proportional counter connected to a linear amplifier and an oscillograph to record the total energy of disintegration of the α-particle together with that of the residual recoiling nucleus ^{11}B.

The counter has a cylindrical anode of about 25 mm. diameter; this was positively charged. The negative electrode was an axial filament 0·5–1 mm. in diameter. The pressure of nitrogen filling the counter was 4–5 atmosphere. At this pressure not only is the ionization increased but also the range of the disintegration products is sufficiently reduced to ensure their being entirely contained in the counter. Zinc was chosen as the metal for the outer electrode on the grounds of ease of purification; the total effective volume of the counter was 15–20 c.c. The potential difference between anode and cathode was about 900 volts and the counter filament was connected to the grid of the first amplifying valve.

The source of neutrons was the usual radon – beryllium mixture of strength 150–400 millicuries. Difficulties arising from the intense γ-radiation were reduced to a minimum by the insertion of absorbing blocks of lead. For details of the linear amplifier, reference is made to an earlier publication of Thibaud, Cartan and Comparat (1938). Special precautions were taken to maintain constant conditions of amplification; for example, changes in resistance were prevented by keeping the apparatus to within 5°–10° C. by thermostat. The sensitivity and reliability of the instrument was checked at frequent intervals with a standard polonium source. As a further check, the constancy of amplification was tested by measurement of the heights of the peaks observed on the oscillograph when a weak A.C. potential was applied to the ionization chamber. The oscillograph was of the Dubois electromagnetic type and this suffered from some zero displacement.

Measurements. The final results were expressed in the form of curves with $N = f(E_{a+B})$, where N is the number of peaks corresponding to a total energy of the disintegration products E_{a+B}. Apart from the error arising from statistical fluctuations, which could be readily estimated, the chief source of uncertainty lay in the determination of the exact heights of the peaks. These heights varied from 10 mm. to 50 mm. and it was estimated that measurements

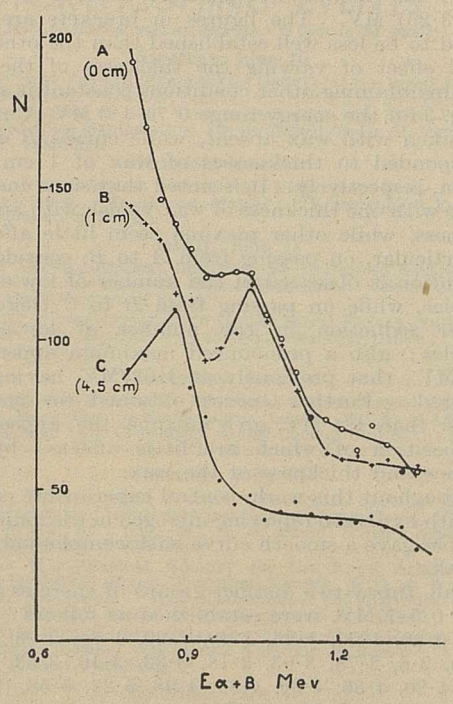

FIG. 3.

could be made to within 0·25–0·5 mm. Hence for smaller energies, corresponding to less than 1 MV., the maximum error was about 5 per cent, while it was correspondingly smaller at larger energies. With an intense γ-ray background, however, the zero band is widened considerably and the error may rise to 3–4 mm. The effect is strikingly demonstrated using α-particles from a polonium source. In the presence of γ-radiation, a typical α-ray peak is reduced in height by more than 50 per cent and increased in breadth by a factor of three or four times. Hence in deciding the reality of the existence of a flattened resonance group, some procedure such as the taking of several independent recordings was carried out to see if the point of inflexion was repeated.

Several sets of measurements were made with the same counter but under somewhat different experimental conditions. Some correspond to a layer of paraffin wax, 0–10 cm. thick, interposed between the source and the ionization chamber; others were made with no wax and only a sufficiently thick layer of lead to absorb most of the γ-radiation. As a control on the effect of the thermal neutrons, a thin layer of cadmium (0–5 mm.) could be inserted, and as a check on the behaviour of the ionization chamber, this could be filled with hydrogen instead of nitrogen. Typical of the measurements made were the following: (*a*) Ten recordings of 1 hour each made with different thicknesses of wax and with neutrons in the energy range 0·5–1·8 MV. (*b*) Three recordings of 4 hours each with three different thicknesses of wax —energy range of neutrons 0·75–3·6 MV., and so on.

Results. Some of the results obtained are shown in Figs. 2 and 3. In Fig. 2, the energy range of the incident neutrons was 0·75–3·6 MV. with a thickness of wax of 4·5 cm. The general behaviour, which is quite typical, shows a decrease of intensity with energy, together with distinct groups superposed on the smoothed curve, for example, at energies of 0·87, 1·12, 1·26, 1·60, 1·74, 2·08, 2·28, 2·55, 2·75 (3·00) and (3·25) MV. The figures in brackets are considered to be less well established than the others.

The effect of varying the thickness of the wax while maintaining other conditions constant is shown in Fig. 3 for the energy range 0·75–1·3 MV. Curve *A* was taken with wax absent, while curves *B* and *C* corresponded to thicknesses of wax of 1 cm. and 4·5 cm. respectively. It is noted that some maxima visible with one thickness of wax vanish with another thickness, while other maxima seem little affected. In particular, on passing from *A* to *B*, considerable diminution is observed in the number of low-energy particles, while on passing from *B* to *C* there is a further reduction in the number of low-energy particles; also a pronounced maximum appears at 0·87 MV., that previously at 1·02 MV. having disappeared. Further curves obtained for energies greater than 1·4 MV. give maxima the appearance and position of which are little affected by the presence and thickness of the wax.

Throughout this work, control experiments carried out with hydrogen replacing nitrogen in the ionization chamber gave a smooth curve with complete absence of peaks.

In all, thirty-two distinct groups of energies in the range 0·5–7 MV. were established as follows: 0·60, 0·75, 0·90, 1·05, 1·25, 1·40, 1·60, 1·75, 2·05, 2·25, (2·42), 2·6, 2·78, 3·03, 3·18, 3·33, 3·46, 3·63, 3·76, 4·02, 4·20, 4·36, 4·66, 4·82, 4·98, 5·27, 5·58, (6·04), (6·22), (6·41), (6·66), (7·00).

The average interval is about 0·2 MV. and the spacing is approximately uniform from one end of the energy scale to the other. There is some evidence for a doublet structure between 1·5 MV. and 4 MV. We may note that the rapid decrease in intensity with energy is partly due to the highly inhomogeneous distribution of energy of the neutrons from the source, but it is also partly due to the established decrease in the yield from nitrogen at higher neutron energies. The smoothed curve shows a minimum slope at about 3 MV.; this fact is discussed later.

Interpretation and Discussion. Perhaps the main result of the work is the interpretation of the thirty-two peaks as thirty-two energy-levels of ^{15}N. The question then arises whether all the groups consist of the same type of particles; in particular, do the low-energy groups, so affected in appearance by the introduction of paraffin wax, differ in any way from the groups of higher energy?

Before answering this question, Comparat points out comparisons with other workers. Wilhelmy, Maurer and others, found fewer groups with an interval of about 0·5 MV. Comparat claims that he includes these groups and has demonstrated the existence of the others owing to the superior sensitivity and selectivity of his apparatus, the resolving power of which was estimated at about 0·1 MV. In support of the reality of these levels he quotes recent work by Hansen which also shows a large number of levels although the source was quite different, the neutrons being obtained by the deuteron bombardment of beryllium or lithium.

The particles at lower energy, the production of which is affected by the thickness of paraffin wax, are considered to be protons produced by the reaction

$$^{14}N + {}^{1}n \rightarrow {}^{15}N \rightarrow {}^{14}C + {}^{1}H \qquad (3)$$

The particles of higher energy are α-particles produced according to reaction (1). The existence of two groups of particles explains the change in shape of the smoothed curve at about 3 MV. The curve is assumed to be compounded of two curves, one giving the yield of protons and the other that of α-particles, the latter curve having a maximum in the region of 3 MV. Careful examination shows that at very low energies the curve again shows a change of shape and this is attributed to a third type of interaction, namely, the elastic recoil of nitrogen nuclei on neutron impact.

Comparat conceives the possibility of an apparatus of higher resolving power demonstrating the existence of still more levels of ^{15}N. That the number of undiscovered levels should prove large he considers improbable on the practical grounds of the reproducibility of existing groups under conditions of varying sensitivity of his apparatus and on theoretical considerations of the spacing of the energy levels of light nuclei. Theory also supports the view that the low-energy particles are protons, since α-particles of such low energy would have very great difficulty in penetrating the potential barrier of the nitrogen nucleus.

By extending these experiments to oxygen and other elements a veritable nuclear spectroscopy of energy levels could be evolved. Valuable information on nuclear structure might then be forthcoming by examining the distribution and width of energy levels as a function of the number of nuclear particles, thus throwing light on the nature of the forces which bind these nuclear particles together.

F. C. CHAMPION.

CENTENARY OF ZOOLOGICAL TEACHING IN TRINITY COLLEGE, DUBLIN*

By PROF. J. BRONTË GATENBY

IN April one hundred years ago, the Board of Trinity College, Dublin, appointed Robert Ball as director of the Museum, with rooms and facilities for delivering lectures "illustrative of its contents and uses". The study of natural history in the University of Dublin began much earlier with the work of William and Thomas Molyneux, grandsons of the Englishman, Sir Thomas Molyneux, Chancellor of the Exchequer in Ireland in 1558. It was William Molyneux who, in 1684, demonstrated the flow of the blood in the newt, by means of the microscope. Whitley Stokes, father of the great Sir William Stokes, the physician, was appointed professor of natural history and curator of the Museum in 1815. His lectures dealt with "Volcanic Theory and Igneous Origin of Rocks, different portions of Zoology, Mineralogy and a Course in Mining and Metallurgy, and with the Natural Resources of Ireland". In 1791, Whitley Stokes was put on trial for his alleged implication in the United Irishmen Movement. He suffered much for his political opinions.

After the appointment of Robert Ball, the study of zoology was not pursued vigorously because his lectures did not have the status of a university subject. Ball, who was a Civil servant in the Chief Secretary's office, was retired on pension by the Government in 1852 on the ground that he "devoted much attention to scientific pursuits, and it was not expedient that public servants should be thus occupied". Ball died in 1857, and in the same year, after his death, the Rev. Samuel Haughton, F.R.S., later professor of geology, announced that the Board of Trinity College had promoted the study of zoology to a recognized university subject. Haughton took an active interest in the development of the School of Physic at Trinity College, and was responsible for bringing in first-class men from outside, such as Alexander Macalister (later professor of anatomy at Cambridge) and Daniel Cunningham (of Edinburgh), whose two sons, Admiral Sir Andrew Cunningham and General Sir Alan Cunningham, have had remarkable careers in recent times. After Robert Ball, the human anatomist Robert Harrison was appointed the first lecturer in zoology, a position he occupied for two years. Afterwards, Edward Percival Wright was appointed lecturer, and then in 1868 became the first professor of zoology. Wright transferred to the Botany School of Trinity College in 1869, and Alexander Macalister was brought in from the College of Surgeons of Ireland as professor of zoology (and comparative anatomy) in 1870. Later, Macalister became professor of human anatomy and chirurgery in Trinity College; he went to Cambridge in 1883. He was succeeded by William Henry Mackintosh as professor of zoology in 1879, who held the chair for forty-two years. He was at the same time registrar of the School of Physic, a position which needed considerable work; his interest in theology and missionary teaching also made inroads in his time, so that he did not publish any original work in the middle and later periods of his life.

It is of interest to zoologists to notice that George James Allman, the authority on Hydrozoa, was appointed professor of botany in Trinity College in 1844, and that the foundations of his exact knowledge of various groups of Cœlenterata were laid in Dublin. Allman was professor of botany in Dublin for twelve years, going to the chair of natural history in Edinburgh in 1856. James Allman was born at Bandon, Co. Cork, in 1812, and at first studied for the Irish Bar. Later he abandoned law and entered the College of Surgeons. He obtained what training he had in science, partly at the Irish College of Surgeons and partly in various private medical schools which then flourished in Great Britain and Ireland. Allman was attracted to the study of the Cœlenterata, after hearing a paper on a "large and beautiful collection of zoophytes" made by a Mr. A. H. Hassell, a Dublin amateur zoologist.

Another great College of Surgeons graduate who did much for the Trinity College School was Alexander Macalister. His father had been brought to Dublin in 1830, as secretary of the Sunday School Society of Ireland. When a small boy, Alexander Macalister was befriended by the curator of the Glasnevin Botanical Gardens, and on his advice, sent to the College of Surgeons at the age of fourteen, becoming a qualified medical man three years later. In view of the fact that Macalister's schooling was poor, it is astonishing that Dr. E. Barclay-Smith (*J. Anat.*, **54**; 1919–20) was able to write of him, "he was an able mathematician and familiar with many languages both living and dead. In Archæology, Zoology, Egyptology, Theology, Biblical History . . . he was an inexhaustible mine of knowledge". Macalister was for thirty-six years professor of anatomy at Cambridge. Macalister was born in 1844, the same year that George James Allman and Robert Ball became members of the staff of Trinity College, Dublin.

* From an address delivered to the Dublin University Biologica Association on May 22.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, June 10

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Some Aspects of High Vacuum Technique, viz., High Vacuum Gauges and Glass Manipulation" (to be opened by Dr. M. Pirani and Dr. B. P. Dudding).

Monday, June 12

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. Gordon Manley: "Topographical Features and the Climate of Britain".

Tuesday, June 13

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. Elise J. Baumgartel: "Some Observations on the Prehistory of Egypt".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. C. H. Caffyn: "Rocks and their Structure".

Wednesday, June 14

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 3.30 p.m. —Discussion on "The Consumer's Supply Control Unit of the Future and its Effect on the Design of the Electricity Meter".

Thursday, June 15

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2), at 1 p.m.—Mr. H. G. Maule: "Some Aspects of Factory Inspection in War Time".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.— Dr. H. L. Hamburger: "The Mathematical and Historical Background of Hilbert's Theory of the Continuous Spectrum".

CHADWICK PUBLIC LECTURE (at the Chelsea Physic Garden, Swan Walk, Chelsea, London, S.W.3), at 4 p.m.—Dr. B. Barnes: "Vegetation and Human Well-Being".*

Saturday, June 17

BIOCHEMICAL SOCIETY (in the Physiology Department, University College, Dundee), at 2 p.m.

APPOINTMENTS VACANT

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

APPRENTICE SUPERVISOR by large Engineering works to supervise educational and training schemes for apprentices and young persons (Nottingham district)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2021XA) (June 14).

PROFESSOR OF BOTANY, ASSISTANT LECTURERS IN ECONOMIC HISTORY, GEOGRAPHY, BOTANY and ZOOLOGY, ORGANIZING TUTOR IN ADULT EDUCATION for Derbyshire, and a TUTOR IN PSYCHOLOGY—The Registrar, University College, Nottingham (June 14).

HENRY MECHAN CHAIR OF PUBLIC HEALTH—The Acting Secretary of University Court, The University, Glasgow (June 15).

SPEECH THERAPIST—The Director of Education, Education Offices, 15 John Street, Sunderland (June 16).

ASSISTANT (with Graduate or satisfactory industrial qualifications) to take MATHEMATICS, ENGINEERING, SCIENCE and DRAWING—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (June 17).

LECTURER IN DIETETICS in connexion with Course leading to University of London Academic Post-Graduate Diploma in Dietetics—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 17).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Technical College, Sunderland (June 17).

HEAD OF THE DEPARTMENT OF PHYSICS in the Bradford Technical College—The Director of Education, Town Hall, Bradford (June 17).

METALLURGIST by Firm of Engineers with wide interests (Ph.D., or equivalent, minimum technical qualification)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2286XA) (June 17).

ASSISTANT MASTER (full-time) in the Smith Junior Nautical School to teach mainly MATHEMATICS and SCIENCE—The Director of Education, City Hall, Cardiff (June 19).

HONOURS GRADUATE IN ENGINEERING to teach ENGINEERING SCIENCE, DRAWING and MATHEMATICS in the Merthyr Tydfil Technical School—The Director of Education, Education Department, Pontmorlais, Merthyr Tydfil, Glam. (June 21).

QUALIFIED ENGINEER by Tyre Manufacturers to direct experimental work on test rigs (location, Wiltshire)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2098XA) (June 21).

DEPUTY CHIEF ENGINEER (location, City of Manchester)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.834XA) (June 21).

DEPUTY BOROUGH ELECTRICAL ENGINEER (location, County Borough of St. Helens)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.851XA) (June 21).

PHYSICIST for essential War Work (work would include experience in various research departments of a North London firm specializing in optical instruments for scientific and industrial research and control)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.518XA) (June 21).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Wimbledon, London, S.W.19 (June 23).

DEMONSTRATOR (man or woman) in the CHEMISTRY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, Brunswick Square, London, W.C.1 (June 23).

PRINCIPAL ENGINEERING ASSISTANT on the permanent staff of the Buildings Department of the Kent County Council—The Council Architect, Kent County Council, Springfield, Maidstone (June 24).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Manchester 13 (June 26).

CHEMICAL ENGINEER for Aluminium Powder and Paste Works (location, Middlesex)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2149XA) (July 1).

LECTURER or SENIOR LECTURER IN GEOGRAPHY, and an ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

LECTURER IN CIVIL ENGINEERING—The Registrar, Municipal College, Portsmouth.

LECTURER (full-time) IN MECHANICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham 21.

GRADUATE IN ELECTRICAL ENGINEERING, and a GRADUATE (or equivalent qualification) IN BUILDING OR STRUCTURAL ENGINEERING, in the Darlington Technical College and Technical School—The Chief Education Officer, Education Offices, Darlington.

LECTURER IN ELECTRICAL ENGINEERING (mainly for teaching Senior Day and Evening students), a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN CHEMISTRY (with subsidiary MATHEMATICS, PHYSICS, or BIOLOGY), in the Southend-on-Sea Municipal College—The Chief Education Officer, Education Offices, Warrior Square, Southend-on-Sea.

LECTURER (full-time) IN MECHANICAL ENGINEERING, and a MASTER to teach SCIENCE and MATHEMATICS in the Junior Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, Wimbledon, London, S.W.19.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report for 1942–43 of the Research Departments of the College of the Pharmaceutical Society of Great Britain. Pp. 42. (London: Pharmaceutical Society.) [55

Council for Education in Appreciation of Physical Environment. First Annual Report. Pp. 7. (London: Council for Education in Appreciation of Physical Environment.) [85

Principles of Good Lighting. (Lighting Reconstruction Pamphlet, No. 1.) Pp. 7. The Lighting of Public Buildings. (Lighting Reconstruction Pamphlet, No. 2.) Pp. 11. The Lighting of Schools. (Lighting Reconstruction Pamphlet, No. 3.) Pp. 14. (London: Illuminating Engineering Society.) [85

Gas Research Board. Fourth Annual Report of the Council of the Gas Research Board. (Communication GRB.8.) Pp. 32. (London: Gas Research Board.) [85

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 20: Sea Trout of the Waterville (Currane) River. By Arthur E. J. Went. Pp. 201–213. 1*s*. 6*d*. Vol. 23 (N.S.), No. 21: Reaction of *p*-Dimethylaminobenzaldehyde with Aromatic Amino Compounds. By A. E. A. Werner. Pp. 214–221. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [85

Iron and Steel Institute. Report of Council for 1943. Pp. 30. (London: Iron and Steel Institute.) [95

A Reading List for Relief Workers. Pp. 36. (London and New York: Royal Institute of International Affairs.) 1*s*. net. [95

A Short Account of the Moss Exchange Club and the British Bryological Society. Compiled from the Annual Reports by Eleonora Armitage. Pp. 24. (Ross: The Author, Dadnor.) [95

Report of the Marlborough College Natural History Society for the Year 1943. (No. 92.) Pp. 24. (Marlborough: Marlborough College.) 1*s*. 6*d*.; to non-Members, 5*s*. [155

Proceedings of the Royal Irish Academy. Vol. 49, Section C, No. 5: The Galway Fishery. By Arthur E. J. Went. Pp. 187–219+plate 13. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. [155

Annual Report of the Oundle School Natural History Society. Pp. 22. (Oundle: Oundle School.) [155

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 12, 1943. Pp. vii+163. (London: Brompton Hospital.) 8*s*. net. [185

Other Countries

Imperial College of Tropical Agriculture: Department of Mycology and Bacteriology. Memoir No. 8: Studies in the Witches' Broom Disease of Cacao caused by *Marasmius perniciosus* Stahel, Part 2: Field Studies and Control Methods. By R. E. D. Baker and S. H. Crowdy. Pp. 28+7 plates. (Trinidad: Imperial College of Tropical Agriculture.) 3*s*. net. [194

U.S. Department of Agriculture. Miscellaneous Publication No. 526: Insecticides and Equipment for Controlling Insects on Fruits and Vegetables. By N. F. Coward and C. A. Weigel, C. M. Smith and L. F. Steiner. Pp. 52. (Washington, D.C.: Government Printing Office.) 10 cents. [194

Yale University Publications in Anthropology, Nos. 25 and 26: The Ciboney Culture of Cayo Redondo, Cuba, by Cornelius Osgood; Archeology of the Maniabon Hills, Cuba, by Irving Rouse. Pp. 252+14 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press.) 23*s*. 6*d*. net. [204

Natural and Synthetic Fibers: a Looseleaf Literature and Patent Digest. Edited by Milton Harris and H. Mark. First Year, 1944, 12 issues. First issue. Pp. 64. (New York: Interscience Publishers, Inc.) Subscription, 60 dollars a year; Binder, 3 dollars. [214

Fats, Oils, Detergents: a Looseleaf Abstract Service. First Year, 1944, 12 issues. First issue. Pp. 48. (New York: Interscience Publishers, Inc.) Subscription, 36 dollars a year; Binder, 3 dollars. [244

Brooklyn Botanic Garden Record. Vol. 33, No. 1: Thirty-third Annual Report of the Brooklyn Botanic Garden, 1943. Pp. 68. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [254

Legislative Council, Fiji. Council Paper No. 18: Annual Report of the Medical Department for 1942. Pp. 24. (Suva: Government Printer.) [264

India Central Jute Committee. Agricultural Research Memoir No. 1: Anatomical Studies on Jute (Corchorus) with Special Reference to the Formation of Fibre. By S. S. Ghosh, K. R. Rao and J. S. Patel. Pp. iii+24+7 plates. 1·8 rupees; 2*s*. Agricultural Research Memoir No. 2; Anatomy of Retted Jute. By J. S. Patel and S. S. Ghosh. Pp. iii+16+4 plates. 1 rupee; 1*s*. 6*d*. (Calcutta: India Central Jute Committee.) [274

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 60: Preparation of Compost Manure from Town Wastes. By Dr. C. N. Acharya. Pp. 10. (Delhi: Manager of Publications.) 7 annas; 8*d*. [284

American Philosophical Society. Year Book 1942, January 1, 1942—December 31, 1942. Pp. 398. (Philadelphia: American Philosophical Society.) [15

United States Tariff Commission. United States Consumption of Food in Terms of Fats, Proteins, Carbohydrates and Calories, 1939–43. Pp. ii+123. (Washington, D.C.: United States Tariff Commission.) [25

Geological Survey of British Guiana. Bulletin No. 16: The Geology and Geography of the Towakaima Region, Upper Barama Valley, North West District. By D. W. Bishopp. Pp. iv+28. 24 cents. Bulletin No. 17: Report on the Geology, Gold and Diamond Deposits of the Awarapari-Issineru-Putareng Area, Upper Mazaruni River. By Dr. B. A. Bryn Davies. Pp. 30+2 plates. 24 cents; Photographic Supplement. Pp. ii+17 plates. 24 cents. Bulletin No. 18: Report on the Geology of the Waikuri District, Cuyuni River. By S. Bracewell. Pp. 16. 24 cents. Bulletin No. 19: Report on the Area between Arakaka and Kokerit, North West District. By S. Bracewell. Pp. 32+4 plates. 24 cents. (Georgetown: Geological Survey of British Guiana.) [95

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