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SCIENCE AND ACADEMIC ISOLATION

THE recent Conference on Science and World Order organized by the British Association has undoubtedly done much to clarify among men of science a realization of their social responsibilities. More than this, it has initiated, we hope, a deeper understanding on the part of our leaders and statesmen of the vital position science occupies in a modern community. For science is no mere collection of facts and theories, but a living force for progress. Technological advance would be impossible without the background of a scientific culture. The development of the arts of peace owes much to science. The technique of industrial production is an application of scientific knowledge to human needs ; large-scale agriculture demands the close collaboration of the farmer and the man of science ; public health measures and preventive medicine are often based on the most recent scientific discoveries. It is clear then that increasing the well-being of the ordinary citizen is largely a scientific task. It is equally clear that men of science have not been allowed to direct the application of their results in the social and economic fields to the extent that the importance of their work demands.

In time of war this situation becomes of more serious import, for it is not the development of society which is at stake but its very existence. The exigencies of war raise special problems which can only be solved by the immediate application of scientific knowledge. Yet men of science are employed by Government departments and industrial concerns mainly as advisers with little or no executive authority. Consequently their advice runs the risk of being overlooked or insufficiently implemented. The Civil Servant or factory manager, who in general is not conspicuous for the depth of his scientific knowledge, finds it difficult to understand that an integrated scientific plan is essential for the efficient operation of the war economy. Piecemeal methods often defeat their own ends. The relevant scientific facts must be considered in totality in determining policy. A better state of affairs would result if men of science were given executive authority in those spheres of the national effort in which their work is directly applicable. Mr. Anthony Eden, in his address of welcome to the foreign representatives attending the British Association Conference, suggested that diplomacy in future must be the servant of science, instead of vice versa. It would be an excellent thing if a beginning along these lines could be made now without waiting for the termination of hostilities.

But the onus does not rest solely on statesmen and politicians. It rests very largely on men of science themselves. The undoubted fact that the applications of scientific knowledge for the common welfare have often been frustrated or misused has been regarded with complacency or even cynicism by some men of science. Even to-day there is a too prevalent attitude to let things run their appointed course. There still lingers in the minds of some men of science, including several of considerable achievement, a doubt as to the necessity for the planning of science and organization of men of science for social ends. That this doubt is considerable and honestly held is clear. Planning and organization are held to be detrimental to the absolute freedom of the individual man of science to undertake what research he will when he will.

While the maximum freedom in science is necessary, that such *absolute* freedom of choice is desirable, or even usually obtains, is debatable. It is not sufficiently realized that the type of work that a man of science undertakes in the great majority of instances is conditioned by the fact that he has to earn his living by that work. Except for people with private means and a handful of established university teachers, complete indulgence of the individual's scientific curiosity is impossible. Even in a democratic society, scientific research, taken as a whole, is subject to inevitable restraints and conditions. The problem is not to eliminate them, but to make sure that they are reasonable, socially useful conditions, and that their operation is in the hands of the men of science themselves. This requires democratic organization.

Too often to-day the general guidance of scientific work is in the hands of laymen or persons whose scientific knowledge is incommensurate with the responsibility of their task. We need here to distinguish sharply between conditions of work in university laboratories and research institutions, and those obtaining in industrial and Government laboratories and factories. We need also to appreciate that, particularly in time of war, the overwhelming majority of scientifically trained men and women work under the latter conditions. Sufficient evidence has been accumulated, notably by such bodies as the Association of Scientific Workers, to show that there is room for considerable improvement in many of these places. There can be a great waste of effort among a team of scientific workers if their research is poorly directed and co-ordinated. We are not satisfied that the best use of our scientific brain-power is, in fact, being achieved in this connexion. The frustration the younger scientific worker must inevitably feel when working under inadequate direction was the subject of comment in the leading article of a recent issue of NATURE (November 1). The loss to the nation's effort as a result should also be emphasized.

The long-term view of scientific planning characterized the recent Conference on Science and World Order. It showed that men of science are thinking, in advance, of their part in the planning of the post-war world. Doubts have been expressed as to whether this historic Conference will, in fact, give rise to anything concrete. Surely the correct attitude is to realize that this meeting of men of science was merely an initiation of activity ; but, it should be pointed out, of activity on an international scale. Positive results will only be forthcoming in direct ratio to the amount of help given by the individual man of science. The Division for the Social and International Relations of Science of the British Association has set up several committees to deal with some of the problems arising out of the Conference. These committees should not be left to work in isolation but should be given the fullest assistance and encouragement. It is sincerely to be hoped that they will receive the support required to enable them to make contributions of real and lasting value to society.

The British Association, however, is not a formal representative organization of scientific men, and as such its usefulness, although considerable, is limited in certain respects. There are in Great Britain a number of learned and professional societies and associations. In the past these bodies have been mainly concerned with their own particular interests. Yet in so far as they represent men and women with specialized knowledge, they owe it to their members and to the community to participate in the wider affairs of the nation. At the moment their voice is too often silent. The tradition of academic isolation dies hard.

There are several encouraging features in the present situation. The chief of these is the renewed determination to get things done which is exemplified by many of our leading men of science. It is not generally realized how deeply this is reflected among the younger rank-and-file scientific workers. Reference to the desirability of including younger brains on many scientific committees was made in the leading article in NATURE already referred to. But in many cases suitable committees do not exist and need to be formed. We are concerned at the present time primarily with the relation of science to winning the war. Regional production committees need not necessarily seek scientific advice, or accept it after having sought it.

In this respect it should be noted that the Scientific Advisory Committee of the Trades Union Congress seems not to function, although it, or a similar body, could now express itself directly through T.U.C. members of planning committees. Ways and means should be thought out of bringing scientific advice *directly* to bodies dealing with industrial production. The application of even elementary scientific research to production problems has resulted in the past in an immense saving both of money and labour. There is no reason for supposing that we have reached saturation point in this respect.

The present war situation calls for considerably increased effort by men of science as much as by the factory worker or farm hand. Pre-war concepts of the pursuit of knowledge for its own sake are not now applicable. Every available scientific brain must be at work on problems connected with the War, and co-ordination of effort must be effected. As Mr. J. G. Crowther said at the British Association Conference, a country which has produced Newton, Clerk Maxwell, Faraday, Rutherford and other towering figures does not lack good men of science, and is not to be defeated for want of them. What we must ensure is that the maximum use is made of them in this critical time for ourselves and our Allies. It is timely, therefore, that the Association of Scientific Workers has announced a conference to be held in January on the general topic of science and the War effort (see p. 657). As this body represents in the main young working men of Science and engineers directly engaged with war and production problems, its voice should receive attention. The general body of scientific workers and technicians should use this opportunity of discussing together their important place in the nation's effort. At the meeting of Soviet men of science held in Moscow on October 12 (NATURE, October 25, p. 490) an appeal was broadcast to scientific workers of the world. Their colleagues in Great Britain have the responsibility of answering their appeal concretely and quickly. Messages of support and encouragement serve a limited purpose only. British men of science and engineers must pool all their knowledge, skill and ingenuity to fulfil their part in the pledge which has been given by Lord Beaverbrook: "We've spoken the word, but you must do the deed."

CHRISTIANITY AND THE MECHANISTS

Christianity and the Mechanists
By Dr. W. Osborne Greenwood. Pp. 296. (London: Eyre and Spottiswoode (Publishers), Ltd., 1941.) 9*s*. net.

WHY are writers who approach religious problems from the angle of the sciences so often haphazard in their reasoning, striding forward regardless of obstacles, the moment they quit the strictly scientific beat? They are as reckless as the theologians who dabble in science, and with less excuse; for their scientific training should have taught them to be more careful. The book before us provokes this question. Not that it is lacking in interest or merit, at all events in its negative contentions. The author is a medical man conversant, both within his professional field and outside of it, with the opinions and needs of the public, especially of the younger generation. He knows how their outlook upon the larger problems of life has been prejudiced by uncritical acceptance of the dogmatic tradition of Victorian science, a tradition which still dominates popular thinking, despite the fact that recent developments in physics have gone far to undermine its dogmatism. The majority of the students in our secondary schools and universities still echo the outworn shibboleths and are convinced before their minds are fully fledged that science has scotched religion. It is to such as these, and not to specialist readers, that the author addresses himself.

Dr. Greenwood writes as a believer in Christianity, with engaging sincerity and in a clear and attractive style. He opens with a brief survey (four chapters, comprising the first quarter of the book) of present-day physics, treating with admirable lucidity of the structure of the atom and the problem of entropy, in order to show the grounds that have led many of the leading physicists to postulate a divine mind as the author of the universe. But his main concern is with biology, partly as the field of his own life-work, but chiefly because it is the biologists rather than the physicists who are most solid in their resistance to the hypothesis of theism. He is out to expose the inadequacy of a mechanistic interpretation of the phenomena of life and mind, save in so far as it is regarded as a methodological assumption. "We must be on our guard against overloading a working hypothesis with more than it will or can carry" (p. 146). He shows clearly that a living organism cannot be fully explained by the analytic method which resolves the whole into an aggregate of its parts (p. 129), and that the *form* of organization (this holds also of the physical atom and of the electron) is not a material entity or composed of material entities as its constituents (cf. 44 f., 67). "There is something more in an organism than its several organs and this something is what controls the creature as a whole." How paradoxical is the view which holds the more complex biological structures and activities to be the result of chance is illustrated by a detailed study of *Epeira diademata* (Chapter 10) and of the brain and nervous system (Chapter 11). A like measure is meted out to Loeb's theory of tropisms (Chapter 9).

This argument might have been rendered even more convincing if Dr. Greenwood had instanced the impracticability of giving any mechanistic account of truth. If Loeb's belief in his own theory and its rejection by a disbeliever are equally and alike "conditioned reflexes", what meaning can be attached to the claim that one of the two opposed beliefs is true, and the other false ? The beliefs in both cases are determined mechanically by the psychical and physical antecedents, and there is no more to be said.

It is when we pass to Dr. Greenwood's inferences to theism that the question we asked at the outset becomes urgent. He seems to think that the rejection of a mechanistic explanation carries with it of necessity a reference to God as the ultimate ground of Nature. As though these two were the only possible alternatives! He rushes to his conclusions—which, be it observed, may well be true—with a swiftness that makes the reader gasp. Take, for example, the argument on p. 188, based on the unquestioned evidence of religious belief (as of artistic skill) in the cave-dwellers of the third interglaciation period.

"At this juncture it may very usefully be asked of the mechanist, Of what survival value is all this ? Any mechanical method of development is at least consistent in one respect, that if any variation appears, be it in organ or habit, function or any characteristic whatever, which is not of some distinct survival value, it is ruthlessly suppressed and cut out. It must be of some definite advantage to the individual or to the race in order to become perpetuated and be a characteristic worth preserving. But a religious spirit and leaning would, among these primitive folk, be precisely one of those possessions which would not help in a material sense to preserve either individual or race. It would not ensure more success in hunting, nor would it, *per se*, help in combat if there *were* such a state of affairs as intertribal war. The religious spirit, therefore, which has not only persisted in spite of these disabilities but grown to the sublime conceptions of to-day, cannot be regarded as due to any mechanical causation but can only be understood when viewed as a divine gift."

An objector will urge, first, that primitive religion has a definite survival value as promoting courage in the individual and social cohesion in the tribe, while the observable decay of religious beliefs in the civilization of to-day is due to the loss of survival value that they once possessed. Further, he will note that Dr. Greenwood is equally ready to credit God with the authorship of much that assists survival and that this, if it be true, seems to show that the presence or absence of survival value is irrelevant to the case for theism. To regard its absence as evidence of divine origin is scarcely complimentary to the Deity. Moreover, even if we allow that mechanical causality fails to explain the phenomena of religion, it by no means follows that they must be interpreted as a divine gift.

There are a host of alternative explanations that call for consideration. A goodly array of philosophers will contend that to seek a ground for the world as a whole is beyond the competence of human reason ; that the causal relation holds only within the universe and only of the connexions of events in space and time. It may be questioned, again, whether the universe is a whole and not rather a mass of inter-related phenomena within an ever-expanding context. Even Aquinas held that reason could not disprove the eternity of the material world and that the belief in Creation could be authorized only by revelation. Again (if we are to indulge in this line of speculation), Hume's suggestion that the world is a self-developing organism merits serious discussion, say, in the form given to the theory in Alexander's "Space Time and Deity". Finally, there is the case for regarding the universe as a spiritual whole ; in other words, for pantheism. If, as the author contends in agreement with Jeans, the solid matter of the traditional physics has been sublimated into something that looks uncommonly like mentality, why should not the purposiveness discernible in Nature, and the evolutionary process that culminates, for our present knowledge, in mind and personality, be ascribed to the agency of an immanent world-spirit or society of world-spirits ? No appeal to Christian theism that ignores these speculative alternatives is likely to evoke a response from the inquiring minds of the present generation.

Our sympathy with Dr. Greenwood's aims makes us all the more sensitive to the shortcomings of his argument. His leading concepts seem to stand sorely in need of clarification. The interesting suggestion (p. 114) that the increase of entropy may be arrested and even reversed by the higher energy of life raises doubts as to the equivocal use of the term 'energy', which are intensified by its extension to spiritual activity as displayed by Christ's *Kenosis* at the Incarnation (p. 65). Later in the book (Chapter 13) we hear of a vitally important distinction between mind and personality, but are left greatly in the dark when we ask for the precise nature of the difference. It is not enough to be told (p. 213) that personality is conscious individuality; and is the fact that the amœba splits into two instead of dying (pp. 220—221) really pertinent to the Christian hope of immortality? 'Creation' is another ambiguous term of constant recurrence. What does Dr. Greenwood mean when he tells us (p. 197) that "man's mind is of the same nature and essence" as the infinite mind behind the universe, "for it does (within its limited scope) the same creative things"?

God, in creating, creates *ex nihilo*, that is, with no material to work on other than himself. In this lies the radical difference between His creative act and the releasing of pent-up energy from an inert chaos with which it is identified in an earlier passage (p. 47). Perfect inertness and complete absence of organization are not 'nothing' in the absolute sense demanded by orthodox theism. The analogy between divine and human creation has been treated recently, with much more subtlety and caution, by Miss Dorothy Sayers in "The Mind of the Maker".

We offer these criticisms in the hope that Dr. Greenwood may find time, amid his many useful avocations, to develop his constructive argument to theism in more detail. That he has the ability to do this is shown by his convincing refutation of materialism. But there is much in his more positive contentions that needs expansion and clearing up. As it is, he has set himself to prove a little too much and has actually proved much too little.

W. G. de Burgh.

ADJUSTMENT IN MARRIAGE

Happy Marriage
By Norman E. Himes. English edition revised by Lella Secor Florence. Pp. 368. (London: George Allen and Unwin, Ltd., 1941.) 12*s*. 6*d*. net.

Few people would care to deny that marriage relations constitute an important source of the variance of total social happiness. A reasonable interpretation of available evidence makes it likely that marriage originally came into existence as an institution in response to the need for safeguarding the family and its property and hence to acquire rights over the procreative activities of the female. But monogamous marriage in modern society, *de jure* if not entirely *de facto*, still exercises proper functions in regulating the sexual and parental impulses and in providing for various other social and psychological needs. The permanence and stability of marriage are very sensitive to economic and ecological conditions in society. One current difficulty comes to mind. The exigencies of war, compelling prolonged separation and abstinence and, consequently, frustration and conflict, have certainly raised the incidence of psychoneuroses in married women. It is surprising therefore that so little scientific attention has been given to the conditions of a stable and happy union on one hand and of the difficulties that may arise from this union on the other.

The admirable work of Prof. L. M. Terman and his associates at Stanford University is outstanding in this field, and much that is of value in the book under review is a diluted account of Terman's conclusions. Dr. Himes is not concerned in the present study to deal with fundamental problems nor are any new data presented. The reader is offered a handbook of prudent guidance enriched by long experience in the medical problems of contraception. Excursions into economic advice for prospective couples to which a few chapters are devoted may serve a purpose for some of the more suggestible members of the public.

Late age at marriage, by curtailing the child-bearing period, is one factor contributing to a reduced fertility, and it is encouraging to see the strong plea made in this book for earlier marriages both in the interests of fertility and to facilitate sex adjustments in general. The most useful chapters are those that deal with pre-marital and marital sex relations, contraceptive techniques, sterility and venereal disease.

Two points deserve comment. First, the excess of males in the sex ratio is not, as Dr. Himes supposes, due to the higher death-rate of females *in utero* but to the greater number of males conceived; the death-rate of male is higher than that of female embryos. Secondly, to advocate homogeneity of the prospective partners in respect of race, religion, economic and social status, age, education and outlook is dangerous when little or no evidence is adduced in support of the merits of this advice. Such restrictions would strengthen existing class and group stratification and obstruct genetic combinations which are in the interests of the community as a whole.

John Cohen.

ADMINISTRATION AS A SOCIAL PROCESS

Dynamic Administration

The Collected Papers of Mary Parker Follett. Edited by Dr. Henry C. Metcalf and L. Urwick. Pp. 320. (London: Management Publications Trust, Ltd., 1941.)

THE happily chosen title of this collection of papers strikes the keynote which gives them their unity. Behind the admirable analysis of the principles of administration contained in them lies the conception of administration and organization as dynamic rather than static. The task of the administrator is not that of crystallizing the experience of the past in set forms which will guide him in dealing with present or future situations. It is rather that of understanding the whole situation confronting him, recognizing the interacting and unifying elements, and so relating their functions that he sets in motion a process which continuously promotes unity and coherence.

This conception of leadership as the relating of experience and organizing it into power over the situation is elaborated most fully in the two papers on "The Psychology of Control" and on "Leader and Expert", and these with the further paper on "Some Discrepancies in Leadership Theory and Practice" may make the most direct appeal to the scientific worker as such. The same ideas, however, are found in all the papers, the ultimate value of which is indeed in the challenge they offer to constructive and creative thinking at a time when many are being called to fill new administrative posts and when the character of administration over wide fields is subject to searching scrutiny. No reader of those keen examinations of administration and policy provided by the forty or so reports of the Select Committee on National Expenditure can have any doubts as to the great service which Major Urwick and Dr. Metcalf have rendered by editing this collection of lectures at the present time; it is unfortunate that they have not completed their work by providing the book with the index it deserves.

With the exception of the final paper, "Individualism in a Planned Society", which in somewhat different form has been published in the "Papers on the Science of Administration" edited by L. Gulick and L. Urwick, these papers, some of which were delivered in Great Britain but never published, have not been readily accessible, and it is a tribute to the vitality of Mary Follett's thought and the keenness of her analysis that they should make such appropriate reading after the lapse of a decade or more. This is true of international no less than of business situations. Her observation in March 1927 that "we shall never be able to make an international settlement and erect some power to enforce it; the settlement must be such as to provide its own momentum" is a warning for post-war reconstruction that has been forcibly underlined by experience of the last two decades.

A large part of the stimulus of these papers lies in the new points of view they suggest or the new approach to existing problems. They do not provide ready-made solutions to problems that the administrator is likely to encounter, but they do assist him to the fundamental thinking about his problems or situations which will enable him to reach real solutions or control. The emphasis throughout is on the psychological foundations, and the papers on "The Giving of Orders", on "The Meaning of Responsibility in Business Management" and on "Power" are examples of the way in which Mary Follett first demonstrates the shallowness of much conventional thinking, and then enables us to reach the real meaning of situations or problems so essential if the integration on which she insists is to be achieved.

This fundamental thinking is the most valuable feature of these papers, and its applications to the situations that are arising daily in war production or to the problems that will be encountered in reconstruction are almost unlimited. The observations on depersonalizing orders and discovering the law of the situation afford a clue to the solution of many of the acute problems which arise in the control of labour under war-time conditions. These are ideas to be explored further, and they are a typical example of the integration on which Miss Follett insists throughout. They lead naturally to views on conciliation and arbitration and on co-operation advanced in two papers on the psychology of consent and participation and on the psychology of conciliation and arbitration, which some will find novel if not startling.

If these papers can be warmly commended to the practical administrator, they are equally valuable as a contribution to the creative and constructive thought which must precede as well as inspire the making and execution of plans and policy in reconstruction. Miss Follett is more than an expositor of the fundamental principles of organization, so clearly outlined in the final paper

"Individualism in a Planned Society". She sees administration as a social process which, whether in a Government department, an industry or a business, must be integrated with the purposes and welfare of the society of which the more limited activity forms a part. Her view of administration as a continuous and progressing activity is in line with the ideas advanced by Mannheim in "Man and Society in an Age of Reconstruction", and the final two essays provide as complete an answer to those who reject the idea of planning as they do a corrective to the prejudiced or narrow thinking which sometimes characterizes the approach to management problems. Indeed, their contribution to efficient administration is scarcely more direct than it is to the creative thinking by which alone we can evolve the collective controls required to preserve and expand our tradition and heritage of freedom.

R. Brightman.

THE LIFE OF INVERTEBRATES

A General Zoology of the Invertebrates
By G. S. Carter. Pp. xxviii+510+13 plates. (London: Sidgwick and Jackson, Ltd., 1940.) 25*s*.

In the periodic swing of interest between form and function morphology had a long innings in the schools of Britain, and even now that the animal alive has won its meed of study, the text-books in general use scarcely reflect the change in outlook that this century has seen. With a telling contribution to the literature of the class-room Dr. Carter has supplied the missing link, and teacher and student will appreciate the labour of collecting and collation which has gathered in a unified survey the results of many scattered investigations.

Two impressions stand out from a reading of his volume: one is of the broad conception of the plan and the thoroughness of its execution, and the other is of the ease and effectiveness of the writing.

The plan is laid around four major topics. The first deals with the properties of protoplasm, the cells and the 'Protista', which are regarded as single cells, for the author rejects the non-cellular conception of the Protozoa since he looks upon a cell as the unit of organization of all animal protoplasm. The second topic, the multicellular body, gives an opportunity for excellent reviews of such subjects as regeneration, dedifferentiation and reconstitution, axial gradients and organizers, and various aspects of the problem of growth. But we miss here any discussion of ecdysis in the Arthropoda or of discontinuous growth in general, or of the recent work upon various types of cuticle.

Comparative physiology is discussed in the longest and most detailed section of the book, marked by a particularly good account of nervous co-ordination. Finally, general problems of invertebrate zoology include life-histories, comparative behaviour, ecology and evolution. Limitation of space has resulted in a somewhat sketchy treatment of the first three, but the last embodies a very interesting speculation upon the evolutionary relationships of invertebrate phyla. The suggestion is that the Metazoa should be divided into two superphyla—the Echinoderm superphylum, including only Echinoderms and Chordates, characterized by pluteus larva, radial cleavage, equipotential development and enterocœl; and the Annelid superphylum including all the remaining Metazoa, except the Cœlenterates and Sponges, with trochosphere larva, spiral cleavage, mosaic development and schizocœl.

The distinctions, however, do not always hold, as the author points out, and in the matter of cœlome development it might be stated that Hamann, Dawydoff, and recently H. Barraclough Fell have shown that even in some echinoderms the cœlom is schizocœlic.

The grouping of the Lamellibranchs as sessile animals is unusual; the figures of the prophase of mitosis scarcely represent the modern view; and in the figures showing parasitic modifications in copepods, that of Achtheres is inaccurate, Penella has an incomplete head, and the series might have been completed by the addition of Xenocœloma, described by Caullery, with its gonads and ducts included in the host and only a pair of egg-sacs outside The only misprint we have noticed is in the legend of Fig. 51.

These are small matters; the great matter is that here is a work, well indexed, with a useful bibliography mainly of monographs and general reviews, which, as a highly successful and up-to-date synthesis of the biology of invertebrates, meets a long-felt need and will give a new drive to the study of the living animal.

RAMANUJAN

By Prof. L. J. Mordell, F.R.S.

PROF. G. H. HARDY who, some thirteen years ago, supervised the editing of Ramanujan's collected papers, has now produced a new volume dealing with Ramanujan.* It is a series of essays rather than a systematic account of his work. However, it includes most of his more important discoveries, and also much recent work associated with the results found by Ramanujan. There are twelve essays, and it will make my subsequent remarks more intelligible if I give their titles in full : (1) The Indian mathematician Ramanujan ; (2) Ramanujan and the theory of prime numbers ; (3) Round numbers ; (4) Some more problems of the analytic theory of numbers ; (5) A lattice point problem ; (6) Ramanujan's work on partitions ; (7) Hypergeometric series ; (8) Asymptotic theory of partitions ; (9) The representation of numbers as sums of squares ; (10) Ramanujan's function $\tau(n)$; (11) Definite integrals ; (12) Elliptic and modular functions.

I may as well say at once that the book is beautifully written in an informal style, and reads as smoothly and fascinatingly as a delightful novel. The simplicity and clearness of the style, and the care in setting out the formulæ, are so marked everywhere as to make it plain that the book is certainly a labour of love on which its author has spared no effort. Proofs are given with a minimum of unpleasant detail, with the right emphasis on the salient features and with useful and interesting comments and notes. The book is a model of good exposition. It is a handsome quarto volume printed in such a way as to make it a pleasure to read and a credit to the printers.

The main facts of Ramanujan's career are well known, and the lives of few other mathematicians for some generations past have been so full of human interest. The story of his life is that of the rise of an obscure Indian in the face of the greatest difficulties to the position of the most famous mathematician that India has ever produced and of his early death just after he had won the most coveted distinctions. The publicity given to him suggests that the world likes to hear about mathematicians ; and in fact Lord Riddell, the journalist peer, who heard of Ramanujan from Mr. Montagu, at one time Secretary for India, was so interested that he sent for a copy of Ramanujan's collected works and wrote a review, confining himself, of course, to an account of Ramanujan's life.

* Ramanujan : Twelve Lectures on Subjects suggested by his Life and Work. By Prof. G. H. Hardy. Pp. vii+236. (Cambridge : At the University Press, 1940.) 25s. net.

Ramanujan was born in 1887 near Kumbakonam, a fair-sized town about 160 miles from Madras. Like many other mathematicians, he came of poor and humble folk. His schooling was normal, though at an early age he was recognized as a boy with exceptional abilities. He went to the local high school from the age of seven to sixteen, and in 1904 entered the Government college at Kumbakonam, where he won a scholarship. In no other science as in mathematics is it so easy for a student's interest to be aroused at an early age. The simplest properties of numbers which occur in arithmetic, or the simplest properties of geometrical figures, have often sufficed. Apparently Ramanujan's interest displayed itself when he studied trigonometry and found for himself results given in Part 2 of Loney's "Trigonometry." Then, at the age of sixteen, he borrowed an old book by Carr, "A Synopsis of Elementary Results in Pure and Applied Mathematics". This covers roughly the subjects of Schedule A of the present Mathematical Tripos, and contains the enunciation of some six thousand theorems with proofs that are often little more than cross-references. Carr has sections on algebra, trigonometry, calculus and analytical geometry, and emphasizes in particular the formal side of the integral calculus. It was this book that really awakened Ramanujan's genius. It secured such a grip on him that he is said to have spent all his time at college—including lecture periods in other subjects—upon his mathematics. Many years ago Huxley (and probably many others before him) said that one of the most important objects of any educational system should be to catch the small percentage of the population with some special aptitude, to turn them to account for the good of society, to see that they are not starved by poverty, and that they are put in the positions in which they can do the work for which they are specially fitted. If Ramanujan had lived in Britain he could have started early specialization in preparation for a scholarship examination at one of the universities, with what wonderful results no one can imagine. Unfortunately, the educational system at Kumbakonam was not elastic enough to deal with persons like him. As a result, his neglect of college work other than mathematics led to disaster. He lost his scholarship, left college, ran away from home, came back, returned to college, but did not make up for his absence. He then entered Pachaiyappa's College, Madras, in 1906, but, falling ill, returned to Kumbakonam. He appeared as a private student for the F.A. examination in December 1907 and failed. In England he would probably then have been in the middle or near the end of his college career, with possibly the Tripos before him, and also an immediately successful career.

But from 1907 until 1912, Ramanujan was adrift in the world without any definite occupation except his mathematics, which must have absorbed most of his energy. The results of this are embodied in some now famous note-books. In 1909 he married and so, as remarks his biographer, he had to find some regular employment. He had great difficulty in finding any because of his unfortunate college career. In 1910 he began to find more influential friends, who tried in vain to find a tolerable position for him. But in 1912, at about the age of twenty-five, he became a clerk in the office of the Port Trust of Madras at a salary of about £30 per annum. Not much has been published about his life during these critical years 1907–1912. His first substantial paper had been published in 1911 in the *Journal of the Indian Mathematical Society*. In 1912, he began to secure some recognition in India. It is really an easy matter for anyone who has done brilliant mathematical work to bring himself to the attention of the mathematical world, no matter how obscure or unknown he is or how insignificant a position he occupies. All he need do is to send an account of his results to a leading authority. One can recall the classic instances of Jacobi's letters to Legendre announcing his discovery of the elliptic functions, and of Hermite's letters to Jacobi containing his new discoveries in number-theory.

Ramanujan wrote to Hardy in January 1913, sending him the enunciation of a great many results he had found, many of them strikingly original and thoroughly intriguing, others well known, and some false and yet not without considerable interest and significance. Events had begun by this time to take a more favourable turn in India. The University of Madras gave him a scholarship of some £60 per annum, adequate for a married Indian, and he was also sounded about a trip to England, which he declined. In 1914, however, he was prevailed upon to go to Cambridge with help from the University of Madras and from Trinity College. There he had three years of uninterrupted activity and continuous contact with Hardy, the results of which are visible in his "Collected Papers." He fell ill in 1917, and never fully recovered, dying in 1918 shortly after his election to the Royal Society and to a fellowship at Trinity College. He was the first Indian to have been awarded either honour.

It may well be asked at once what kind of mathematics could be done by a person with Ramanujan's training, especially before he came to England, and what characteristics his talents display. Mathematical research is possible in many directions, and two extreme ones suggest themselves. In one, for example, modern algebra, it is necessary to master a technique requiring considerable preparation and study, and research is practically impossible without this. In the other comparatively little pre-knowledge is required; only native wit and exceptional ability and intuition. This applies especially to identities involving infinite series, products, continued fractions and integrals. Probably many of the results found will not be new.

Thus the simply periodic functions, for example, those for which $f(x+1)=f(x)$, and in particular the elementary trigonometric functions, lead to the well-known series and products associated with the sine function, as well as to the familiar Bernoulli numbers in the expansion of $1/(e^x-1)$ in ascending powers of x. Then the hypergeometric series

$$\sum_0^\infty \frac{a.\ a+1.\ \ldots\ a+n-1.\ b.\ b+1.\ \ldots\ b+n-1}{n!\ c.\ c+1.\ \ldots\ c+n-1} x^n,$$

which includes most of the series occurring in elementary mathematics, lends itself to all sorts of extensions and generalizations. This series is also closely associated with the gamma function $\Gamma(x)$. This function, the characteristic property of which is $\Gamma(x+1) = x\,\Gamma(x)$ and which is a generalization of $x\,!$, is rich in applications to identities of the kind mentioned above.

There are also two classes of far more abstruse functions of the greatest importance in the mathematics of the last century. One is the elliptic or doubly periodic functions, the chief property of which may be typified by

$$f(x+1)=f(x), \qquad f(x+\omega)=f(x),$$

where ω is a complex constant. The simplest elliptic functions are those called $\wp(z)$, sn z, cn z. From the eliptic functions arise the modular functions, of which the simplest have the curious general periodicity property that if ω is a complex variable and α, β, γ, δ are any integers such that $\alpha\delta-\beta\gamma=1$, then

$$f\left(\frac{\alpha\omega+\beta}{\gamma\omega+\delta}\right)=f(\omega).$$

The function which naturally arises in studying such functions can be written as

$$\Delta\,(\omega_1, \omega_2) = (2\pi/\omega_2)^{12}q^2 \prod_1^\infty (1-q^{2n})^{24}.$$

Here ω_1, ω_2 are two complex numbers whose ratio $\omega=\omega_1/\omega_2$ has a positive imaginary part, and $q=e^{\pi i\omega}$ so that $|q|<1$. Then

$$\Delta\,(\omega_1, \omega_2) = \Delta\,(\alpha\omega_1+\beta\omega_2, \gamma\omega+\delta\omega_2).$$

The general theory of elliptic and modular functions has been treated in monumental works by Klein and Fricke, and by Weber, and reveals at once the most beautiful and fascinating series and products, and enables us not only to prove directly any relevant identities but also to state beforehand their nature and form. Many of these identities can be found by quite elementary means and others by the display of great ingenuity. There may then be no connexion with the general theory, and the results may appear to one unfamiliar with it as an extraordinary collection of strange, curious and isolated results, an impression sometimes heightened by the unusual form in which they can be expressed.

Finally, the theory also shows that if $f(\omega)$ is a modular function and n is any positive integer, then algebraic equations of great interest called modular equations connect $f(n\omega)$ and $f(\omega)$, and that these can be expressed in a multiplicity of ways. Further, if we put $f(n\omega) = f(\omega)$, which then involves $n\omega = (\alpha\omega + \beta)/(\gamma\omega + \delta)$, so that ω is a complex quadratic surd, the equations are solvable by radicals, as was shown by Abel about a century ago. Some of these equations can be solved very simply, while the solution of others involves a wonderful collection of surds.

It was chiefly in these subjects that Ramanujan's best work was done. They gave him ample scope for his exceptional and brilliant genius, which displayed such wonderful imagination, intuition and insight. For formal manipulation of infinite processes and an instinctive feeling for algebraical formulae, he was unrivalled since the time of Euler and Jacobi. His fertility in producing a host of strange and curious results was unbounded and ceased only with his death.

I mention first some results illustrating his inductive powers.

Suppose that q is a complex number and $|q| < 1$. Write

$$1/\prod_1^\infty (1-q^n) = 1 + \sum_1^\infty p(n)q^n.$$

Then the coefficient of q^n in the series is a very important function of n known as the partition function, of which more later. It is easily shown to be the number of solutions in positive integers $x, y, z, t, \ldots$ of

$$x + 2y + 3z + 4t + \ldots = n.$$

Though it had been known and studied since the time of Euler, very little was known of its properties; for example, it is even now not known when $p(n)$ is even or when it is odd. Ramanujan found by observation that $p(5n + 4)$ is divisible by 5, and then proved it. Though no one else had noticed this result, it is easily suggested to anyone studying the numerical values of $p(n)$. A proof is also obvious from the identity

$$p(4)+p(9)q+p(14)q^2+ \ldots = 5\{(1-q^5)(1-q^{10})(1-q^{15})\ldots\}^5\{(1-q)(1-q^2)(1-q^3)\ldots\}^{-6},$$

due to Ramanujan who, however, never published a proof. Many such identities, though striking in appearance, are in fact simply particular results in the theory of the modular functions.

Another result on a rather different footing found inductively without proof by Ramanujan is

$$1+\sum_1^\infty \frac{q^{n^2}}{(1-q)(1-q^2)\ldots(1-q^n)} = \frac{1}{(1-q)(1-q^4)(1-q^6)(1-q^9)\ldots}.$$

What seems remarkable in this formula is that in the product on the right-hand side, the indices of the powers of q are of the form $5n \pm 1$, while in the series on the left-hand side, 5 plays no part in the indices. Such an identity seems very difficult to discover empirically, but still it might be possible for someone without his genius. The formula, which seemed difficult to prove, was in fact originally found and proved by Rogers and then overlooked for some twenty years.

The most remarkable result Ramanujan found inductively, again without proof, is one which would have occurred to very few people indeed. Write

$$q\{(1-q)(1-q^2)(1-q^3)\ldots\}^{24} = \sum_1^\infty \tau(n)q^n,$$

where the product is associated with the important modular function $\Delta(\omega_1, \omega_2)$, so that it can be expected that the coefficients $\tau(n)$ are also important. Then Ramanujan conjectured that

$$\sum_1^\infty \tau(n)n^{-s} = \prod_p (1-\tau(p)p^{-s}+p^{11-2s})^{-1},$$

where the right-hand product is extended over all primes p. This identity implies in particular that $\tau(mn) = \tau(m)\tau(n)$, when m and n are prime to each other. The identity was afterwards proved by Mordell, but only recently Hecke found independently the formula, the proof, and important extensions. Ramanujan also conjectured that if p is a prime number, $\tau(p) \leq 2p^{\frac{11}{2}}$, whence it follows that $\tau(n)$ is of order of magnitude $n^{\frac{11}{2}+\epsilon}$, but no one has ever proved this. Recently Rankine has got so far as $n^{\frac{29}{5}}$.

The most pregnant result stated by Ramanujan is that the coefficient of x^n in $(1-2x+2x^4-\ldots)^{-1}$ is the integer nearest to

$$\frac{1}{4n}\left(\cosh\pi\sqrt{n} - \frac{1}{\pi\sqrt{n}}\sinh\pi\sqrt{n}\right).$$

This statement is false, but the formula is a genuine approximation, though not so close as Ramanujan imagined. This result, included among those sent by Ramanujan to Hardy in 1913, obviously led to the corresponding problem for the function $p(n)$ and to their joint work on partitions. This was the beginning of the method, developed by Hardy and Littlewood, for solving problems dealing with the partitions of numbers in various ways, and transformed later almost out of recognition by Vinogradoff. Thus Vinogradoff has proved that every sufficiently large odd integer is the sum of three primes. The final result of the original application of the method was to obtain a series giving exceedingly good and rapid approximations to the value of $p(n)$; for example, when $n = 200$, the error made in taking eight terms of the series gives an error of only 0·004 in the value of $p(n)$, a number of thirteen digits. Rademacher has recently replaced the asymptotic series by an equally effective convergent series.

In hypergeometric series, there is an important and fundamental formula involving many parameters due to Dougall; this was rediscovered by Ramanujan, and probably the methods he used would have led to a rigorous proof. From it he deduced a host of other results. He was in possession of yet others, suggesting that he had not revealed all the results in his possession.

Definite integrals greatly interested Ramanujan. Many of his results were found before he came to England and while he held a research scholarship at the University of Madras. It will suffice to mention the following:

$$\int_0^\infty x^{s-1}(f(0)-xf(1)+x^2f(2)-\ldots.)dx = \frac{\pi}{\sin\pi s}f(-s).$$

The result is a purely formal one. It is obviously not true unless the function $f(x)$ satisfies appropriate conditions, since the formula implies the false result that $f(s)$ is identically zero when $f(0)=f(1)=f(2)=\ldots=0$. Often with results found formally without rigorous proof, it is a routine matter to obtain such a proof, but this does not apply to the present one. As shown by Hardy, the proof involves ideas and methods of which Ramanujan knew nothing in 1914 and which he had scarcely absorbed before his death. The formula is a really interesting one suggesting many other results, some of which can be proved in other ways. I wish that Prof. Hardy had given an account of other definite integrals evaluated by Ramanujan, for example, those associated with Gauss's sums. For Ramanujan was the first to evaluate, in a characteristically original way, definite integrals such as $\int_0^\infty \frac{\cos tx}{\cosh x}\cos mx^2\,dx$, which had not been done by writers such as Kronecker and Hardy himself, who had both studied related integrals.

This seems to be the place to speak of Ramanujan's characteristic trait, which made him in his earlier days before his stay at Cambridge almost unique among mathematicians. A mathematical theorem is invariably associated with proof, and no mathematician would be satisfied with a result unless he had a proof. It may happen that he is led to believe in the truth of results which he cannot prove, but this in no way diminishes his desire to find proofs, which are ever his goal. But as Littlewood says: "Ramanujan had no clear cut conception of proof; if a significant piece of reasoning occurred somewhere, and the total mixture of evidence and intuition gave him certainty, he looked no further." This is all the more surprising as the idea of proof is so fundamental even in elementary mathematics. But even in his very first long paper already referred to, which deals with Bernoulli's numbers, after writing down the values of twenty of them, he states that it will be observed, *inter alia*, that the numerator of $B_{2n}/2n$ in its lowest terms is a prime number. He takes the numerical evidence as sufficient, and there is no trace of any suggestion that there is need of other proof of these results, which as it happens, are well known. Proofs of many of the results stated in his notebooks and letters were given afterwards by Hardy and G. N. Watson.

Ramanujan was not a well-read mathematician. In India, he apparently did not avail himself of books that were accessible to him. The only reference I find to books influencing his early work, in addition to those of Loney and Carr already mentioned, is to Edwards's "Differential Calculus" and Hardy's tract on "Orders of Infinity". There were available at Madras several books a study of which might have had a decisive influence on his work, for example, Bromwich's "Infinite Series" and Whittaker's "Modern Analysis", one of which Hardy thinks he may have seen, and also Matthews' "Theory of Numbers". He would have realized that some of the ideas expressed in his early letters were well known; such as the meaning of $\Gamma(n)$ when n is negative, and methods of attaching meanings to non-convergent series. He would have seen how vital it was to replace some of his naive points of view by more rigorous ones; for example, that a distinction must be made between $\sum_1^\infty f(n)$ and $\lim_{s\to 0}\sum_1^\infty f(n)n^{-s}$; and he would not have been so easily led astray by false analogy, as in his work on primes mentioned later. Strangely enough, he must have studied most assiduously some book on elliptic functions, probably Greenhill's. As already remarked, this subject is particularly rich in infinite series and products of a type in which Ramanujan revelled, including applications to modular functions and singular moduli. Greenhill's is an old-fashioned book, and so Ramanujan would be unaware that many of his results, strange and fantastic as they seem to those who have not a modern knowledge of the subject, are often particular cases of a general theory with which he was unfamiliar. A comparison which suggests itself is that of finding areas and lengths of curves. Before the invention of the calculus, each result proved was no mean feat. After its invention, however, the centre of interest shifted, though one might still admire now and then ingenuity displayed in obtaining special results. Needless to say, Ramanujan showed remarkable ingenuity, and gave proofs of many of his results, but of others he could have had no rigorous proof.

Ramanujan's methods were peculiarly his own. Probably no other mathematician has relied so much upon his native wit. Most mathematicians find it a great advantage to have as extensive a knowledge as possible of lines related to their own. This increases the possibility of successful research, though sometimes there is much to be said in favour of attacking difficult problems unhampered by current ideas as to the method of approach. It is futile to wonder what Ramanujan could have done with the better tools he might have had in more favourable circumstances.

Ramanujan had very little systematic knowledge of number theory. Most of his work on this subject dealt with number-theoretic functions the values or properties of which could be investigated in a non-arithmetical spirit. Prime number theory has so developed during the last fifty years as to suggest that adequate knowledge and training are indispensable for work in this field. Ramanujan had neither, with the result that most of the results to which he was led, some by false and unproved analogies (though even thinking of some of them required a vivid imagination), were either erroneous or erroneously proved, and very little was of permanent value. This applies also to an assertion in one of his first letters to Hardy that "the number of numbers between A and x which are either squares or sums of two squares is

$$K\int_A^x \frac{dt}{\sqrt{\log t}} + \theta(x),$$

where $K = 0{\cdot}764\ldots$ and $\theta(x)$ is very small compared with the integral." He later gave a false estimate for $\theta(x)$. The problem was solved by Landau in 1908 and the solution depends upon the application of the standard methods of prime number theory.

Another result mentioned in an early letter to Hardy dealt with a lattice point problem which can be expressed as follows. To find the number of positive integer values of x, y for which $ax + by \leq n$, where a, b are given and n is large. This is an important problem afterwards considered by Hardy, Littlewood and Ostrowski, and it is surprising what interesting developments arose from so innocent looking a problem.

Much more important were Ramanujan's contributions to the question of the representation of numbers as sums of squares; that is, for given k, n to find the number $r_k(n)$ of solutions in integers $x_1, x_2, \ldots x_k$ of $x_1^2+x_2^2 \;\ldots\; +x_k^2=n$. If we write $\theta(q) = \sum_{m=-\infty}^{\infty} q^{x^2}$ the question reduces to that of finding other expressions for $\theta^k(q)$ which allow of simple expansions in powers of q. Thus, as shown by Jacobi,

$$\theta^2(q) = 1+4\left(\frac{q}{1-q}-\frac{q^3}{1-q^3}+\frac{q^5}{1-q^5}-\ldots\right),$$

from which $r_2(n)$ is four times the difference between the number of divisors of n of the respective forms $4m+1$, $4m+3$. Expansions had been found by several writers over a period of years in the case of an even number of squares, but there had seemed to be no straightforward method for establishing the formulæ. A general identity was given by Ramanujan for $\theta^{2s}(q)$ without proof but with the characteristic remark "it can be shown". The proper approach to results of this kind is the methods of the theory of modular functions discovered by Mordell, which are also appropriate for the more difficult case when the number of squares is odd, as was discovered later by Hardy.

A fair proportion of the material which Prof. Hardy has now discussed was discovered by Ramanujan in the five years after he left school, and recorded in the notebooks he kept. Some of my previous remarks have shown how unfortunate it was that he had not at an earlier age the advantage of expert guidance and supervision, so that his talents could be properly directed. This would have spared him a great deal of time spent upon known work or upon erroneous ideas, or upon unnecessary elaboration in producing a great many detailed results where perhaps a few would have been sufficient. He would have learnt the importance of rigorous proof. There is of course always the possibility that he might have proved unresponsive to guidance; and after all there is much to be said for experience of any kind that can produce results.

Though Ramanujan had a hard and difficult struggle in his earlier days, it was not so after he wrote to Hardy. In fact, he could not have found a more appreciative, a more generous or a more influential patron, collaborator and friend. Thus it is through Hardy that Ramanujan's name is associated jointly with several beautiful theorems in which he had been anticipated, for example, in the Rogers-Ramanujan identities and in the Dougall-Ramanujan hypergeometric identity. I recall that in the first edition of one of Landau's books, Kakeya's name is attached to a theorem, but the name completely disappeared in the second edition after Landau had discovered that Kakeya had been anticipated by Eneström. Again, Hardy associates Ramanujan's name in Lecture VIII of the present volume with the asymptotic formula for the number of partitions of n. The proof depends upon Cauchy's integral for a function of a complex variable, a subject of which Ramanujan knew practically nothing. Of course the first suggestions as to the possibility of such results and some indication of their form were due to Ramanujan, and no doubt he was full of suggestions as to the form the final results should take. There would obviously have been no such formula without Ramanujan, and one can easily understand Hardy's gratitude for having come in contact with Ramanujan.

In attempting to assess the standing of Ramanujan as a mathematician, it is difficult not to be influenced by admiration and wonder at his success in becoming a professional mathematician in spite of the greatest difficulties. The estimate depends, as for all mathematicians, essentially upon the novelty and importance of his original work. Though some of it was wrong, and some of no permanent value; though some was over-specialization of results embodied in general theory; though some of his most interesting work was anticipated or not proved, nevertheless, there remains an impressive and formidable balance which has had great influence in shaping the direction of some of the best research since his death. To very few other mathematicians are Klein's remarks made many years ago so appropriate as to Ramanujan. "The secret of gifted productivity will always be that of finding new questions and new points of view, and without these mathematics would stagnate. In a certain sense, mathematics has been advanced most by those who are distinguished more for intuition than for rigorous methods of proof."

THE COSMICAL ABUNDANCE OF THE ELEMENTS*

By Prof. Henry Norris Russell

EIGHTY-EIGHT chemical elements have been isolated. Their separation by chemical means is sometimes easy, sometimes very difficult, and the best available tests differ greatly in sensitivity. Spectroscopic analysis provides a test for all constituents at once; but these tests, too, are unequally sensitive. Fortunately, the two methods supplement one another.

The composition of the earth's crust—above an arbitrary depth, such as ten miles—is well known. Oxygen is the most abundant element, whether by weight or number of atoms. Silicon is next, and then aluminium, iron, magnesium, calcium, sodium and potassium. These eight elements account for 98 per cent of the whole mass—the hydrogen in the oceans for but a quarter of the remainder.

The high mean density of the earth, and the seismological evidence for a liquid core, show that the 'crust' is not a fair sample of the whole. We may hope to do better with meteorites, taking an average of the various types (stone, iron, sulphides) in the ratio of their abundance (10 : 2 : 1, according to Goldschmidt). The result is significantly, but not greatly, different. Iron, magnesium, nickel and sulphur are more abundant; silicon, aluminium, and the alkali metals less. Just these differences are to be expected if the granitic 'crust' of the earth has segregated from a main mass similar in composition to meteorites.

Recent photographic observations of bright meteors show that their orbits were elliptical and of short period, so that they are samples of the solar system rather than the cosmos. Other selection processes may have operated. The spectra of comets suggest strongly that some of the solid bodies whence the gases escape may be composed largely of carbon compounds. Such a body accompanying a stony meteorite in its flight through the earth's atmosphere would be immediately destroyed.

Outside the earth, we must rely on the spectroscope alone. In the stars, the conspicuous differences along the spectral sequence are known to arise from differences of temperature and ionization. Miss Payne's conclusion (1925) that the general run of stars are very similar in composition has been fully confirmed.

Sixty elements have been identified in the sun; and the apparent absence of almost all the rest explained by unfavourable situations of their ultimate lines in the inaccessible ultra-violet. More than forty have been identified in Pegasi.

On good *coudé* spectrograms, equivalent widths of stellar lines may be well measured; and the data for the sun are extensive. To find from these the 'effective numbers of atoms above the photo-

* Abstract of an address delivered at the symposium on September 26, in connexion with the celebration of the fiftieth anniversary of the University of Chicago.

sphere' concerned in producing the line demands a knowledge of the curve of growth. Its theoretical form is well known, but involves the temperature of the atmosphere, the broadening of the stronger lines by collision damping, and the possible effects of turbulence—all involving parameters which must be found from observation.

The 'effective number of atoms' depends on the degree of ionization of the element, the Boltzmann factor for the lower state involved, and the transition probability (or *f*-value). The first two may be found from the observations if the third is known for enough lines. We have to depend for these at present mainly on an approximate theory. Good observed values are badly needed, and are now being obtained. The position of the 'photosphere' depends on the general opacity and its variation with wave-length (for which our best values still come from the limb-darkening of the sun).

The most comprehensive attempt at quantitative analysis of the sun's atmosphere is still my reconnaissance in 1929, based perforce on Rowland's estimates of intensity, and omitting many refinements for lack (at that time) of data. The calibration thus derived turns out to agree surprisingly well with modern curves of growth.

An analysis by Dr. Leo Goldberg, with all present refinements, is in progress. Through his generosity a comparison with his unpublished results may be presented. They cover at present only the more abundant elements. Omitting elements for which the older determinations were noted as doubtful, the logarithms of the number of atoms above the photosphere differ, on the average, by ± 0·28, corresponding to a factor of 1·9, while the range in abundance is 200,000-fold. Allowance has here been made for differences in the assumed temperature of the solar atmosphere, and in zero point. Goldberg's absolute values are smaller by a factor of about 30, owing to allowance for collision damping, which was unthought of in 1929.

For these same elements, the relative abundances in the sun, and in meteorites (according to Goldschmidt) show an average discordance of ± 0·45 in the logarithm, which in view of the uncertainties of determination does not indicate any definite difference in composition. For the rarer elements, the solar values of 1929 are smaller than Goldschmidt's by a factor as great as 20 for the rarest. The abundance of these elements, unlike the others, is found from very faint solar lines. An error in the old calibration of such lines (which was difficult) would account for the discrepancy.

There is therefore no present reason to conclude that meteorites differ in composition from the sun's atmosphere, so far as the metals are concerned.

For the lighter non-metals, the situation is very different. Carbon, nitrogen, oxygen and sulphur have lines in the infra-red, from which the numbers of atoms in the corresponding excited states can be found. But the Boltzmann factors are very large, and the temperature is not known well enough to permit their accurate evaluation. The hydrogen lines are so sensitive to broadening that they cannot be used to obtain its solar abundance.

No fewer than six indirect methods have been developed by various investigators. These give for the ratio of the number of hydrogen atoms to that of all the metals together values ranging from 1,000 to 8,000.

The inert gases show no absorption lines in the sun This serious gap in our knowledge has been filled by an investigation by Unsöld based on measures of line-widths in spectra of the star τ Scorpii, taken at the McDonald Observatory. This gives what appear to be reliable values for the abundance of the light elements, and also of magnesium, aluminium and silicon. For every atom of magnesium or silicon (which are almost equally abundant) there are approximately three of carbon, six of nitrogen, sixteen of oxygen, eighteen of neon, 3,000 of helium, and 16,000 of hydrogen. The enormous preponderance of hydrogen is again confirmed, and helium turns out to be a rather good second. Fluorine, sulphur, phosphorus and argon should be determinable in the same way.

Only the large differences in composition among the stars can be detected, pending study of high-dispersion spectra. The most notable example is furnished by the stars of classes *R* and *N*, the spectra of which show enormously strong bands due to carbon molecules and carbon compounds. Here there is no doubt that, as the late R. H. Curtiss first suggested, we have to deal with reducing atmospheres in the ordinary chemical sense, containing more carbon than oxygen, while the great majority of the cooler stars have oxidizing atmospheres, the excess of oxygen permitting the formation of the metallic oxides, which show in their spectra.

At higher temperatures, where compounds are dissociated, differences in composition are spectroscopically less conspicuous. One star of about the sun's temperature, R. Coronæ Borealis, has been found by Berman to contain carbon in great excess, and little hydrogen; and another, υ Sagittarii, analysed by Greenstein, shows helium in great preponderance, and hydrogen almost absent.

In the gaseous nebulæ, and the envelopes of novæ, the density is very low, and the dilution of the exciting radiation great. These conditions strongly favour the emission of forbidden lines, and favour the detection of those elements which have such lines accessible. Nitrogen, oxygen, fluorine, neon, sulphur, chlorine and carbon have this advantage. Hydrogen and helium, which show strong permitted lines, must be very abundant. The metals are at a great disadvantage, but faint lines of several have been found. Allowing for the very different conditions of excitation, there is small evidence of composition differing from the stars.

The isolated atoms and molecules which absorb interstellar lines are all in the lowest component of their ground-states. Magnesium, silicon, and many other elements are thus removed from observation, and the spectra of the rest reduced to a very few observable lines. Sodium, potassium, calcium, titanium and iron have been detected, and the compounds CH and CN. The electron-abundance, found by comparison of Ca and Ca^{+}, shows that hydrogen, though not directly observable, is very abundant. In general, there appears to be a great similarity of composition, except for the solid bodies, which are just what might be expected in masses segregated by condensation.

BIOLOGY IN HUMAN RELATIONS*

By MRS. S. NEVILLE-ROLFE, O.B.E.
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VICTORY of arms will not remove the causes of war. These lie in the lack of ability, character and emotional development of man himself. If the forces he has created are to be readjusted and canalized to human service and welfare, it is urgent to fit man for the task. The recognition of this possibility and a concentration of effort in an endeavour to understand and improve the quality of man, both of to-day and to-morrow, intellectually, emotionally and physically, would give a re-birth to hope.

The attempt of the Economic Conference to reduce financial tensions by a planned money policy failed owing to the recognition that man has not attained a standard of integrity and trustworthiness requisite to success. Countless instances exist of man's inadequacy being the barrier to progress.

Since the beginning of the century, research workers of the universities, the experimental farms, the consulting rooms and the hospitals have added much factual knowledge to our store, but its application to man has been checked by its seeming conflict with traditional values and by the barriers of prejudice and unreasoning fears inherent in man himself. Biology is being applied to his material advantage in agriculture, in medicine and in food production, but hardly at all to man himself. Psychology has been discovering why man behaves as he does and disclosing the extent to which unrecognized and repressed emotions result in individual and group action entirely contrary to the dictates of intelligence. Physiology is explaining something of the interdependence of mind and body and the results of glandular disharmony on character. Anthropology and sociology demonstrate the dependence of the individual on the group and of the interaction between man and his environment. What we now need is a concerted endeavour to collate, interpret and apply these various discoveries.

Social biology rests on the factual contributions made by all sciences bearing on the development of man. Its task is to correlate and devise methods for their application, related to ethical principles, suited to the general pattern of each social structure.

A wide range of war and post-war problems awaits attention ; to select but a few : migration and evacuation in relation to the family ; nutrition and maternal mortality ; miscegenation ; family allowances ; optimum marriage age ; fertility, care and status of the unfit. The problems are legion. The present urgency is to democratize existing knowledge under responsible auspices.

An ignorant population is in danger—a prey to exploitation in the biological, as well as in the economic and political, fields. The harm can be irreparable when personality itself is injured. We see a terrifying example in the psychological conditioning of Nazi youth to cruelty and the harnessing of its emotional drive to the false values of national aggrandizement. In the biological field the same applies to the ease with which a distorted interpretation of eugenics has been imposed on a biologically ignorant population and used as a political weapon.

Even after two generations of education in Great Britain, the omission of social biology in school curricula has deprived science of an understanding public. Facts are discovered and published, but make little impression on individual practice, social behaviour or administration, as they relate to no emotionally accepted values.

Knowledge of nutrition, heredity and health is

* Substance of a paper read at the Conference on Science and World Order, on September 28.

available, yet bad feeding, unprotected defectives and irresponsible sex behaviour prevail. The evacuation disclosures of habits at direct variance with accepted standards of cleanliness, all demonstrate the futility of a system of education which ignores preparation for life in a living world. Such an omission is a serious handicap to a nation at war.

Measures should be taken forthwith to relate social biology to ethical values, and to apply present knowledge to current problems. This is admittedly incomplete, but each additional fact, each extension of our intellectual range and of our capacity to appreciate beauty in form, sound, colour and sense, each new harmony between intuition and science that illuminates truth, clarifies our spiritual vision. Social biology, drawing its facts from science, may be pictured using them as pieces of a jigsaw puzzle from which each generation must compose the ever-deepening and satisfying key-picture of what man is and can be. We must produce, on the basis of existing knowledge, a rough and tentative outline of that picture, now dimly perceived, of complete and developed man.

Of equal urgency is to promote a wider understanding and development of the whole man. Every educational system has concentrated on the training of intelligence, none has yet taken cognizance of the paramount influence of the emotional condition of man on his behaviour, or attempted to apply even our present knowledge of psychology. We are a world of emotional children with adult minds—babies playing ball with bombs.

A true democracy can only be created by the emotionally and intellectually developed, inspired with a positive purpose in life.

Emotion and intelligence, united in a common objective, obtain astounding results in thought, in action and in conduct, as exemplified by the ideal of the League of Nations, the Battle of Britain, the brotherhood of the bombed and homeless.

Unfortunately, even the groundwork of emotional understanding does not yet form a necessary part of the training of our leaders. Though some training in psychology is given to teachers, little emphasis is placed on the emotional aspect. Normal psychology and emotional development have no definite place in the training of the medical and allied services or in that of the judiciary.

Yet, how can a medical practitioner understand the whole personality of his ordinary patient when the only psychology he has studied is that of the abnormal ? How can the midwife and the health visitor handle problems of family adjustment and emotional stress with no understanding of this side of her own or her patients' nature ? How can the magistrate on the bench judge wisely actions arising from subconscious repressions when these to him appear irresponsible excuses ?

We are adolescents who have grown out of our clothes. The manners and customs fitting the knowledge available in the past constrict development ; the tight buttons of outworn prejudice and the belts and bands of repressed emotion seriously check healthy personal growth and racial progress.

That the younger generation welcomes information and guidance on matters of social biology is evidenced by more than a hundred thousand of the 16–25 age group who have attended *ad hoc* courses of lectures presenting a biological outline of how minds and bodies function, and encourage discussion on the related personal and social questions. These have been provided by progressive local authorities through the British Social Hygiene Council. Since 1934 the Educational Advisory Board of the Council has worked to promote the introduction of biology related to man into the educational system, and has made steady, if slow, progress, now gaining momentum through war conditions.

Up to date, local authorities have sponsored fifteen teachers' courses, and twenty teachers' conferences, and about thirty are now interested in, or considering, emergency programmes. It is a beginning in the effort to equip youth for personal and public life.

It is recognized already in military circles (though not always practised) that those trained and experienced in the War of 1914–18 are not the best improvisors of strategy and tactics for a war of dive-bombers and tanks. This principle applies even more strongly to questions which affect the development of man himself.

The emotionally immature, belonging to a previous generation, with a background of traditional dogma as religion, of *laisser-faire* as social economics, of philanthropic charity as good citizenship, and an idea of the 'equality of man' which ignores biological evidence, are not qualified to govern, or to lead youth in the present world crisis ; yet it is they who are in control to-day. The old in experience and young in mind have ever been outstanding leaders, but the old in mind and years are unable to grasp the new problems or to relate new knowledge to spiritual values. They fear youth and from a mistaken sense of duty they continue to bear burdens beyond their years, and are barring advance. Hence the time-lag between the laboratory and the public is greatest in social biology.

It is vital to reach the younger generation in service and civil life, the parents of the future, and gain their intellectual interest and emotional drive behind the idea that man may control and

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STANLEY DUMBELL,
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November, 1941.

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direct to the service of man the forces that he has set in motion.

To bring youth into world affairs, they must learn how to participate in the solution of daily problems. In science, in every firm and works, on committees of management, the Whitley Councils, staff and workers' conferences—let the under-twenty-fives be included to an adequate extent in each group represented and secure an equal proportion in each local government committee, social organization and voluntary body. Once the young see some hope of taking an effective share in the national effort, the service will not be lacking. The intelligence quotient reaches its adult level at about thirteen or fourteen. Experience is needed, but so are drive, a new outlook, and faith in man's destiny.

The claim of youth to the knowledge that could equip them for life, the demand for opportunity to enable them to grapple with those problems beyond the grasp of the old in mind, must be met soon, if the younger generation is to contribute effectively to the War and the post-war endeavour.

The present 'youth movement' was inspired from Germany; though misdirected in aim, its methods were effective in giving the Nazi leaders what they sought, because emotional and intellectual efforts were united, leadership was entrusted to youth, and its driving force was positive. The Scout and Guide movement, British in origin, also owed its success to its positive ideal and the leadership of youth. The present youth movement in Britain has not included the biological essentials. The control of the 'movement' is with few exceptions in the hands of older members of education committees, and of voluntary organizations established to meet older ideas and conditions. It is unrelated to reality and therefore unrelated to youth.

The young to-day have a deeper sense of spiritual values, but their positive philosophy must embody all truth as at present perceived. They are politically minded and see in personal freedom and impartial justice man's most precious possession, but of the present incomplete interpretation of the idea of Democracy, of Fascism, Nazism or Bolshevism, indeed of all existing systems, they tend to say "a plague on all your houses; we want something better!" Let them have the opportunity to create it.

PERCH IN BRITISH LAKES

A NEW FISHING INDUSTRY

By Dr. E. B. Worthington

Freshwater Biological Association, Wray Castle

It is common knowledge that progressive changes in the physical conditions of an environment are paralleled by changes in the plant and animal communities inhabiting it. One of the first workers to elaborate the principle for the freshwater environment was Pearsall[1], who illustrated it with reference to the plant communities of the English lakes, but recognized that the animal communities were subject to corresponding changes. Thus, in the fish fauna of the English lakes there is a tendency for the original association of species, dominated by char (*Salvelinus willughbii*) and brown trout, to change into one dominated by perch and pike. Under natural conditions the change is very slow, being connected with the accumulation of silt and the general increase in productivity of water resulting therefrom; but in certain cases unconscious intervention from man appears to have accelerated the process. Thus for Windermere there is some documentary and much hearsay evidence that during the past fifty years the char and trout, which formerly gave rise to prosperous food and sporting fisheries, have been largely superseded by perch and pike, the change having probably been hastened by a general increase of productivity resulting from the addition of sewage.

From the fishery point of view the perch are recognized as a curse not only in Windermere but also in many other lakes in the district (see Watson[2]), because, as their numbers have increased they have become so dwarfed in average size as to be practically valueless to either the angler or the housewife. In order to save the fisheries, it seemed necessary to force evolution backwards, as it were, and thereby to cause the lake's fish biology to revert to the condition it was in, say, a century ago. The War has provided a use for these millions of small, unwanted fish. Their removal will, it is expected, benefit the post-war fishery, and at the same time initiate a large-scale ecological experiment which is likely to repay study for some years to come.

The perch of Windermere was first studied scientifically by Allen[3], who found that for most of its life the perch is a direct competitor with the trout for food supplies, and showed, with the aid of unbaited traps, that the perch undergoes a definite annual migration, from water deeper than 60 ft. where it spends the winter, into water shallower than 30 ft., to spawn in the spring and afterwards to spend the growing period of summer.

Soon after the outbreak of war in 1939, Allen's results were followed up on a larger scale to ascertain whether a method could be devised for catching perch in numbers large enough for practical fishery purposes, and also to obtain more detailed information about their interesting seasonal migration. Unbaited traps made of wire netting were fished near Wray Castle in depths of water ranging from 5 ft. to 100 ft. continuously for more than twelve months, the traps being lifted three times each week for the removal of fish. A few perch were taken throughout the year, but immediately after the fish had moved into the shallows in the spring they entered the traps in really large numbers for a period of about two months. A catch of five hundred fish from one lift of a single trap was by no means exceptional. The fish taken were all small, averaging a little less than 1 oz. each in weight, and the total weight taken at the optimum depth per trap per night's fishing averaged 8½ lb. over a period of eight weeks.

These perch traps are easy and cheap to make, costing less than £1 each, complete with rope and a marking float. Their manipulation requires but little labour since they remain in the water throughout the fishing season, serving not only to catch the fish but also to store them alive until the appropriate time for landing. Some pike and eels find their way into the traps following the perch, but char are never caught and trout only in the proportion of one to about 50,000 perch, and even these few can be returned to the water undamaged. Therefore, these traps seemed to be ideal instruments with which to make available perch for human consumption, and at the same time to improve the post-war fisheries.

A scheme was drawn up for the Freshwater Biological Association to start a commercial trap fishery on Windermere in the spring of 1941, using 380 traps, the correct depth of fishing to be determined by a pilot series of traps in one part of the lake. Through the good offices of the Development Commissioners and the Ministry of Agriculture and Fisheries, a grant was made to go part way towards the capital cost, and the materials for the traps were made available. Volunteer evening labour was organized among some thirty fishers living near the Lake, so that all the traps could be lifted on two or three evenings each week. British Fish Canners Ltd., of Leeds, conducted trials with samples of the fish and found that by suitable processing they could be canned like pilchards, and this firm offered to purchase the whole catch.

The first season's operations were restricted mainly to the north basin of Windermere and were essentially experimental, but they had the satisfactory result that during two months more than a million perch were sent to the canning factory at Leeds and, packed in about 150,000 tins, are being marketed as 'Perchines (Lakeland Perch)'. In addition, more than 500 eels and about 200 pike were removed from the lake. For the area of water less than 20 m. in depth, which is inhabited by these fish, the cropping rate worked out at about 46 lb. per acre. From the commercial point of view this fishery paid its way handsomely: after deducting running costs such as labour, bonuses to the volunteer fishermen, transport of fish, and allowing a 10 per cent depreciation on the gear, the proceeds from fish sold gave a net return on capital expenditure of 69 per cent during the first season of two months.

Now that the method has been demonstrated, it is hoped that a considerable expansion of this fishery will take place in 1942 and 1943. With this object in view the catching propensities of a few traps were tried out in some eight other lakes in the Lake District during the spring of 1941. In most of these results were promising, and in some the perch traps were found to catch large quantities of eels, which are of considerably higher food and cash value than perch. The method is applicable primarily in those waters where trout fishing is practised, and as such does not in any sense prejudice the angling interests of our freshwaters, but on the other hand offers an opportunity for their improvement. Apart from the Lake District itself, there are many lakes and reservoirs in England, Wales, southern Scotland and Ireland which are suffering likewise from a superabundance of perch. The new method of catching them may have a particular application in storage reservoirs, from which the removal of a crop each year is highly desirable to keep the water in good condition.

Thus it is expected that this new industry has considerable opportunities for expansion during and perhaps after the War, if the necessary organization can be brought into being. In 1942 it is hoped to enlarge considerably the fishery on Windermere and to establish similar fisheries on several other waters in the Lake District. At the same time a few traps will be given a trial in as many other likely waters as possible to prepare the ground for further commercial development in 1943.

[1] Pearsall, W. H., *Proc. Roy. Soc.*, B, **92**, 259–84 (1921).
[2] Watson, J., "The English Lake District Fisheries" (London and Edinburgh, 1925).
[3] Allen, K. R., *J. Animal Ecol.*, **4**, 264–73 (1935).

OBITUARIES

Prof. A. G. Green, F.R.S.

BY the death of Prof. Arthur George Green on September 12, at the age of seventy-seven, the British dyestuffs industry has lost its foremost chemist and an indefatigable champion whose experience had extended over fifty-six years. His genius as a chemist lay in his capacity to produce a simple solution to any problem in hand derived from facts already known, a solution so simple that it had been overlooked by smaller minds enmeshed in the difficulties of a more complex approach.

Green first showed this capacity when, in 1887, at the age of twenty-three, having been appointed to the staff of Brooke, Simpson and Spiller in 1885, he made primuline by the fusion of *p*-toluidine with sulphur, and finding that when sulphonated it possessed affinity for the cotton fibre, he proceeded to diazotize its free amino-group and couple it with various components on the fibre, thus establishing the process of ingrain dyeing which gave to cotton users organic dyes faster in many respects than those they had had heretofore. As an offshoot to this work, in collaboration with Cross and Bevan, he laid the foundation of the modern diazotype copying processes, using diazotized primuline as the light-sensitive medium and developing the screened areas where the diazo-compound had not been destroyed by light, thus producing positives direct. For this he received the Silver Medal of the Royal Society of Arts in 1891.

The dye-making industry was then declining in the face of Continental competition, and a less tenacious man might well have left so unpromising a field from which he had won little but a broad reputation. Green saw, however, that this decline was due to the failure of the empirical methods which had brought Britain success in the Industrial Revolution, and that the cause was to be found in the application by its competitors of a new technique in industry to which the key was the close application of science from day to day, exemplified in the highest degree in the manufacture of the synthetic organic dyes. He refused, therefore, to desert the industry, the salvation of which became a life cause with him, and from 1894 until 1901 he was manager to the Clayton Aniline Company, and after two years as a consultant in London became in 1903 professor of tinctorial chemistry in the University of Leeds.

In his unique combination of theoretical knowledge and practical experience, Green was henceforward recognized as the leading British authority on the dyestuffs industry, and he made every effort to show that its fate in Britain was due to neglect of research. His influence now became profound, for his students included men who were afterwards to carry out the task of rebuilding the British industry, as well as those who were to make their mark among the dye-users. With them he carried out researches on the constitution of aniline black and of the stilbene dyes, together with other work on azo, triphenylmethane, and quinone-imine dyes, much of it inspired by the quinonoid theory of colour.

Green was well known in Germany, where he had a strong friendship with Caro; the spectacle of the creeping madness which has engulfed Germany gave him great pain. On the outbreak of war in 1914, he turned to the question of the supply of explosives, and his method of making picric acid starting from 1 : 2 : 4-chlorodinitrobenzene was widely used. He served on the Ministry of Munitions Committee throughout the War. He resigned his chair at Leeds in 1916 and became director of research to Levinstein Ltd., at Manchester, where in 1917–18 he established the manufacture of mustard gas on the technical scale, a duty the necessity for which he strongly disliked. In 1919 he returned to the dyestuff field and was particularly attracted by the problem of dyeing cellulose acetate silk, for which fibre he produced the first range of special dyes, the ionamines; these are aminoazo bases solubilized as *N*-methyl-ω-sulphonates which are decomposed in the dyebath, regenerating the finely divided base with which the fibre is dyed. Also his work on the sulphuric esters of the β-hydroxyethylarylamines led eventually to the 'solacet' dyes of the Imperial Chemical Industries, Ltd. Unable to agree with the policy of the board, he left the British Dyestuffs Corporation in 1923 and returned to his private practice, which was extensive both in Europe and the United States.

An interest in chemotherapy was early aroused in Green, especially by Ehrlich's view that the action of a drug may be considered as the selective dyeing of the organism invading the body. In partnership with Dr. M. Coplans, he brought out a stabilized form of calcium acetyl salicylate, and in recent years he had been working with the α-sulphonate of *N*-ethylsulphanilamide. He was a member of the Industrial Solvents Committee of the Medical Research Council.

Green was elected to the Royal Society in 1915 and to the livery of the Dyers Company of the City of London in 1918. He was awarded the Dyers Company's Gold Medal for research with two bars, the first and second (with W. Johnson) awards being for his work on aniline black and the third for the ionamines. He was Perkin Medallist in 1917, and in 1934–35 jubilee president of the Society of Dyers and Colourists; as a member of learned societies, he was active in all movements to improve the status of the profession of chemistry.

Green was educated at Lancing and studied under Williamson at University College, London. His shy, sensitive and inquiring nature rebelled at the authoritative tone of the classical-clerical teaching of the 'seventies, which suffered no questioning and no criticism and held the scientific outlook in gentle derision or contempt. Hence his appreciation of much that the humanities stand for was seared; he jettisoned from his mind anything that might bear the taint of mysticism and under a quiet exterior he applied to life an austere and almost fierce logic which made him a tenacious worker in the laboratory and an uncompromising opponent in the council room. He was a great teacher, visiting his students or staff at the bench. He would carry out a novel synthesis of several stages in test-tubes, and obtain sufficient product both to make a dyeing and a rough assay of its fastness properties; thus he imparted directly his skill, experience and enthusiasm. In return he was given loyalty and affection in an uncommon degree. He disliked all forms of ostentation and few knew how often he gave help to the unfortunate, including the victims of Hitlerite oppression. Finally, in his later years, he had the satisfaction of seeing in the policy of Imperial Chemical Industries, Ltd., towards research the realization of the cause for which he had fought, and nothing gave him greater pleasure than his periodical visits in his advisory capacity to the new laboratories of the Dyestuffs Group at Blackley.

Green's garden was his recreation, but even there he could not resist the urge to experiment, and he had obtained results indicating that traces of fluorescent dyes applied to the soil can affect the growth of plants.

His marriage with Constance Fanny, daughter of Henry Charles Heath, miniature painter, lasted for fifty-two years, and they showed to a wide circle of friends a perfect example of married life. She was a woman of great courage, and had it not been for her influence Green might never have emerged from a life of monastic seclusion to play the part he did. The shock of her unexpected death in January 1941 was one from which an already weakened heart could not recover, and he died suddenly and peacefully in his sleep nine months after her.

K. H. SAUNDERS.

Dr. J. S. Plaskett, C.B.E., F.R.S.

JOHN STANLEY PLASKETT, late director of the Dominion Astrophysical Observatory, Victoria, B.C., who died at Victoria on October 17 at the age of seventy-five, was the doyen of Canadian astronomers. Educated at Woodstock High School in Ontario, and apprenticed to the Edison Electric Company at Schenectady, he gained valuable engineering experience with the Canadian Edison Company at Sherbrook. His chance of securing a university education came somewhat late in life—as he graduated with first-class honours in mathematics and physics at the University of Toronto at the age of thirty-three. It was four years later that his engineering knowledge and experience together with his proved powers of research in photography and spectroscopy led to his appointment to the astronomical branch of the Department of the Interior at Ottawa. In 1905 he led the Canadian Eclipse Expedition to Labrador and was appointed to the post of astronomer at the Government Observatory of Ottawa. Here he was placed in charge of the new 15-in. telescope for which he had already designed the spectroscopic equipment.

Plaskett's early work on stellar radial velocities and on the solar rotation led him to press for a larger telescope to be placed in climatically more suitable surroundings. His efforts were successful and when the Canadian Government established a new observatory at Victoria, B.C., with a 72-in. telescope, on Plaskett fell the main task of dealing with all the optical and engineering problems that had to be faced; to him also naturally fell the task of directing the work of the new observatory. Stellar radial velocities, spectroscopic orbits of eclipsing variables, the physical nature of early-type stars—particularly *O*-type stars —such were the main subjects of his own work and of the researches of his staff. The distribution in space of the interstellar matter which gave the fixed calcium lines in early type spectra was a subject to which he gave much attention. The part of the Milky Way which was accessible to the Victoria Observatory became its special field of work, and Dr. Plaskett was a strong supporter of the scheme to place a companion large telescope at the Radcliffe Observatory, Pretoria, to complete the study of the southern regions of the Milky Way.

Dr. Plaskett was a regular and welcome attendant at the gatherings of the International Astronomical Union, serving on a number of its working committees. After his retirement from Victoria, he was fully occupied with work in connexion with the optical parts of the 80-in. telescope of the Fort Macdonald Observatory in Texas; recent publications have shown with what success he carried out this task. The value of his scientific work was freely recognized. He became F.R.S.C. in 1910, F.R.S. in 1923, and C.B.E. in 1935 on retirement. He was Gold Medallist and George Darwin lecturer of the Royal Astronomical Society, Bruce Medallist of the Astronomical Society of the Pacific, Draper Medallist of the National Academy of Sciences, and was the recipient of honorary degrees at a number of universities. He leaves a widow and two sons, one of whom is Prof. H. H. Plaskett, professor of astronomy in the University of Oxford.

F. J. M. STRATTON.

Dr. Walter Granger

STUDENTS of mammalian palæontology will have learnt with great regret of the death on September 6 of Dr. Walter Granger of the American Museum of Natural History at the age of sixty-eight.

Granger started his career in 1890 in the American Museum as a taxidermist, but an expedition to the Bad Lands of Dakota after living animals, a part of the world famous for its fossils, changed his outlook and started a love of palæontology which determined his future career. How many expeditions he afterwards made to the western States of the United States to search for fossils the writer of this short account, who has a happy personal memory of one of them, cannot record, but the number must have been well over twenty. In addition, Granger worked for a season in the Fayum Desert of Egypt and was second-in-command to Dr. Roy Chapman Andrews, now director of the American Museum, on the important and successful expeditions to Mongolia sponsored by that institution.

As a collector in the field Granger had very few equals. By long experience he seemed to have acquired an extra sense which led him to the places where the best things were to be found and, when discovered, his superb skill in their excavation and preservation, the result of his acquired knowledge and great patience, came into play, as many a specimen in the galleries of the American Museum bears permanent witness.

He was, however, far from being only a skilled collector. His scientific work, chiefly on the mammals of the Eocene Period, if not as great in quantity as that of some of his colleagues, was in no way behind in quality. His papers are models of clarity and conciseness which students would do well to study.

Granger was a most lovable character, entirely loyal to his friends and colleagues and to the American Museum. He was almost unduly modest about his own attainments, but he never withheld sound and generous advice whenever his help was asked. His quiet sense of fun and his good humour and unperturbability over the various worries incident to expeditions will be well known to those that have had the opportunity of being with him in the field.

Born in Vermont, he left for New York at an age too early for a university training, but towards the end of his career Middlebury University of his native State honoured him and itself with a doctorate *honoris causa.*

Granger was one of a band of vertebrate palæontologists who gathered around the late Prof. Henry Fairfield Osborn, and in his career of just over fifty years in the American Museum he performed a life work which is a monument to his memory.

C. Forster-Cooper.

Prof. W. H. Heaton

The death on October 20 of Prof. W. H. Heaton at the age of eighty-five brought to an end a personal association with University College, Nottingham, almost from its beginning.

William Haslam Heaton, born at Bolton in 1856, attended Manchester Grammar School, where he won an open scholarship at Brasenose College, Oxford. He had a distinguished university career and gained the highest distinctions in both mathematics and physics. He was appointed lecturer and senior demonstrator in the Clarendon Laboratory of Physics at Oxford, and was repeatedly appointed examiner to the Universities of Oxford, Durham and Sheffield.

In 1884 he became professor of mathematics and physics at University College, Nottingham, which had been opened only three years before. There were flourishing evening classes, but scarcely any day students. Prof. Heaton's popular evening lectures on scientific subjects were very successful, but a more difficult task was to build up the full-time day work. One step forward was when an Education Department was opened in 1890. In this he played a leading part, as also in setting up a Department of Engineering, which was later followed by a Department of Mining.

Prof. Heaton became vice-principal in 1896, and in 1906 his teaching responsibilities were lightened by the establishment of a separate chair of physics ; this gave him more time for consideration of general College policy. In spite of his own tastes lying in the direction of science, he clearly perceived that the development of the College had been one-sided, with the Faculty of Arts lagging far behind. In 1911 he became principal, and at once instituted new professorships of English and mining, to be followed later by several other chairs. Many developments in general policy were made at the same time, and the status of the College soon began to rise. This progress was checked by the outbreak of war in 1914, but a new period of rapid development began in 1919. New laboratories were opened and emergency accommodation of every possible kind was added, but the College grew too large for its existing site. Then came the splendid benefactions of Lord Trent and the opening of new College buildings at University Park in 1928.

Prof. Heaton retired in 1929, but still retained an active interest in College affairs and was repeatedly consulted by his successors in the principalship. His death represents a very great loss to the College he served so well.

H. T. H. Piaggio.

Prof. S. Kopeć

News has been received that Prof. Stefan Kopeć, professor of biology in the University of Warsaw, and his son were among those executed near Warsaw as a reprisal for the killing of a Polish 'quisling'. In his early days Kopeć worked on the metabolism of insects with Prof. Garbowski at Cracow. After work on growth in rabbits at the Polish National Institute for Rural Economy at Pulawy he went with a Rockefeller fellowship to the Department of Animal Genetics at the University of Edinburgh. On his return he published a very extensive series of papers on growth and the body proportions of mice. In 1932 he was appointed professor in charge of the Biological Laboratory of the University of Warsaw where he continued his studies on growth. Lately he had been engaged in experimental studies on density of population problems as affecting fertility and growth. His death is a great loss to biological science.

We regret to announce the following deaths :

Dr. E. S. Beaven, the well-known agricultural botanist and plant breeder, on November 12, aged eighty-four.

Dr. J. A. Hood, founder of the Hood chair of mining in the University of Edinburgh, on November 19, aged eighty-two.

Prof. Wal her Nernst, For. Mem. R.S., professor of physical chemistry in the University of Berlin, aged seventy-seven.

Mr. J. F. F. Rowland, formerly public analyst for St. Marylebone, an authority on analytical and bacteriological examination of foodstuffs and water, on November 2, aged seventy.

NEWS AND VIEWS

Veterinary Laboratory, Weybridge

DR. W. HORNER ANDREWS vacated the post of director of the Veterinary Laboratory, Ministry of Agriculture, Weybridge, at the end of September, having held the appointment since 1927. He has taken up an appointment in the office of the Animal Health Branch, Ministry of Agriculture. Prior to taking over the Weybridge post, Dr. Andrews held research appointments in South Africa, where he served on the staff of the late Sir Arnold Theiler. He went to South Africa in 1909 and shared in the research work which led to the development of the Onderstepoort Laboratory near Pretoria which is now so well known. During 1914–18 he joined the South African Army Veterinary Corps and saw service in German South-West Africa, but was recalled to civil duty in 1915. In Africa he had wide experience of virus diseases of animals, Protozoan infections, livestock poisoning and poisonous snakes, and contributed to the literature on these subjects. When a veterinary degree was established in South Africa Dr. Andrews was appointed professor of physiology, and for some years after his return to Great Britain he was an examiner in physiology for the Royal College of Veterinary Surgeons. He was thus able to bring wide experience when he took over the Weybridge Laboratory. In the nature of that appointment much time was devoted to committee work and questions of policy, and much of the development of veterinary research in Great Britain during recent years has been influenced by work done on such committees. Dr. Andrews' personal attention was perhaps directed largely to research on foot-and-mouth disease, consideration of problems relating to bovine contagious abortion, the organization of a growing department dealing with poultry diseases and a host of other questions. The good wishes of his friends go with him in his new field of work.

PROF. T. DALLING is retiring from the chair of animal pathology in the University of Cambridge at the end of this year to assume the directorship of the Ministry of Agriculture's Veterinary Laboratory at Weybridge. He graduated at the Royal (Dick) Veterinary College, Edinburgh, in 1914 and served throughout the War of 1914–18 with the Royal Army Veterinary Corps. Later he joined the late Prof. S. H. Gaiger at Glasgow, and together they worked on some important sheep diseases. Dalling was conspicuously successful in dealing with lamb dysentery, and within a few years, in the course of which he joined the staff of the Wellcome Physiological Research Laboratories at Beckenham, he had discovered the cause and devised a means for its prevention which has resulted in the annual saving of enormous numbers of lambs. This led him and his colleagues to some valuable comparative studies on the transference of maternal immunity to the offspring in different animal species.

At Beckenham Prof. Dalling interested himself with other problems and was one of a team which recognized that a form of infectious jaundice in dogs is caused by the same spirochæte as Weil's disease in man. He was also largely responsible for overcoming the difficulties involved in the preparation and distribution on a large scale of the prophylactics used in the Laidlaw-Dunkin method of immunizing dogs against distemper. He also worked on fowl pox, fowl paralysis, bacillary white diarrhœa and other diseases of poultry. Recently, in collaboration with the late A. Stanley Griffith, he obtained evidence to suggest that the vole type of acid-fast organism discovered by A. Q. Wells may prove of value as an immunizing agent against tuberculosis in cattle.

The Society of Glass Technology

THE twenty-fifth anniversary meeting of the Society of Glass Technology was held at the Department of Glass Technology, Sheffield, on November 19, when in addition to the technical papers which were presented, the day was marked by two interesting official functions. The first was the presentation at lunch of a gold watch and a cheque to Mr. G. S. Duncan, who has recently retired from the post of librarian and assistant to Prof. W. E. S. Turner, after twenty-two years continuous service. These gifts were subscribed by a number of friends in the industry and the presentation was made by Dr. S. B. Bagley, president of the Society. A graceful tribute was paid to Mr. Duncan by Prof. Turner, Head of the Department, who emphasized the almost unique experiences that Mr. Duncan has had, as teacher, soldier and a member of one of the large publishing houses. It is safe to say that no one who has been to the Department of Glass Technology has not received advice and help from Mr. Duncan, and the remarkable development of the Society of Glass Technology is due in no small measure to him.

Later another presentation was made, this time to Prof. Turner himself. Prof. Turner had conferred upon him the honour of fellowship of the Royal Society in 1937 and to mark the occasion a portrait was painted of him in his academic dress by Mr. Edward Halliday, R.A. This portrait was exhibited at the Royal Academy in the summer of 1939 and the portrait was to have been presented to Prof. Turner in October of that year. Owing to the intervention of the War, however, and later to the illness of Prof. Turner, the presentation was not made until recently and it was felt that the twenty-fifth anniversary of the Society was an appropriate occasion. The presentation itself was made by Dr. C. J. Peddle, who was president of the Society in 1939, in a speech which emphasized the importance and unique character of the work that has been carried out in the department by Prof. Turner and his staff. Prof. Turner in replying commented on the fact that when he first went to the Department of Physical Chemistry at Sheffield in 1904, Dr. Peddle was his first honours student, and later his first research student, and that one of his early students was Dr. S. English, who is president-elect of the Society. Attention was directed to the fact that the painting of the portrait was made possible by gifts from 417 members of the Society, representing eighteen different countries, including some of those with which we are now at war. Coloured photographic replicas of the portrait have been made, and one of these is being kept by Prof. Turner and the other is being sent to the United States, where it will hang in the building of the American Ceramic Society at Columbus, Ohio. Finally, Prof. Turner offered the portrait to the University of Sheffield and this was accepted by Sir Henry Stephenson, pro-chancellor of the University.

Science and the War Effort

THE Association of Scientific Workers is organizing an open conference on the general topic of "Science and the War Effort", to be held in the Caxton Hall, Westminster, during January 10 and 11, 1942. The president of the Association, Mr. R. A. Watson Watt, will open the Conference at 10 a.m. on January 10. The proceedings will then develop in two parallel sessions ; one session will be concerned with technical education, which will include the university training of men of science and technicians, also the special technical training of personnel for the Forces and for industry. The parallel session will be discussing building, housing and A.R.P. in the morning; and, during the afternoon, food and agriculture. After tea, both sessions will unite for the main discussion on the latter subject. The session on January 11 will be entirely devoted to discussion of immediate scientific problems in relation to war production and the services. One topic which will be thoroughly examined is the utilization of scientific personnel, about which subject the Industrial Committee of the Association has collected a great deal of material. The remainder of the day will be occupied with the examination of the application of scientific knowledge to production problems and to services problems. This will include consideration of industrial health, conditions of work, and related topics. The final session after tea will be devoted to summing up the results of the Conference.

A feature of the proceedings will be the ample provision for discussion, both during the sessions themselves, and in the tea intervals. It is hoped that members of the general scientific, engineering and technical community will avail themselves of this opportunity. It should be noted that this is the first open conference to be held in Great Britain of scientific workers to discuss their part in the national effort. The Conference Sub-Committee will welcome inquiries and suggestions, both from individuals and from scientific and technical bodies. All communications should be addressed to the Conference Secretary, Association of Scientific Workers, 30 Bedford Row, W.C.1.

American Mathematics and the U.S.S.R.

THE following reply to the message sent by American mathematicians to their colleagues in the U.S.S.R. (see NATURE of November 8, p. 560) was sent from Moscow on October 7 :

"Your splendid message, dear colleagues, found wide response in the hearts of the scientists of our country. We read it with feelings of all the more appreciation and satisfaction in that it again emphasized the community of thoughts and the friendly ties between the mathematicians of the U.S.A. and the U.S.S.R. Many years we jointly worked with you on the development of our science, many of our American colleagues were our welcomed guests, while with a still greater number of American scientists we conduct friendly scientific correspondence. This mutual co-operation was very fruitful and led to a number of important scientific discoveries. In recent years our country became the centre of gravity for eminent European mathematicians who were forced to flee the lands downtrodden by the heel of Nazi barbarians. Our country too is subjected to the invasion of these gloomy medieval forces. The Hitlerites seek to smash the U.S.S.R. in order to make their forces afterwards available for destroying also your great country. The fight now being waged by our people is the fight for the progress of all mankind, for everything advanced, the fight for the flourishing of civilization and of science.

"Our science too has been placed at the service of our country for the destruction of Nazism. Soviet mathematicians, like all Soviet scientists, participate in this fight in common with the whole people. This struggle of Soviet scientists is the common cause of the scientists of all democracies, against the fiend who shoots children, burns libraries, smashes universities, and destroys science. On this momentous day your message, dear friends, has been received by us as the proof of the unity of Soviet and American scientists and their determination to fight the twentieth-century vandals till the end. Let the friendship of the Soviet and the American scientists be the surety of the friendship of our great nations, the surety of the victory of democracy over the dark forces of Hitlerism."

The message was signed by sixty-four Russian mathematicians including A. Sobelev, director of the Steklov Mathematical Institute of the Academy of Sciences of the U.S.S.R., and P. Alexandrov, president of the Moscow Mathematical Society.

Colonial Affairs

MR. G. H. HALL, Under-Secretary of State for the Colonies, made a statement on Colonial policy in the House of Commons on November 20. After a striking tribute to the "universal uprush of loyalty to the Throne and support for our cause in all the peoples of the Colonial Empire", Mr. Hall announced that it has been decided to appoint a Colonial Labour Advisory Committee, to function on the lines of the committees already in existence on medical matters and on education. The Committee, which will be a small one, will consist of representatives of the Colonial Office, and members of the Trades Union Congress and of employers' organizations interested in Colonial affairs. The Colonial Office already has a labour adviser, and the new Committee will serve to strengthen this side of its work. It may be anticipated that as the various provisions of the Welfare and Development Act come more extensively in force, this Committee will grow in importance and its activities play a prominent part in the future of the British Colonial Empire.

A brief survey of Colonial Office activities during the past year was also given by Mr. Hall. Even under war-time conditions it has been possible to send officials of the Colonial Office overseas to examine problems on the spot. Lord Hailey is presiding over a committee examining post-war problems which are likely to arise. Many schemes, amounting to hundreds of thousands of pounds, submitted under the Welfare and Development Act, have been approved. The appointment of an economic and financial adviser to work with Sir Frank Stockdale is being considered. The needs of Colonial peoples in Great Britain have also been examined ; a welfare officer and an assistant welfare officer, the latter an African, have been appointed, and an adviser to Colonial students, who is a West Indian, is being appointed. Mr. Hall concluded by emphasizing that our duty is now to improve the lot of the Colonial peoples, to develop their resources so as to raise their standard of living, and to enable them to take an ever-increasing responsibility in their own government.

Federation of American Societies for Experimental Biology

IN March 1942 the Federation of American Societies for Experimental Biology will issue the first number of a quarterly publication to be named the *Federation Proceedings*. This will be published by an editorial board representing the five constituent societies of the Federation : the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, the American Society for Experimental Pathology, and the American Institute of Nutrition. Four numbers will be published each year. The March issue will appear just previous to the annual meeting of the Federation, and will be composed of two parts. Part 1 will include the abstracts of all the papers to be presented at the annual meeting, about a thousand in all. Part 2 will comprise the programme of the scientific sessions of all the constituent societies of the Federation. The June and September issues will include the full text of perhaps twenty of the papers presented at the annual meeting as selected by the editorial board, including probably the papers on the joint programme of the Federation as a whole as well as the papers of one symposium of each of the five societies. The December issue will include material pertinent to the Federation membership formerly published in the Federation Yearbook, which will hereafter be discontinued. The *Federation Proceedings* will be distributed without further charge to all members of the Federation. The subscription price to non-members will be four dollars (4.50 dollars foreign) payable in advance. Further information can be obtained from Dr. D. R. Hooker, Managing Editor, 19 West Chase Street, Baltimore, Maryland.

Therapeutic Research Corporation

A NEW step in the rationalization of the British fine chemical industry has been taken by the formation of the Therapeutic Research Corporation of Great Britain, Ltd., the directors of which are Lord Trent, of Boots Pure Drug Company, Ltd., Mr. C. A. Hill, of the British Drug Houses, Ltd., Mr. H. Jephcott, of Glaxo Laboratories, Ltd., Mr. T. B. Maxwell, of May and Baker, Ltd., and Mr. T. R. G. Bennett, of the Wellcome Foundation, Ltd. Although each of the directors of the new Corporation is managing director of his own concern, the Corporation is not an amalgamation of these five firms. Each will retain its freedom of action in its special field, but will contribute to the common research pool ; in effect, a much extended research team now becomes available for work on new drugs, and overlapping effort should be eliminated. It is also hoped to secure the interest and co-operation of research workers in academic institutions. The Corporation will have in the various chemical, physiological and bacteriological laboratories at its command the choice of many different lines of approach to its problems and the call on the extensive scientific personnel and equipment of the five companies which are collaborating. This should make for a hopeful start and lay the foundation of a promising superstructure.

Norway : Present and Future

MR. GATHORNE-HARDY's pamphlet "Norway and the War" (Oxford Pamphlets on World Affairs, No. 51. 4*d*. net) gives an account of the physical characteristics and resources of Norway, its people and their democracy, and relations with their Scandinavian neighbours and other powers, which could scarcely be bettered as a contribution to the understanding of the Norwegian resistance to Nazism and of Norway's future. Although little more than a third of the pamphlet deals with Norway and the War proper, the pamphlet contains nothing irrelevant, and it emphasizes the close ties between Norway and Great Britain through the marked similarity of outlook, the ties of the sea, and the long association of various kinds.

Despite the appeal of Germany in scientific and technical circles, Norwegian thought, with its passionate insistence on individual liberty, free speech and parliamentary democracy, is diametrically opposed to the totalitarian ideology, and her neutrality had no spiritual basis. Mr. Gathorne-Hardy emphasizes the important part which confusion, rather than deliberate treachery, played in the situation when Norway was invaded, and also the credit due to the Norwegians for the toughness of their resistance in a singularly desperate situation. After a brief account of the German occupation, he indicates the re-orientation which is taking place in Norwegian foreign policy, now that isolated neutrality and Scandinavian collaboration have proved insufficient security. As an Atlantic and seafaring nation, Norway seems likely to look for help and collaboration mainly to the free nations overseas—the British Empire and the United States.

Recent Earthquakes

ACCORDING to a message in *The Times*, a violent earthquake was experienced about noon (local time) on November 12 at Erzinjan in Anatolia. A number of buildings were damaged in the town but only a few persons were injured. It is feared that the damage and casualties will be greater in the villages near Erzinjan, and further information is awaited. It will be recalled that a very great earthquake struck the same region on December 27, 1939 (NATURE, January 6, 1940, p. 13).

An earthquake of considerable severity (probably the most severe for eight years) shook Los Angeles on November 14. The electric power station in the Beverly Hills district was temporarily stopped and about a hundred small buildings together with some oil storage tanks were wrecked. Gas and water mains were broken, and some suburban homes in the Torrance Gardena district were damaged. Several parked motor-cars were damaged when the front of a store fell into the street. Damage in one district is estimated at a million dollars. No deaths or serious injuries are reported and further information is awaited. Los Angeles and Hollywood were affected by strong earthquakes on October 11, 1940 (NATURE, November 30, 1940, p. 720), and January 28, 1931, besides numerous other occasions.

Dr. George Birkbeck and Technical Education

ON December 1, a century ago, Dr. George Birkbeck died in London and was buried in Kensal Green Cemetery. His name to-day is recalled by Birkbeck College, London, which began its career as the London Mechanics' Institution with Birkbeck as its president. There were at one time hundreds of such institutions, and no doubt many of them exist to-day, but they may all be said to have sprung from the classes for mechanics started by Birkbeck in 1800 at the Anderson College of Glasgow, in which as a young man of twenty-four he held the chair of natural philosophy. Born in Settle, Yorkshire, on January 10, 1776, Birkbeck studied medicine at Leeds, London and Edinburgh, but he began his active career as a lecturer. In 1804 he set up in practice in the City of London and there became known to Hume, Grote, Brougham, and many other men of liberal ideas. In 1809 he assisted in founding the London Institution, in 1824 became president of the Mechanics' Institution, and was a projector of University College, and a supporter of the Society for the Diffusion of Useful Knowledge. He was, as his biographer J. G. Godard says, a "National Reformer". In the prospectus of his class of 1800, he stated that it was "for persons engaged in the exercise of the mechanical arts, whose education in early life has precluded even the possibility of acquiring the smallest portion of scientific knowledge". He lived to see knowledge brought within the reach of all.

Recent Investigation of New Plant Fibres

AN investigation has been carried out by the Royal Botanic Gardens, Kew, in collaboration with the National Physical and Chemical Laboratories and the Imperial Institute, of the mechanical properties of the fibre from nettle stems (*Urtica dioica*) and other plants native to Great Britain, and of methods of extraction. The nettle fibre has been found to be suitable for the manufacture of high-grade paper, and possibly of textiles, while the leaves are commercially valuable for the extraction of chlorophyll. Arrangements were made for the extensive collection of this abundant raw material during 1941.

The Night Sky in December

THE moon is full on Dec. 3d. 20h. 51m. U.T. and new on Dec. 18d. 10h. 20m. Lunar conjunctions with the planets occur on the following dates: Saturn on Dec. 2d. 9h., Saturn 2° N.; Jupiter on Dec. 4d. 7h., Jupiter 4° N.; Venus on Dec. 21d. 16h., Venus 4° S.; Mars on Dec. 26d. 22h., Mars 4° N.; Saturn on Dec. 29d. 11h., Saturn 2° N.; Jupiter on Dec. 31d. 7h., Jupiter 4° N. Jupiter is in opposition to the sun on Dec. 8, and on Dec. 29 Venus attains its greatest brilliancy; the planet is then 38 million miles from the earth. Mercury is a morning star until Dec. 21, then an evening star. Venus, Mars, Saturn and Uranus are evening stars. Neptune is a morning star and Jupiter is a morning star until Dec. 7, then an evening star. The sun enters the sign Capricornus on Dec. 22, the winter solstice. About this time of the year we have the interesting phenomenon of the mornings decreasing in length while the afternoons and the whole periods from sunrise to sunset are increasing; this, as is well known, is due to the equation of time. The first magnitude star α Tauri (Aldebaran) is occulted on Dec. 30d. 22h. 23·4m., reappearance occurring at 23h. 46·6m. The Geminid meteor shower is active during Dec. 7–15, the radiant being close to α Geminorum. Many interesting objects can be seen during the month, such as the great nebulæ of Orion and Andromeda, the open star clusters of Perseus, the Pleiades and the Hyades, and many well-known double stars and variable stars.

Announcements

PROF. BJORN HELLAND-HANSEN, the well-known hydrographer and head of the Meteorological Institute of Bergen, was arrested some six months ago and is still in prison.

THE title of professor of mining geology in the University of London has been conferred on Dr. W. R. Jones, in respect of the post held by him at the Imperial College of Science and Technology.

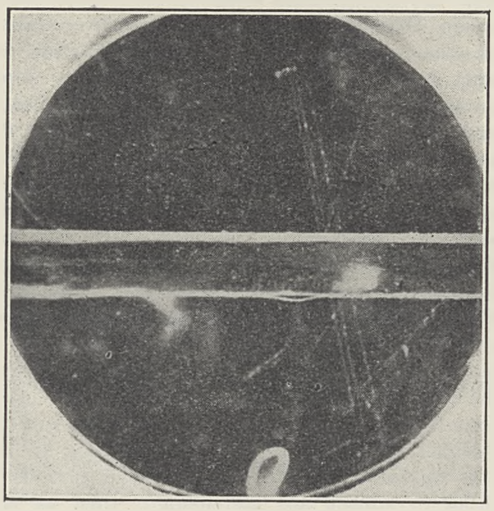
PROF. F. C. BARTLETT, professor of experimental psychology in the University of Cambridge, has been appointed a member of the Medical Research Council in the vacancy caused by the death of Prof. A. J. Clark.

LETTERS TO THE EDITORS

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

Cloud Chamber Investigation of Penetrating Showers

THE existence of penetrating showers, different from electron cascades or knock-on showers, has been established by counter experiments[1,2]. These experiments are most easily interpreted in terms of showers containing several penetrating particles, though other interpretations cannot be excluded[3].



To investigate the nature of these penetrating showers, we have used a deep cloud chamber controlled by a counter system selective for penetrating showers. The counter system consists of three trays each containing two counter sets. The expansions are controlled by sixfold coincidences, namely, coincidences between six counters, one out of each set. The trays are separated by lead absorbers of sufficient thickness to cut out cascade showers. The total thickness of absorber is 30 cm. The cloud chamber is placed between the top tray and the middle tray. In order to distinguish electrons from penetrating particles, a lead plate 2·3 cm. thick is placed across the middle of the chamber.

The rate of sixfold coincidences is 8 ± 1 counts per 100 hours and is due to the following processes: (1) penetrating showers, (2) triple knock-on showers, (3) casual coincidences. The rate of (2) is estimated as 0·7 counts per 100 hours, while that of (3) as 0·5 counts per 100 hours. Thus most of the observed coincidences should be due to penetrating showers.

One of our photographs, reproduced herewith, shows three penetrating particles traversing the lead plate. The stereoscopic projection shows that the three tracks diverge from a point situated in a lead absorber of 2 cm. thickness which is placed over the top counter tray. A somewhat similar photograph has been reported recently by Powell[4]; pairs of penetrating particles have been reported by various observers[5]. A pair of penetrating particles may consist of a meson and knock-on proton, but this explanation is excluded if there are more than two penetrating particles. Three penetrating particles originating from one point indicates the occurrence of multiple processes.

The accompanying table contains a classification of 32 photographs.

Total number of photographs	Photographs with: definitely more than one penetrating particle	probably more than one penetrating particle	one penetrating particle	Big showers	Unclassified photographs
32	2	3	6	4	17

We know from other experiments that the extension of penetrating showers is large compared with the area covered by the cloud chamber and therefore only a fraction of the penetrating particles in any shower is photographed. Further, the density of tracks in the photographs classified as 'big showers' is so great that it is impossible to say whether or not they contain penetrating particles. The photographs obtained may, therefore, be considered compatible with the view that all penetrating showers contain associated penetrating particles. In any case, we can conclude that a not inconsiderable fraction of the penetrating showers contains associated penetrating particles.

It appears from the photographs that the penetrating showers do not consist simply of simultaneous mesons, but are rather complex.

The thirty-two photographs obtained show nine heavily ionizing tracks due to slow mesons or slow protons. Though heavily ionizing particles are known to occur in showers[6], the rate of heavily ionizing particles per photograph in the present investigation is rather high. It seems therefore that the heavily ionizing particles are connected with the penetrating showers.

L. JÁNOSSY.
C. B. MCCUSKER.
G. D. ROCHESTER.

Physical Laboratories,
University of Manchester.
Nov. 6.

[1] Wataghin, Santos and Pompeia, *Phys. Rev.*, **57**, 61–339 (1940); **59**, 902 (1941).
[2] Jánossy and Ingleby, NATURE, **145**, 511 (1940).
[3] Jánossy, *Proc. Roy. Soc.*, A (in the press).
[4] Powell, *Phys. Rev.*, **60**, 413 (1941).
[5] Braddick and Hensby, NATURE, **144**, 1012 (1939); Herzog and Bostick, *Phys. Rev.*, **58**, 218 (1940); Powell, *Phys. Rev.*, **58**, 474 (1940).
[6] Blackett and Occhialini, *Proc. Roy. Soc., A*, **139**, 699 (1933); Anderson and Neddermeyer, *Phys. Rev.*, **50**, 263 (1937).

Absolute Sensitivity of Geiger Counters

THIS subject has, in recent years, become of interest partly (*a*) in cosmic ray experiments, where information can be gained on the specific ionization of cosmic ray particles (Danforth and Ramsey[1]), or on shower sizes (Ramsey and Danforth[2]), and (*b*) in various applications of the coincidence-counting technique to nuclear physical problems, for example the determination of nuclear level schemes. The latter problem has been admirably discussed by Dunworth[3], following work by Feather and Dunworth[4].

We have carried out some preliminary experiments with single β- and γ-ray counters with the view of determining the absolute yields of some nuclear disintegration processes. Unfortunately, it has become necessary to terminate the work before accurate results could be obtained. The possible errors are indicated below. The greatest experimental difficulty is to bridge the gap between natural (∼2 Mev.) and artificial (∼10 Mev.) γ-ray sources.

In the first place, the counting of cosmic ray particles and γ-rays (2—17 Mev.) involves two different mechanisms, the former utilizing ionization in the gas of the counter and the latter the emission of photo-electrons from the cathode. The counter efficiencies in these two sets of conditions show large differences. For example, Street and Woodward[5] reported efficiencies of about 94 per cent for cosmic ray particles, using a Geiger counter telescope, and measured the average number of ion pairs/cm. of path produced by the rays. C. G. and D. D. Montgomery[6] quoted data for primary specific ionization in various gases, and the requisite pressures for different efficiencies with a 1 cm. mean free path through the counter; thus air at 2·5 cm. mercury pressure gives 50 per cent and at 16 cm. pressure, 99 per cent efficiency. Again[1], the measured efficiencies were found to agree very closely with those deduced from a knowledge of the primary specific ionization caused by the operative cosmic rays, and assuming that each ion pair caused a counter discharge (100 per cent efficiency).

For the measurement of γ-rays (∼2 Mev. energy) the problem is to calculate the magnitude of secondary electron currents from the counter cathode. The absorption coefficient for 2 Mev. γ-rays (μ/ρ cm.²/gm.) is given[7] as 0·04, variations of μ/ρ with energy being small, so that the above figure approximately holds for the radium family γ-rays. Taking $\mu = 0{\cdot}4$ for copper, the percentage loss for 0·8 mm. (the cathode thickness for the tubes used in our experiments) is approximately 7 per cent. If we assume that all the absorbed quanta give rise to 2 Mev. electrons (range in copper∼0·1 cm.) distributed uniformly throughout the absorber, it seems that the counter efficiency should be about 0·7 per cent. It is also assumed that the electronic absorption curve is linear, that all the secondary electrons are projected forwards (that is, the Compton effect $\gg$ the photo-electric effect), so that the second wall of the counter cathode is inoperative, and that any secondaries from the pyrex wall are absorbed by the cathode.

This figure agrees with experimental data. Norling's[8] curve shows (for 2 Mev. γ-rays) an efficiency of about 1·2 per cent for brass, 0·2 cm. thick, data being also given for lead and aluminium. Dunworth's[3] figure, for 0·12 cm. thick brass, is about 0·3 per cent; taken from a very complete curve covering the range 0·2—3 Mev. The shape of such curves was calculated by von Droste[9] and Yukawa and Sakata[10].

Our experiments, in which the expected accuracy was not high, were carried out with single counters located at known (large) distances from calibrated sealed-off radium sources. Care was taken to eliminate scattering so far as possible. It has been stated (Kovarik[11]) that $7{\cdot}3 \times 10^{10}$ and $5{\cdot}6 \times 10^{10}$ quanta/sec./gm. are emitted from radium in equilibrium with its short-lived products with a filter of 0·1 cm. glass and 1·5 cm. lead respectively. In the latter case a brass tube which cut off about 2 per cent of the radiation was also used. The efficiency of a typical counter (4 in. cathode, 1 in. diameter, air at 3·5 cm. pressure) was found to be 0·5 per cent (possible error ± 10 per cent) at 1600 v., with a counter striking potential of about 1450 v. The source used was 0·2 mgm. radium in a monel capsule 0·2 mm. thick at a distance of 80 cm. from the counter. Other counters gave similar efficiencies.

We also determined the efficiency of a β-ray counter (ionization now produced largely in the gas of the tube, not the walls) with a duralumin cathode 6 cm. long 2·54 cm. diameter and $3{\cdot}5 \times 10^{-3}$ inch thick strengthened with circumferential ribs. The counter contained air at 3·5 cm. pressure and was run at 1600 v. (striking potential about 1450 v.). The standard source was 1.21 gm. of powdered uranium nitrate (*A. R.* $UO_2(NO_3)_2.6H_2O$) in a 2 mm. thick brass pot 2 cm. high and 1·7 cm. internal diameter, forming a layer about 3 mm. deep. With the counter 9 cm. from the active layer a count of 512 ± 5 per cent in 20 sec. was obtained. Absorption in the counter walls would be almost complete for the uranium rays, hence the number of disintegrations per gm. uranium per minute is taken[12] as $7{\cdot}2 \times 10^5$. After allowing approximately for the source thickness[13] and the finite dimensions of the counter and source (the errors for this arrangement would be much greater than those for the γ-ray experiment described above), the counter efficiency was found to be 0·27 ± 30 per cent, that is 18–35 per cent. The error could probably be reduced to ± 10 per cent by more accurate calculation. Bramley and Brewer[12] obtained 11 per cent efficiency for one of their counters.

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Interchange of the Ammonium and Potassium Ions in Muscle and Yeast

SINCE the muscle membrane is permeable to the ammonium ion, from the theory of potassium equilibria previously described[1,2], the following should hold:

$$a/a_1 = k/k_1 = h/h_1$$

where a,a_1, k,k_1 and h,h_1 are the concentrations of ammonium, potassium and hydrogen ions outside and inside the membrane. On investigation, it appeared that the ammonium ion (or possibly the minute amount of associated free base) has a marked effect on the membrane itself, all ratios being lowered across it (Fenn and Cobb have described such an effect of ammonia on potassium[3]).

With the sartorius muscle of the frog immersed at 2–3° C. in a Ringer fluid designed to maintain constant volume[2], and in which a has the low value of 1 mgm. NH–N/100 ml., k being 117 mgm./100 ml. (30 m.eq./litre), the equilibrium a/a_1 value of 2·1 is reached quickly, but that for potassium very slowly, since much potassium must come out under these conditions and sodium enter. After forty-eight hours the k/k_1 value approaches that for a/a_1 and has fallen from an initial figure of 4·0–2·3.

When the external potassium is much raised—to upwards of 300 m.eq./100 ml.—with provision for maintaining constant volume[2] the k/k_1 ratio across the membrane is much lowered both theoretically and experimentally, and then small ammonium concentrations have no apparent effect on it. After twenty-four hours in the cold, with external k of 150, 210 and 300 m.eq./litre, the a/a_1 values are 1·51, 1·33, and 1·28, the k/k_1 equilibria even without any ammonium being 1·56, 1·36 and 1·28. The results are therefore in accord with theoretical expectation and show a specific effect of the ammonium salt on the muscle membrane.

Yeast. The specific membrane effect of the ammonium ion (or associated base) on muscle is not evident with yeast, and ammonium ion can be made to replace the *whole* of the potassium within the cell, after which it can be taken out and the potassium replaced. (At the same time it may be noted that the simple equilibrium equations applicable to a distensile membrane are not valid for the comparatively rigid membrane of yeast.) A striking peculiarity of the yeast permeability is that the replacement with ammonium goes at a practically negligible rate unless the yeast mixture *is bubbled with carbon dioxide* (3–10 per cent), bubbling with oxygen at the same pH being almost ineffective. Even with carbon dioxide the entrance is very slow compared with muscle and considering the size of the yeast cell. After forty-eight hours at room temperature all the potassium can be taken out, though much the greater part is lost in twenty-four hours and occasionally practically all of it. The following example may be given:

Sample of pressed bakers' yeast suspended in Ringer solution for a short time and centrifuged.

K content	450 mgm./100 gm.
NH–N ,, ...	< 1 mgm./100 gm.

Bubbled for 24 hr. with 3 per cent CO_2, 97 per cent O_2, in Ringer fluid containing 11·9 m.eq. bicarbonate/litre and varying strengths of NH_4Cl.

NH_4Cl in Ringer fluid →	$N/5$	$N/20$	$N/100$
NH_3-N in yeast	400	174	51
K—in yeast (mgm./100 gm.)	0	192	268

Yeast centrifuged and washed in a similar Ringer fluid containing 30 m.eq./KCl per litre and no NH_4Cl; then bubbled in this fluid as before for 24 hr.

NH_3-N in yeast	47	17	7
K—in yeast (mgm./100 gm.)	425	455	436

The complete replacement of the potassium with NH_4 followed by the subsequent reversal shows that potassium in yeast is altogether in the ionized condition.

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Sept. 16.

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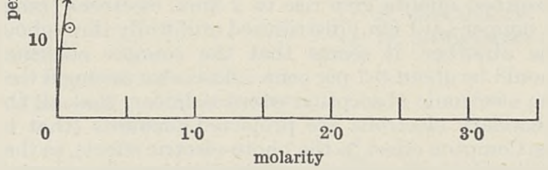
Effect of Sodium and Potassium Ions on Cholinesterase

Mendel, Mundell, and Strelitz[1] reported inhibition by potassium ions, and activation by calcium ions, of cholinesterase from horse serum; and they suggested that certain physiologically antagonistic actions of these ions might be explained on this basis. Nachmansohn[2] stated that sodium and potassium ions in high concentrations activate the cholinesterase from the electric organ of the Torpedo to the same degree, but no experimental data were given. Nachmansohn's communication evoked critical replies from Mendel, Mundell, and Strelitz[3], and Massart and Dufait[4]. The former authors raised the possibility of differences in the enzyme systems in horse serum and Torpedo, and also suggested that the sodium and potassium salts used by Nachmansohn may have contained sufficient of the activating bivalent metals to give the effect he reported.

In order to throw light on this controversial issue the present study was made, dealing with the effect of the addition of chemically pure sodium chloride and potassium chloride to cholinesterase-acetylcholine chloride systems using dialysed horse and rabbit sera as sources of the enzyme. The usual manometric method employing the Warburg apparatus was used with the substitution of 0·20 per cent $NaHCO_3$ for bicarbonate-Ringer solution. The accompanying figure demonstrates the activating effect of both salts upon the activity of the rabbit enzyme. However, neither of the salts produced a consistent activation



EFFECT OF SODIUM AND POTASSIUM IONS ON CHOLINESTERASE IN RABBIT SERUM.

×, NaCl; ⊙, KCl. Hydrolysis measured at 30° C. in a total volume of 4 c.c. containing 15 mgm. acetylcholine chloride and 0·2 c.c. dialysed serum. Reaction period, 120 minutes. Corrections applied for non-enzymatic hydrolysis in presence of the corresponding concentration of the appropriate salt.

or inhibition of the horse serum enzyme. In some experiments small activations or inhibitions were observed, but these were not reproducible, and hence must be considered the result of experimental variation.

The points of accord and conflict between the present findings and previously published work are apparent. In agreement with the suggestion of Mendel, Mundell, and Strelitz[3], it would appear that the source of the enzyme is a crucial factor in determining the effect of sodium and potassium ions on cholinesterase. Nachmansohn's statement[2] that ". . . the enzyme is only active in the presence of divalent cations. After dialysis the enzyme practically completely loses its activity" may apply for cholinesterase from the electric organ of the Torpedo, but does not for the enzyme from horse or rabbit serum.

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[3] Mendel, B., Mundell, D., and Strelitz, F., Nature, 145, 822 (1940).
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Science in the U.S.S.R.

The words quoted by Prof. J. B. S. Haldane[1] occur in a letter written by Boyle at the age of nineteen years and nine months. One can well imagine how their author in his maturity might have deprecated what has been read into them, in some such way as "I scruple not to say, that those who know me best, will scarce believe me apt to constrain Natural Philosophy into a course so strait, as some wou'd pretend".

Prof. Haldane also makes the remarkable assertion that Thomas Sprat, the literary divine who was the early historian of the Royal Society, postulated "a class basis for science". That is exactly what Sprat did not do ; nor, so far as I know, did any of the creators of the Society, for they came of all classes and they held it open to all who were able. Thus, another letter from the youthful Boyle, written five months after that which Prof. Haldane has used, remarks of the leaders of the Invisible or Philosophical College that, "though ambitious to lead the way to any generous design, [they are] of so humble and teachable a genius, as they disdain not to be directed to the meanest, so he can but plead reason for his opinion ; . . .". And there should be set against Prof. Haldane's sentence taken from Sprat's "History of the Royal Society" a number of passages from the same work, which show the "comprehensive Temper" of British science as it then was ; I choose one only (1667 ed., p. 67) :

"But, though the *Society* entertains very many men of *particular Professions* ; yet the farr greater Number are *Gentlemen*, free, and unconfin'd. By the help of this, there was hopefull Provision made against *two corruptions* of Learning, which have been long complain'd of, but never remov'd : The *one*, that *Knowledge* still degenerates, to consult *present profit* too soon ; the *other*, that *Philosophers* have bin always *Masters, & Scholars* ; some imposing, & all the other submitting ; and not as equal observers without dependence.

"The first of these may be call'd, the *marrying of Arts too soon* ; and putting them to generation, before they come to be of Age ; and has been the cause of much inconvenience. It weakens their strength ; It makes an unhappy disproportion in their increase ; while not the *best*, but the *most gainfull* of them florish : But above all, it diminishes that very profit for which men strive. It busies them about possessing some petty prize ; while Nature itself, with all its mighty Treasures, slips from them ; . . ."

So far as a movement must be judged at all by isolated quotations instead of by the sum of acts and deeds, these two passages convey, I believe, a much less misleading idea of historical fact than do those which Prof. Haldane has chosen.

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[1] Nature, 148, 598 (Nov. 15, 1941).

What Mr. Maisky said exactly and what was the context make such a difference that I do not propose to argue or comment on his words. Short quotations without the full story are very dangerous and unfair, as I know to my cost.

It is with Prof. Haldane's conclusions as to British science that I wish to deal. The words of Boyle and Sprat may indeed have been inspired by the desire at that time to get going an organization of real science, as compared with alchemy, and the difficult task with this was, I have no doubt, the fact that it had to be wrapped up with the possibility of utility.

To say, as does Prof. Haldane, that British science is applied and not pure seems to me a travesty of fact. If it were so, some of the great work of the past must have been related to objectives rather than to knowledge for knowledge's sake. It would follow that Darwin did his work in order to organize a menagerie ; that Crookes's work on the exhausted tube was based on a keen desire to develop neon advertisements ; that Thomson juggled with electrons in order to sell radio sets ; and I suppose Eddington's theory of the expanding universe might at a future date be related to a keen desire to increase the value of real estate.

If there is a criticism to be made of British science, then I think it is that the team of applied scientists do not rally enough round the pure scientists. The standard example of this is the discovery of the great dyes, which were turned into an industry in Germany by the applied scientists in that country.

I have at the present time the honour of being associated with many physicists working on *ad hoc* problems connected with the War. It is indeed remarkable what they do, and they deserve the nation's profound thanks. I do notice, however, a keen desire on their part to get away from the particular to the general. I like this tendency. It is healthy and praiseworthy, but according to Prof. Haldane against the traditions of British science. I cannot accept this.

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RESEARCH ITEMS

Electrical Phenomena in Heart Muscle During Activity

J. A. E. EYSTER, in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15, dealt with the electrical potentials which develop in the heart in the interval immediately preceding and during the contraction of the organ, and their relation to the contraction process. Potential-time curves of two types, unipolar and differential, are recorded by means of direct current amplifiers and cathode ray oscillographs, along with a constant reference curve. The characteristics of these curves and their relation to each other and to the onset of contraction in the various localized regions of the heart will be discussed. The electrical phenomena are characterized by their polar distribution. Regions of positive and negative potentials arise simultaneously, undergo growth and decline, and a certain shift in their spatial relations during the action potential period. It is shown that the onset of contraction in any region is coincident with the maximum flow of electrical current in the region, established by neighbouring regions in which the potentials are respectively above and below the potential of resting muscle.

Defective Fat Metabolism and Arteriosclerosis

THIS was discussed by L. R. Drogstedt in a paper read at the Autumn Meeting of the U.S. National Academy of Science held during October 13–15. Arteriosclerosis is not a necessary part of the ageing process, since not all old people develop it. The following evidence suggests that it may represent a metabolic defect associated with disturbed fat metabolism. The feeding of cholesterol in excessive amounts produces arteriosclerosis in rabbits that resembles very closely the human disease. The incidence of arteriosclerosis is abnormally high in patients with diabetes mellitus and occurs not infrequently in young individuals. Diets rich in fat are especially apt to produce arteriosclerosis in diabetics, and conversely, low fat diets have a protective effect. A similar high incidence of arteriosclerosis is found in depancreatized dogs in which a disturbance in fat utilization is produced by deprivation of lipocaic.

Origin of the Temperate Floras of South America

THIS was discussed by D. H. Campbell in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences during October 13–15. The continents of North America and Eurasia have very similar temperate floras and have always been more or less closely united. The climate is a continental one with great extremes of temperature. There is in the northern regions a preponderance of conifers and deciduous angiosperms. In South America, the temperate regions are very limited in extent, and the climate is much more temperate, with no such marked differences between winter and summer. The vegetation has little in common with the north temperate floras, but in the extreme south has many types common to New Zealand and Australia, and to a less degree to South Africa. As shown by fossils from the tertiary of Argentina, there is a large element derived from the tropical regions of Brazil, while at the south the 'sub-antarctic' flora predominates. It is evident that the modern floras differ but little from the tertiary ones. It seems likely that the northern and southern temperate floras have always been separate, and they have probably been distinct since the late Palæozoic.

Foot-Rot in Sheep

THE spreading destruction of superficial parts of the underlying epithelium of the sheep's foot, leading to detachment of the horn, is a disease hitherto very prevalent in the moderate rainfall areas of southern Australia. The primary causal agent has now been shown by Beveridge (Bull. 140, Australian Council for Scientific and Industrial Research, 1941) to be a newly discovered bacterium for which the name *Fusiformis nodosus* (n. sp.) is suggested. It is a large, anaerobic, Gram-negative, non-mobile, rod-shaped organism, usually with enlargements at both ends. Probably *Spirochœta penortha* is a specific accessory causal agent, while a mobile fusiform is a constant secondary invader, doubtless playing some part in the pathogenesis of the disease. Except in artificial culture, *F. nodosus* cannot survive for more than a few days apart from lesions, of which there are three different types. It has now been possible to elaborate a plan of control of the disease which has been applied to several large sheep stations. Not only was foot-rot eradicated from these stations, but also they remained free during an epizootic in the neighbourhood.

Lamp-brush Chromosomes

PRE-TREATMENT with sodium hydroxide and urea on the salivary gland chromosomes of *Drosophila melanogaster* has been used by M. Kodani (*J. Hered.*, **32**, 147; 1941) to induce the lamp-brush effect previously obtained in the chromosomes of other organisms. The author finds that there are definite achromatic regions which contain little nucleic acid. By marking the *X*-chromosome with inversions it was possible to construct a lamp-brush chromosome map. The chromatic regions correspond with the chromosomes of Heitz in mitotic prophase and were considered to contain active gene loci. Heterochromatin within euchromatin regions differs from the heterochromatin at the proximal end. The heterochromatin in euchromatin regions corresponds in position with regions of the salivary gland chromosomes which contain few and small bands, and it is believed that mutant loci are located in the euchromatin region which is characterized by thick bands with a condensation of nucleic acid.

Earthquakes Registered in Australia

DURING the months of April, May and June 1941, seventy-two earthquakes were registered at the Riverview College Observatory, New South Wales. There were twenty-eight in April, twenty in May and twenty-four in June. The seismograms for all these have been interpreted. The greatest shock in April was on April 29 from an epicentre near 27° S., 118° E., which gave a ground amplitude of about 1/7 mm. at Riverview. In May the greatest shock was on May 17, which gave a ground amplitude of near 1/4 mm. at Riverview. The epicentre has been provisionally estimated to be at 11° S., 166° E. The shock of May 4 was felt at Finke in central Australia, and another shock on May 4 also had its epicentre in central Australia. In June the greatest shock was on June 27, which also was felt at Finke in central Australia. The epicentre was at a distance of 1,680 km. from Riverview, where the maximum ground amplitude attained was near 1/4 mm. Microseisms hindered the interpretation of some of the records.

Nitrosyl Cyanide Salts

A STUDY of the metal carbonyls and nitrosyl carbonyls shows that, for all volatile compounds of this class, the effective atomic number is the same as the atomic number of one of the inert gases. The general tendency of elements to acquire the effective atomic number of the nearest inert gas apparently does not hold in the formation of simple compounds of the heavy metals, but the complex compounds of the heavy metals have an obvious tendency of this kind. This is shown in sodium nitroprusside, $Na_2\,[Fe\,(CN)_4\,NO]$, and in the unusual manganese nitrosyl cyanide and cyanide salts $K_3\,[Mn\,(CN)_5\,NO]$ and $K_5\,Mn\,(CN)_6$, in which the existence of the complex ions is related to the stabilizing effect of the effective atomic number of 36 (krypton). These salts were prepared by Manchot and collaborators in 1926–28, and the method of preparation of the nitrosyl cyanide has been improved by A. A. Blanchard and F. S. Magnusson (*J. Amer. Chem. Soc.*, **63**, 2236 ; 1941), who have also recorded its reactions. Attempts to prepare analogous nitrosyl cyanides of cobalt, $K[Co(CN)_5NO]$ and $K_2[Co(CN)_5NO]$, were not successful.

Properties of Visual Purple at Low Temperature

THE discovery that visual purple is soluble and stable in a solvent made up of 75 per cent glycerol and 25 per cent water by volume, has enabled E. E. Broda and C. F. Goodeve (*Proc. Roy. Soc.*, A, **179**, 151 ; 1941) to extend the range for experiments below 0° C. At the temperature of solid carbon dioxide such solutions assume a glass-like consistency and remain perfectly homogeneous and brilliantly clear. Even at liquid air temperatures no crystallization occurs, although the great number of minute cracks developed scatter the light and prevent spectroscopic investigations. At room temperatures the spectrum is identical with that of the aqueous solution. At −73° C. the peak of the absorption curve is higher and narrower than at room temperature and it is shifted towards longer waves. The product of photodecomposition at −73° C. has a spectrum independent of *p*H and is at low temperatures thermostable and photostable. Thermal decomposition to indicator yellow occurs at room temperature. The primary product appears to be identical with transient orange. The quantum yield of the photoreaction at low and at room temperature are of the same order.

The Electronic Charge

A NEW determination of *e* has been made in the University of Melbourne by V. D. Hopper and T. H. Laby (*Proc. Roy. Soc.*, A., **178**, 243 ; 1941) using an oil-drop method in which the electric field is horizontal. The oil drops used were larger than those used by previous experimenters, and the velocity of fall and of movement in the direction of the electric field could be estimated with satisfactory accuracy. Assuming $\eta_{23}=1830\times10^{-7}$ C.G.S. units, the value of *e* obtained was $(4{\cdot}8020\pm0{\cdot}0013)\times10^{-10}$ E.S.U. (see also NATURE, **145**, 932 ; 1940). In work in progress, it is hoped to improve the precision of measurement of the viscosity of air by using a method suggested by Fabry and Perot. Laminar flow of air between optically flat disks is involved.

A Photographic Survey of Galactic Clusters

IN two earlier papers (*Mon. Not. Roy. Astro. Soc.*, **100**, 387, and **101**, 89) George Alter described his method of investigation of galactic clusters, and a summary of the first of these appeared in NATURE, **141**, 810 (1940). Alter returns to the subject in a third paper with the above title (*Mon. Not. Roy. Astro. Soc.*, **101**, 5, 6) which deals with seven further clusters, six of which are situated in a rich Cassiopeia region. The other cluster, N.G.C. 225, is situated outside and in front of a dark patch, and an absorbing cloud is indicated by its position in a dark patch and also by an irregularity in the range of distant moduli. Some uncertainty concerning the identification and co-ordinates of N.G.C. 133 and 146 is clarified and it is shown that the former is not really a cluster but only an accidental grouping of a few stars, while Anonymous appears on visual comparison as a cluster very similar to its neighbour N.G.C. 146. The distances found in this recent investigation are generally smaller than those previously determined ; explanations can be found from the fact that in the latter case the distances were found by mere inspection of the photographs, without knowledge of spectral types or colour index, but with various assumptions as to cluster diameters and magnitudes. Tables have been prepared which show the co-ordinates and photographic and photovisual magnitudes of all measurable stars within the cluster regions under investigation, but unfortunately these cannot be printed owing to shortage of paper. Those who are specially interested can obtain copies by applying to the Norman Lockyer Observatory, Sidmouth.

Stellar Photo-electric Photometry

IN the past decade the attention paid by astrophysicists to spectrophotometry with the photoelectric cell has increased as the importance of the results so obtained became evident. Hitherto, however, the observations have been confined to two broad spectral regions, usually overlapping, and defined somewhat loosely by the characteristics of two colour filters the choice of which has been dictated more by the response of the photo-cell used than by the astronomical requirements. A recent paper by J. S. Hall, however (*Astrophys. J.*, **94**, 71 ; 1941), describes a method of working in which emphasis is put on the definition of the spectral energy admitted to the cell. From the grating spectra of stars formed in the focal plane of the objective, two movable slits segregate definite wave-length regions which are then reflected into the photo-cell. The paper gives more than 1,300 heterochromatic magnitudes of 67 bright stars measured in this way at as many as 13 spectral regions from 4500 A. to 10,320 A. Such measurements, especially if they can be extended to fainter stars, will give invaluable information on the extent to which colour temperatures depend on the spectral region in which they are measured, as well as on such related subjects as the effect on stellar colours of intrinsic luminosity and of selective interstellar absorption.

A STRAIGHT-GROWTH METHOD OF AUXIN DETERMINATION IN PLANTS

By E. DOROTHY BRAIN

THE Avena method of estimating auxin in plants requires such technical perfection and specialized apparatus that it is rendered useless to workers who have no access to elaborate equipment. The method described below has been worked out under ordinary greenhouse conditions and, while it is fully recognized that it cannot yield such exact quantitative results as the Avena test method, it has proved of use in comparative work and with more fully controlled conditions suggests possibilities for finer quantitative estimations.

This is an upright-growth method in which pieces of the plant material to be tested are applied with lanoline to the top of cut pea shoots. Peas are grown in soil in pots. The variety used for these experiments was Danby Stratagem. Three seeds to a three-inch pot has been found suitable and the seedlings are grown in the light until they are three or four internodes high. The growth of the internodes is recorded separately. The seedlings are then placed in a dark box, of which the relative humidity is kept up to 100 per cent by the floor being covered with damp soil, and which contains a maximum and minimum thermometer. After twenty-four hours in the dark box the growth of the separate internodes of the pea seedlings is recorded and the peas are prepared for the test by cutting off the part which is still actively growing. Using a safety razor blade, the plants are cut at the node below which growth has just ceased and the height of the remaining stump is recorded as *cut height* (1) (see accompanying figure). A vertical millimetre scale is placed behind each pea and marked at the level of the cut height and the pot level. The pea stumps are replaced in the dark box for thirty to forty minutes to give time for any bleeding from the cut surface. They are then made ready to receive the test material by the top being dried with filter paper and then covered with a layer of lanoline on which the test material is placed. The

Table 1.

RESULTS FOR VARIOUS SEEDLINGS.

Plant used	Cut height (1) in mm.	Cut height (2) in mm.	Increase in mm.
Lupinus albus			
Hypocotyl segments 10 mm.	18·0	19·0	1·0
	20·0	21·0	1·0
,, ,, 5 mm.	14·0	15·0	1·0
	15·0	15·0	—
(Temperature 94°–60° F.)	13·0	14·0	1·0
top of epicotyl	18·0	20·0	2·0
	10·0	12·0	2·0
(Temperature 74°–58° F.)	16·0	18·0	2·0
Lupinus polyphyllus			
hypocotyl segments 5 mm.	20·0	21·0	1·0
	10·0	11·0	1·0
	8·0	9·5	1·5
	12·0	12·0	—
(Temperature 94°–56° F.)	9·0	9·0	—
Helianthus annuus			
hypocotyl segments 10 mm.	23·0	23·5	0·5
	12·0	13·0	1·0
	33·0	34·5	1·5
	15·0	16·0	1·0
(Temperature 88°–56° F.)	17·0	18·0	1·0
Phaseolus multiflorus			
top of epicotyl 15 mm.	30·0	31·5	1·5
	18·0	20·0	2·0
,, ,, ,, 10 mm.	40·0	43·0	3·0
	18·0	20·0	2·0
	29·0	31·5	2·5
(Temperature 80°–56° F.)	20·0	21·0	1·0
Control experiments lanoline	18·0	18·0	—
	16·0	16·0	—
	15·0	15·0	—
	21·0	21·0	—
(Temperature 80°–56° F.)	19·0	19·0	—

Relative humidity 100 per cent.

Table 2.

RESULTS FOR INDOLE-3-ACETIC ACID.

(1) Temperative 80°–56 F. Relative humidity 100 per cent, 0·25 c.c. 1 per cent indole-3-acetic acid in 0·5 gram lanoline paste.

Cut height (1) in mm.	Cut height (2) in mm.	Increase in mm.
	Pea	
33·0	35·0	2·0
17·0	18·0	1·0
35·0	38·0	3·0
30·0	31·0	1·0
15·0	16·0	1·0
22·0	25·0	3·0
10·0	10·0	—
22·0	26·0	4·0
17·0	23·0	6·0
18·0	19·0	1·0

(2) Temperature 72°–54° F. Relative humidity 100 per cent, 40 c.mm. blocks of 1 : 1, 1 per cent indole-3-acetic acid in 3 per cent agar.

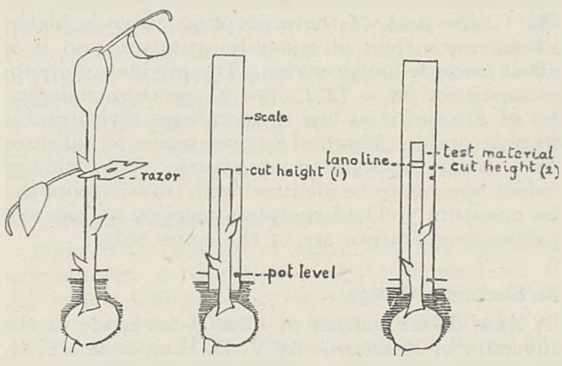
	Pea	
12·0	13·0	1·0
15·0	15·0	—
15·0	17·0	2·0
13·0	15·0	2·0
15·0	16·0	1·0
27·0	29·0	2·0
13·0	13·0	—
15·0	17·0	2·0

40 c.mm. blocks, 1 : 2, 1 per cent indole-3-acetic acid in 3 per cent agar.

12·0	13·0	1·0
17·0	18·0	1·0
31·0	31·0	—
18·0	19·0	1·0
16·0	17·0	1·0
15·0	16·0	1·0
17·0	18·0	1·0
15·0	16·0	1·0
13·0	14·0	1·0

Control experiments, 3 per cent agar blocks.

17·0	17·0	—
17·0	17·0	—
18·0	18·0	—
15·0	15·0	—
8·0	8·0	—
22·0	22·0	—



peas are then replaced in the dark box for twenty-four hours, after which they are removed and the *cut height* (2) is measured by the millimetre rule and the millimetre scale. The maximum and minimum temperature during the experiment are recorded.

More than two hundred tests have been carried out using hypocotyls and epicotyls of different species of seedlings, examples of which are shown in Table I. Control experiments were made by using portions from the base of hypocotyls where growth was known to have ceased and others with lanoline alone applied to the pea stumps. Definite increase in the height of the pea stumps was shown by the application of the actively growing plant material and this could be measured correctly to 0·5 mm. This increased growth is attributable to the amount of growth substance which diffuses out from the plant material applied on the lanoline which restimulates growth in the pea stump.

In order to attempt some standardization of this induced growth, experiments were performed with indole-3-acetic acid in one per cent solution (0·1 mgm. acid per litre). This was first applied in lanoline, a paste being made by mixing 0·25 c.c. with 0·5 gm. of lanoline. Results from this experiment were variable owing to the difficulty of obtaining an even mixture and equal applications to each pea. More experiments were made with the indole-3-acetic acid mixed with a 3 per cent agar gel. Mixtures of equal parts acid and melted agar and one part acid to two parts agar were made into blocks which were applied to the pea stumps. The blocks were made by sucking up the agar mixture into a straw, in which it cooled and set. Then blocks of the required length can be cut with a razor blade and in applying them to the pea stump the straw acts as a support for the agar block. The blocks used were 5 mm. long and approximately 40 c.mm. in volume, which is much larger than those used for the Avena test but of approximately the same volume as the segments of *Lupinus albus* hypocotyls, with which many of the experiments were performed, and a convenient size to fit on to the pea stumps. The blocks were placed on the pea on lanoline as described above.

Results recorded in Table 2 show that a block of 40 c.mm. containing 1 : 2 parts indole-3-acetic acid in 3 per cent agar would produce an increase of 1 mm. in the pea stump. Blocks made of 1 : 1 acid and agar produce greater increase but more variable results. It is, therefore, suggested that an increase of 1 mm. in the pea stump should be regarded as a standard for measurement of the amount of growth substance which has diffused out of the test material, one 'pea unit' being that amount of growth substance which diffuses from an applied block of plant material causing an increase of 1 mm. in height of the pea stump and is equivalent to the growth caused by a block of 1 : 2 indole-3-acetic acid (0·1 mgm. per litre) in 3 per cent agar at a temperature 72–54° F. and 100 per cent relative humidity.

According to Went[1] 0·5 per cent indole-3-acetic acid solution in a 10 c.mm. agar block, at 24°C., and 85 per cent relative humidity would produce 5° curvature in the Avena test, so that the results for the pea method show that an increase of 1·0 mm. in the pea stump would approximate to 5° curvature in the pea test.

[1] Went, F. and W., and Thimann, K. V., "Phytohormones", p. 41 (New York: The Macmillan Company, 1937.)

SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

THE fifteenth annual report of the Department of Scientific and Industrial Research, New Zealand, covers the year 1940–41 and includes the Minister's statement, the report of the Secretary, together with reports of the research committees of the Council of Scientific and Industrial Research and of the work of the Plant Research Bureau, Wheat Research Institute, Magnetic Observatory, Dominion Laboratory Geological Survey Branch, and Metrological Branch*.

The Dairy Research Institute has been occupied with urgent problems relating to the storage and transport of dairy produce under war conditions, and particularly with the view of prolonging the keeping quality of dairy produce likely to be in storage for long periods and methods of packaging and processing butter and cheese to conserve shipping space and weight and packing materials. Special starter rooms embodying the Institute's recommendations for preserving the vitality of starters were erected by some fifteen dairy factories during the past season.

The work of the Plant Research Bureau during the year has been concentrated on minimizing losses in pasture, arable and horticultural crops by intensifying control measures, the maintenance of full supplies of certified pasture and crop seeds and the propagation and collection of important medicina plants to help supply emergency requirements in Great Britain and locally. Attention has also been given to local substitutes for imported plant materials such as seaweed products like agar and carrageen, the most efficient methods of preparing and conserving supplementary fodders and the instructional and research work required by the administration of the Termites Act, 1940. A considerable amount of work has been carried out on linen flax. The Plant Diseases Division at Owairaka, Auckland, has tested a number of organic mercurials for control of *Corticium vagum*, and has examined a number of copper compounds against standard Bordeaux mixture and biological work on sulphur sprays and the testing of derris products. Spray investigations and demonstrations in the field of fruit research have also been continued by the Division, while other work has been directed to the study of the insects attacking timber in an endeavour to select those satisfactory for testing timber preservatives and timber treatments. Tobacco research has included further work on the investigation of mosaic and that at the Cawthron Institute on control of damping-off fungi with soil dressings gave promise of success. Use of Semesan and zinc oxide with seed did not give satisfactory results, although Semesan gave satisfactory control if mixed with the soil to a depth of ¾ in. The outstanding

* New Zealand. Fifteenth Annual Report of the Department of Scientific and Industrial Research. Pp. 92. (Wellington: Government Printer, 1941.) 9*d*.

problems in fruit research have been concerned with methods of storing under the best possible conditions the surplus of fruit thrown on the local market when export stopped. This has involved resorting to orchard storage on a greatly increased scale to supplement cold storage facilities. Experimental work in co-operation with the Cawthron Institute has yielded valuable information regarding the optimum conditions of temperature and humidity in orchard stores, the best methods of wrapping and packing and the varieties and grades of fruit best suited for orchard storage.

Work at the Plant Chemistry Laboratory received a severe set-back through the destruction of the laboratory and a greater part of its equipment by fire during the year. Very good work has, however, been done under difficult conditions in supplying a considerable amount of alkaloidal material from perennial rye-grass to the Department of Agriculture for animal experiments in connexion with facial eczema studies and in obtaining chemical data on the digestibility or nutritive value of silage from selected pastures. Chemical studies on the effect of naphthylacetic acid on the composition of cuttings and on the relation of accessory substances such as auxines and vitamins to soil fertility has continued. In collaboration with the Mines Department surveys of minerals of strategic value and special economic importance in war-time have been intensified, including surveys of local resources of such minerals as serpentine, magnesite, oil shale, sulphur, sands and clays. A special committee was set up to co-ordinate investigations by the Department of Agriculture and Scientific Industrial Research, the Cawthron Institute and the Canterbury Agricultural College on the manufacture and agricultural value of a reverted phosphatic fertilizer obtained by incorporating ground serpentine with superphosphate.

The activities of the research associations servicing the tanners, the boot and shoe manufacturers and the wool manufacturers have been directed specially to war-time manufacturing problems, including the provision of satisfactory substitutes for imported materials which are not now available. Other investigations have been concerned with local substitutes for imported pottery materials, adhesives, agar and carrageen. The Physical Testing Laboratory, in addition to a large amount of work on physical testing and precision-instrument constructing, is extending its operations in regard to standards of reference for use in connexion with the manufacture of munitions.

The Chemical Engineering Section of the Dominion Laboratory has been largely occupied with the investigation of producer gas as an emergency fuel for motor vehicles, and its semi-commercial trials on the gas storage of apples to improve their keeping qualities for local consumption has yielded valuable data. Much chemical work has been done in connexion with a survey of national coal resources, and other work has been concerned with stone preservation and spray residues on cabbages, and investigations on casein paint and on the utilization of bentonite are also in progress.

The Geological Survey has carried out special geological and geophysical surveys for the Public Works Department in the Waikato in connexion with hydro-electric developments, and a re-survey of magnetic stations throughout New Zealand is being made to provide data required by the defence services.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, NOVEMBER 29

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 11 a.m.—Dr. G. M. Findlay will open a general discussion on "The Mode of Action of Chemotherapeutic Agents".

INSTITUTE OF PHYSICS (MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "Physics in the United States and Recent Practical Applications of Nuclear Physics".*

MONDAY, DECEMBER 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Capt. R. Hamond: "Through Western Tibet in 1939".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Curtin Cosbie: "Brewing, the Story of a National Industry"—3: "Brewing Research" (Cantor Lectures, III).

TUESDAY, DECEMBER 2

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, DECEMBER 3

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (Joint Meeting with the Society of Public Analysts) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 11 a.m.—Mr. A. L. Bacharach: "The Nutritional Bases for Fortification of Foods".

THURSDAY, DECEMBER 4

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. Benjamin Farrington: "The Hand in Healing: a Study in Greek Medicine from Hippocrates to Ramazzini".

FRIDAY, DECEMBER 5

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "Some Problems in Wartime Horticulture with particular reference to Vegetable Production".

SATURDAY, DECEMBER 6

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Dr. W. G. Wearmouth: "Physical Problems in the Plastics Industry".

APPOINTMENTS VACANT

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

SENIOR LECTURER (ungraded) in the Department of Biochemistry—The Registrar, The University, Liverpool (December 6).

TEACHER OF ELECTRICAL ENGINEERING AND ALLIED SUBJECTS in the Cambridgeshire Technical School—The Education Secretary, Shire Hall, Cambridge (December 8).

ENGINEER for the Sierra Leone Public Works Department—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E. 338).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 578, Vol. 231: The Heart of the Salamander (*Salamandra salamandra*, L.), with Special Reference to the Conducting System and its Bearing on the Phylogeny of the Conducting Systems of Mammalian and Avian Hearts. By F. Davies and E. T. B. Francis. Pp. 99–130+plates 7–8. (London: Cambridge University Press.) 7*s*. [411

The Amazing Insects. By G. E. O. Knight. Pp. 16. (London: Insecta—Mammalia.) 1*s*. [411

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