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Research as a Nation's Investment

SOCIAL conventions classify us as workmen, as employers of labour, as professional persons, as people of leisure, or as the 'idle rich' ; but there are times when we all seem to be 'in very much the same boat'. In modern politics a man's vote is worth the same as his master's, and we are getting accustomed to the corollary that this implies an equal degree of responsibility in the public regulation of the affairs of both. One of the more important of these affairs is the means of livelihood, and one of the primary duties of the State is to formulate and carry out such policies as will, in a fundamental and broadly conceived way, promote the material prosperity of its citizens.

If world events during the past fourteen years had not already taught us the lesson, those of the immediate past, and indeed of the present, must surely have made abundantly clear how vitally the ordinary individual in a community such as ours depends for his well-being on the industrial condition of the nation. Business men and operatives may be the first to feel the effects of competition and the loss of markets, but sooner or later the 'sheltered' worker, the professional man, and the gentleman of leisure, whether as earners of income or as payers of tax, are caught in the inevitable undercurrent. The first impulse of each is to exert his bodily strength against the tide, and the second to help another to struggle. No doubt the first few men who fell into the sea struggled likewise, until by research and invention means were found to ride instead of sink ; so that to-day the sea is a great highway of commerce, and not merely a human grave. All because man was not content only to turn his face towards 'adverse forces', but went to some trouble, and doubtless to some initial expense, to obtain knowledge enough to convert a menace into an advantage.

Whether our pre-history is weak or not, this is what passes through the mind on reading Sir Frank Smith's recent Norman Lockyer lecture of the British Science Guild on "Industrial Research and the Nation's Balance Sheet"*, and on looking for some adequate reflection of its thesis in the debate in Parliament on the Address in reply to the King's Speech. The discourse is an opportune contribution to the nation's discussions, and the

* The British Science Guild. The Norman Lockyer Lecture, 1932 : Industrial Research and the Nation's Balance Sheet. By Sir Frank Smith. Pp. 31. (British Science Guild, 6 John Street, London, W.C.2.) 1*s*.

occasion demands that prominence should be given to hard facts and authoritative opinions concerning the relation which subsists between the organised prosecution of research and the industrial future of Great Britain. In one or other of its aspects the matter has frequently been examined in the columns of NATURE; nevertheless, so vital is its importance, and so convinced are we that the exigencies of the moment are more likely to obscure than to clarify political vision, that we must return to it again and again without apology, and with all the earnestness at our command.

Four references appear to have been made during the debate following the King's Speech to the part which science must play in solving our industrial problems; we could have wished for a wider appreciation of the real position. Mr. Davies said that the fundamental cause of our depression is the failure to re-adapt our lives to the swift-moving changes brought about by science, which is a partial truth, but not a very helpful pronouncement. The Marquess of Dufferin and Ava expressed the hope that the Government would help in every way scientific research, so that the country might be given a start comparable with that which it had in the nineteenth century; perhaps an assumption that such a policy may be taken for granted may explain the noticeable absence of any echo in the Upper House. The Prime Minister, Mr. Batey, and the noble Marquess referred specifically to the hydrogenation of coal, a process which, if commercially successful, would infuse new life into the coal-mining industry and reduce or arrest the importation of petrol.

Sir Frank Smith's discourse contains statements of fact which show generally, and in this specific instance particularly, how profitable such research is. Five or six years ago, the cost of producing petrol from coal by hydrogenation was estimated to be not less than 2*s*. 6*d*. a gallon, whereas to-day it is 9*d*.; what it will be five years hence will depend on many factors, not the least of which is the progress of research. The main product is not just some sort of oil, but a No. 1 grade petrol. Now, petrol to the value of £13,690,000 was imported in 1931, and Sir Frank Smith states that this year the same quantity of petrol may cost us £26,000,000. In the consideration of figures and opportunities such as these, the cost of the research itself is surely of small moment. Nor are results and prospects far different in other directions of industrial research. Millions of workers are now employed in the new industries based directly on scientific research—artificial silk, wireless, the generation and use of electric power, motor transport, and the cinema; recent investigations into the storage of apples—of which we import nearly eight million pounds worth a year—are believed to have led to an increase in the growers' returns by £100,000. One reads here of a former loss of £250,000 in a year which has been reduced to negligible proportions; there of a loss of fifty million pounds a year which awaits its turn for attention.

Every day in 1931 Great Britain imported on the average more than a million pounds worth of food; how much that we paid for was wasted by deterioration before it could be consumed? If home produce is included, and if (as has been stated) such loss approaches twenty per cent, is not the prize worth an enormously intensified national effort? Research means more than the invention of some ingenious mechanical device which captures the imagination, or alleviates an unwelcome personal exertion; it is not served by romancing Press 'stories' in which a slender basis of fact is made the theme of a sensational announcement. Whether its achievements intrigue the public, or whether they can be appreciated only by technicians, the simple fact is that scientific research has proved itself to be one of the pillars of modern competitive industry. What the ordinary citizen so often fails to realise is the part which fundamental scientific research (exemplified by that performed at the universities) and applied technical research (exemplified by that performed by the industries themselves and by such agencies as the Department of Scientific and Industrial Research) is *already* playing in maintaining him with some degree of stability and comfort in that state of life which he has reached. Nor does he properly appreciate the crash—industrial, political, and social—which would necessarily follow the neglect of opportunities to acquire new knowledge of material resources and new power to use them.

It is the business of scientific men and women to explain to others the position as they know it and the future as they see it. To-day it is more necessary than ever that they should strive to show the voter that research is not merely the concern of the capitalist who uses it to safeguard his possessions; not only the concern of the employer whom it helps to use services and materials to the best advantage; not only the servant of the worker, the conditions of whose

labour have, in many cases, been improved out of all recognition; but also the benefactor of the poor, into whose homes it brings much that was formerly reserved for the rich; and the chief hope of the unemployed, whose chance of a job depends so much on the development of new industries. Where industry and research are concerned, we are indeed all 'in very much the same boat'. The bigger and the better we can make that boat, the happier and the safer we shall be.

The Legality of Sterilisation

EARLY this year a Departmental Committee was appointed by the Minister of Health to examine and report upon the information already available regarding the hereditary transmission and other causes of mental disorder and deficiency, to consider the value of sterilisation as a preventive measure, having regard to its physical, psychological and social aspects, and to the experience of legislation in other countries permitting it, and to suggest what further inquiries might usefully be undertaken in this connexion. This Committee, which is still sitting, is not concerned with the translation into action of any recommendation that it may make, but there is in being a small non-party group, the secretary of which is Wing-Commander A. W. H. James, already prepared with a permissive Bill to legalise the voluntary sterilisation of certain mental defectives, and which has been waiting for the opportunity of introducing this during private members' time. Recently this Parliamentary Sterilisation Committee has circulated to both Houses a memorandum which explains its views and gives a detailed account of the Bill that it is proposed to introduce.

This Bill must surely commend itself to biologists, physicians and lawyers, for it is well drafted, deals only with the mentally deficient (a group with regard to the desirability of whose procreation no doubt has ever been expressed by anyone) and it is a sound project in racial improvement. Many will perhaps deplore the fact that this Bill restricts itself to the mentally deficient, and is meant to apply only to England and Wales. It is greatly to be hoped that it will become law, for the present dubiety concerning the legality of sterilisation cannot possibly be allowed to continue. It would seem that the legality of sterilisation of a normal adult is doubtful. Certainly, a number of sane persons are being sterilised voluntarily, considering this the most efficient method of contraception, and being convinced that they should not run the risk of producing a second abnormal child; none of these, so far, has been prosecuted. There is little doubt, however, that it is unlawful to sterilise a defective, yet this is being done, but only in the case of the well-to-do. It is because sterilisation might be regarded as being illegal that it remains, for the time being, a luxury for the rich, since State, municipal and charitable institutions dare not do it.

So it is that the well-to-do, through voluntary sterilisation, are preventing the repetition of hereditary blunders, whilst the poor, who outnumber them, cannot imitate them, even though they would. For this reason, if for no others, it is highly desirable that this Bill, a purely permissive Bill, concerned solely with voluntary sterilisation, shall become a law of the land.

The Scientific Spirit in Education

Education and the Social Order. By Bertrand Russell. Pp. 254. (London: George Allen and Unwin, Ltd., 1932.) 7*s.* 6*d.* net.

THIS brilliant and provocative essay on the relation of the individualistic and the civic or social aspects of education is in the true lineage of Thomas Huxley and Prof. H. E. Armstrong and deals out essentially the same trenchant criticism of our crooked thinking and stupid prejudices in this field, above all on the place of science in education that we associate with these pioneers and their followers. Mr. Bertrand Russell's philosophic temper makes the book a contribution to the theory and practice of education which even his opponents ignore at their peril, and his able analysis of the social aspects of the educational problem, no less than his fair but searching criticisms of many of the weaknesses in our present system, should commend the book to all scientific workers who are concerned with the place of science in the modern State.

Like every other thinker of this age, Mr. Russell sees that the future of civilisation depends on co-operation, not merely nationally but also internationally, and he considers that the most vital need of the near future is the cultivation of a vivid sense of citizenship of the world. He recognises that under the transforming hand of science the world has become one economic unit, although the backwardness of our political institutions and

beliefs lead each nation to impoverish itself by economic isolation demanding competition when co-operation of the human race as a whole is the price to be paid for the resources and productive powers conferred by science. Until the world has become secure as a single economic and political unit, our whole civilisation is in jeopardy and thus the establishment of an international authority sufficiently strong to impose its settlement of disputes upon recalcitrant States is a reform as fundamental from an educational as from other points of view.

The formidable obstacles to such reforms can only be overcome as a result of education: "The cure for our problems is to make men sane and to make men sane they must be educated sanely." Obviously Mr. Russell leans to individualism, but the philosophic outlook leads him reluctantly to concede that politically in relation to the needs of the civic the education of the citizen must take precedence of that of the individual. Doubtless even the philosopher in him finds some satisfaction for this concession in the paradox that while governmental power depends finally on science, the scientific spirit or the frame of mind which facilitates discovery is one which favours change and certainly not *a priori* the beliefs or opinions which the State considers it prudent for the good citizen to hold. Whether or not the conflict thus suggested between the scientific spirit and the governmental use of science is likely to bring scientific progress to a standstill, there are obviously real dangers in the situations which may arise unless a scientific spirit or a willingness to experiment, not usually characteristic of administrators, finds its way into the seat of power in the modern State. The repression of scientific thought, like the repression of individuality, may have powerful and unexpected repercussions; and Mr. Russell's picture of a society in which the educational system has imposed excessive uniformity, governed in consequence by those whose suavity enables them to please the crowd, is less fantastic than might at first appear.

Having conceded the importance of education for citizenship at the present time, Mr. Russell has felt himself at liberty to indulge in his powers of wit and irony; and he has not dealt too gently with the numerous prejudices and superstitions which encumber education to-day and hinder its fundamental task of fitting the individual for life. Such questions as education and heredity, emotion and discipline, the influence of the home versus the influence of school, the place of the herd instinct, sex, patriotism and class feeling in education, he touches shrewdly and does not shrink from pressing home his argument to uncomfortable conclusions. Once again we are reminded that unless the virulence of nationalism can be abated civilisation cannot continue, or that for those contemplating the entry of a profession, the latter part of their education should be spent in acquiring such knowledge as would enable them to pursue their profession with intelligence and breadth of outlook. On the subject of competition he has trenchant remarks to make not merely on the evils of the examination system but also on the related problem of over-education. "Our social structure increasingly depends upon trained and well-informed intelligence." "The average citizen cannot play his part in a complicated world unless he is more accustomed than at present to view practical issues as matters to be decided by the application of trained intelligence to masses of fact, rather than by prejudice, emotion and clap trap." How far we are as yet from this position every newspaper reveals daily; and much of the interest with which the communistic experiments in Russia are followed is due to the fact that they represent the trial of an educational system in which the anti-social element of competition has been eliminated.

Education, however, is not governed wholly by utilitarian conditions or, as Mr. Russell points out, the place of science would be much larger. Economic factors bulk large and have varying effects—incidentally, they do not provide the obstacle to raising the school age in England and Mr. Russell's hit at sectarianism goes fairly home, equally with his criticism of the dead hand of endowment. One of the most valuable chapters in the book is that which analyses the dangers attending the growing tendency to propaganda in education. Failure to teach the young to reach correct conclusions wherever possible not only promotes faction and the danger of destructive conflict but also gravely impedes scientific progress as well as retards the development of that invaluable asset in practical life—the ability to reach true conclusions on insufficient data, dependent on the scientific absence of bias and power of hypothetical thought but also on that quality called judgment which even our universities seem largely unable to impart.

Into this attempt to reconcile individuality and citizenship in education, Mr. Russell weaves a good

deal of his own philosophy of conduct. He gives us indeed no detailed programme though he clearly looks to the growth of the experimental spirit, notably in administration, for the toleration of individuality in the scientific State, and this can only come as education becomes more scientific. This reads strangely like General Smuts's plea for the scientific expert in public affairs, and the whole book might equally be regarded as an exposition of that statesman's warning of the dangerous gap between scientific advance and stationary ethical development—a plea for sincere and courageous thinking and an honest endeavour to order our lives and the lives of the community in harmony with modern knowledge and resources.

R. BRIGHTMAN.

British Freshwater Copepods

British Fresh-Water Copepoda. By Dr. Robert Gurney. Vol. 1. (Ray Society Vol. 118 for the Year 1931.) Pp. lii + 238. Vol. 2. (Ray Society Vol. 119 for the Year 1932.) Pp. ix + 336. (London: Dulau and Co., Ltd., 1932.) 25*s*. each volume.

DR. ROBERT GURNEY'S monograph has been eagerly awaited by all copepod workers. It comes at a peculiarly propitious time for Brady's book, esteemed as it was for many years, and still useful, is now definitely out of date, and a very large amount has been done on the subject since its publication. It is fitting that this new handbook should also be published by the Ray Society, for here we can always rely on the combination of the best matter with excellent editing and form. The present work is not only up to the usual standard but also is exceptionally good, as we should expect from the author who, among many other things, is an expert in the study of copepods, not only systematic—although his knowledge of their systematics is very extensive—but also their bionomics, which study is becoming increasingly important.

The publication of this work at the present time is propitious from another point of view, because the Freshwater Biological Association has recently been founded and among the many subjects of study the bionomics of the copepods may perhaps be said to be among the first in importance. In other countries much has been done in this line but there is still much to do and this book with its suggestiveness and its beautiful and accurate drawings (original drawings by the author himself) will go far in helping those in Great Britain to take a leading part in such biological studies. To determine the species accurately is of the first importance in any scientific research of this kind, and there is now no excuse for it to be neglected.

The species of freshwater copepods in the British fauna are well known and it is not likely that new species will be discovered, but many workers are interested in finding new, so-called, sub-species and varieties. As Dr. Gurney truly remarks, "what is most needed now is not search for these new forms and the hasty emission of geographical speculations founded upon them, but painstaking study of variability and experimental breeding".

The book embodies much of the author's own work and shows a wide knowledge of the work of others. Vol. 1 begins with a bibliography of forty-three pages. Then follows the general part with a good historical account of work done in Britain and in Europe, economic importance of copepods, their food, habitat and methods of collecting, distribution, distribution in relation to the origin of the freshwater fauna, classification, genera and sub-genera, species and sub-species, distribution of allied species, external structure and metamorphosis.

The systematic part, occupying about two-thirds of the book, includes the four families of the Calanoida—Centropagidæ, Diaptomidæ, Temoridæ and Acartiidæ. Each species is carefully described and figured with details of all important structures, and, what is peculiarly satisfactory, the development, in most cases worked out by the author. In thus embracing the development in a large number of species the monograph is unique.

The distribution of each species both in Britain and abroad is given in great detail. In a few instances marine species which enter rivers or estuaries are included, such as the coastal species *Centropages hamatus* which is common in estuaries, and *Acartia clausi*, the latter having a distinct estuarine form, physiologically and structurally distinct.

Vol. 2 deals entirely with the Harpacticoida, the most difficult and exacting group of all the Copepoda. Although many workers have occupied themselves with it there still remains much to be done and the systematic part is in a very unsettled state. Dr. Gurney has done much to clear things up and in spite of some opposition wisely remains

faithful to his own interpretations. Unlike the Calanoida, in which many of the life-histories are complete, the Harpacticoida are little known and until the publication of this volume in no case had the sequence of the copepodid stages been fully worked out. Differences in the nauplian stages are very small and in the copepodid stages measurements are unreliable owing to the contractility of the body. The general characters of the Harpacticid nauplius are given in the first volume. In the second the nauplii of *Canthocamptus pygmæus* are described as typical and the copepodid stages of *Canthocamptus staphylinus*, which are precisely comparable to those of a calanoid. The nauplii of other species are described and figured whenever possible.

The distribution of the Harpacticoida offers many interesting problems and there is much work to be done in clearing these up. The author's discussions under the head of bionomics of the separate species are very valuable and in some cases at least tend to repudiate the idea of any influence due to the glacial period.

The descriptions of the separate species as found in Great Britain are full and clear, involving much laborious counting and figuring of spines and setæ, the figures as before being models of what such illustrations should be.

Marine as well as freshwater copepod workers will be greatly helped by this important work and will look forward to the third volume.

The Science of Colloids

Kapillarchemie: eine Darstellung der Chemie der Kolloide und verwandter Gebiete. Von Prof. Dr. Herbert Freundlich. Band 2. Vierte unter Mitwirkung von J. Bikerman umgearbeitete Auflage. Pp. xi + 955. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1932.) 69 gold marks.

PROGRESS in science, like corrosion, is apt to travel along interfaces, and few areas recently brought under the plough of adventurous workers have yielded a richer harvest than the territory between chemistry and physics occupied by the science of colloids. All the tools available in both the classical branches of knowledge are necessary for the exploitation of this field, yet it requires also its own distinctive outlook and skill. The growth of standard works in a new subject such as this is naturally slow, for each worker tends to review the field from a point of view dependent on his special explorations, and in consequence many of the earlier books were partial in their account of the work done and it was difficult to obtain from them a clear and balanced view of the whole subject.

Prof. Freundlich's "Kapillarchemie" has always been largely free from this defect, and with almost uncanny foresight he adopted in the first edition in 1909 the classification which has served for each succeeding edition. The first volume of the present edition, published two years ago, contains the introductory matter on which the subsequent development of the theme depends, and this second volume will appeal more to the colloid chemist who is interested in the practical side of the subject. In it the typical colloid systems—sols and gels—are systematically discussed, and it is very significant that a much larger proportion of generalised statement is now possible, at least for sols, than could be made a few years ago; so that only one-sixth of the total space devoted to lyophobe sols is now required for individual properties, whereas formerly it was necessary to deal with almost every sol singly. The gels and to some extent the lyophile sols are too distinctive in many properties for general treatment.

One of the most interesting recent developments in the study of colloids is the application of X-ray analysis to the constituent particles of sols and to such gels as rubber and cellulose and their derivatives. The research which has been carried out in these directions is ably summarised and illustrated. The same may be said of other modern work; it is, indeed, very satisfactory to find even some of the more obscure memoirs discussed systematically and in proportion.

While the output of work along the main lines continues in ever-increasing volume, there is evidence that some of the less obvious though not less important systems are being studied. Sols and gels in non-aqueous media, in which ionic effects are absent or profoundly modified, smokes, fogs, foams and colloid systems in solid media, all deserve further attention, if only because of their industrial importance. The meagre information available is indicated in this work.

It is perhaps superfluous to add that in style and completeness, this new edition of "Freundlich" easily maintains its place as the foremost textbook of colloid chemistry. P. C. L. THORNE.

Short Reviews

Chemical Engineering and Thermodynamics applied to the Cement Rotary Kiln. By Dr. Geoffrey Martin. Pp. xv + 244. (London: Crosby Lockwood and Son, 1932.) 31*s*.

THE cement industry, at a time of great prosperity, celebrated the centenary of the discovery of Portland cement by Aspin by abandoning its research association and allowing the scientific staff to dissipate! Whatever the causes that led to this action, it can only be regarded with regret. Every industry sheltered by a tariff or existing as a monopoly has a national obligation from which it cannot escape. The country has a right to buy cement of the highest quality at the lowest price, equal in every way to that available throughout the world, and it is doubtful whether, under modern conditions, fundamental advances can be achieved without the daily aid of applied science.

Amongst the practical problems of the industry those connected with the rotatory kiln stand foremost. Its fuel efficiency is to-day stated to be but 19·2 per cent, the radiation losses 15 per cent. Dr. Martin has prepared what amounts to a research treatise in which he reduces to a matter of exact thermodynamical calculation most of the quantities connected with the rotatory kiln, and sets out data which should enable engineers to design a really efficient kiln.

The book is essentially one for experts, and the mass of data required will need a good deal of sifting and analysis before use, but it is set out so that the task should not be beyond the capacity of any designing engineer, to whom the work will be indispensable. It is of interest that in the clinkering zone only the heat above a temperature of 1481° F. is of value, so that there is an enormous loss when this high grade heat passes up the kiln to the preheating and evaporating zone.

In a final chapter the author describes recent efforts to design kilns of greater thermal efficiency, particularly some methods of preventing these internal radiation losses: he also deals with the flotation kiln which is under experiment at Asheham. The work is a definite contribution to the detailed study of an important subject though it is certainly very difficult to read.

An Introduction to the Theory of Canonical Matrices. By Prof. H. W. Turnbull and Dr. A. C. Aitken. Pp. xiii + 192. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1932.) 17*s*. 6*d*. net.

A SIGN of the present-day tendency of mathematical thought is in the changed character of many of the books now produced. In the last few years almost all new books in pure mathematics have represented one of two main branches—geometry and analysis. Just now, works on algebra are being published in greater profusion, not the old type of algebra reminiscent of such authors as Salmon and Weber, but a newer type in which the fundamental laws of ordinary algebra are not necessarily valid.

A matrix can be defined most simply as the transformation from one tetrahedron of reference (in n dimensions) to another and, when there are three tetrahedra, the transformation from A to B can be compounded with that from B to C into a single transformation from A to C. Quite recently Heisenberg and Dirac have shown that matrices are eminently suited to the purpose of stating and developing the laws of the new quantum mechanics. The authors of the book before us have collected together, with very full references, all the more important investigations on matrices, and now present them as a co-ordinated whole. A central problem is the reduction of a homogeneous quadratic function of n variables to the form

$$a_1x_1^2 + a_2x_2^2 + \ldots\ldots + a_nx_n^2$$

This is possible in $\frac{1}{2}n(n-1)$ ways and, when all the symbols are real, the number of positive a's is the same for each.

Although the book is mainly a compilation, Chap. ix contains a new investigation of the canonical reduction of a pencil of matrices when the determinant of every member of the pencil is zero. Some applications of matrices to projective geometry are given, and others to differential equations and dynamical oscillations. The book is practically self-contained and is intelligible to a reader with ordinary mathematical knowledge.

Hunger and Work in a Savage Tribe: a Functional Study of Nutrition among the Southern Bantu. By Dr. Audrey I. Richards. Pp. xvi + 238. (London: George Routledge and Sons, Ltd., 1932.) 10*s*. 6*d*. net.

DR. RICHARDS' study of the satisfaction of hunger as an element in the organisation of human society has a twofold interest. It is, as Prof. B. Malinowski says in a highly laudatory preface, the first systematic study of the subject in anthropological literature; and it is an originally conceived and at the same time instructive example of the application of the conception of 'function' to the study of the part played by certain biological needs of man in knitting together and determining the form and relations of economic and social units in a given society. Incidentally, it affords the author an opportunity of arguing cogently and pointedly against the predominance of sex in human affairs as interpreted by the psycho-analysts on the ground of the greater insistency of the needs of the human organism in the matter of food—needs which cannot be repressed indefinitely or even for any great length of time.

Dr. Richards, after stating her case in relation to the points of view of psychology and biology, and pointing out the inadequacy of the commonly accepted economic and sociological methods of approach, proceeds to show how among the south-eastern Bantu food—its acquisition, preparation, preservation and distribution—is fundamental, functionally, in determining the organisation and

working of the social, economic and religious systems, imposing on each social group and its individual members an appropriate ritual and code of behaviour. The whole conception has been worked out by the author systematically to its logical conclusions; and lest it should be thought that Dr. Richards has merely added another to 'arm-chair' studies based upon the observations of others, it must be mentioned that she has tested her material thoroughly in the field during over a year's residence among the Bamba.

Petroleum in the United States and Possessions. By Ralph Arnold and William J. Kemnitzer. Pp. xxi + 1052. (New York and London: Harper and Bros., 1931.) 63*s.* net.

THIS volume constitutes the second of a series of four books destined to cover the entire field of petroleum technology, the others being devoted to principles, occurrences external to the United States, and economics. The incentive to this achievement is "the desire to learn the facts of petroleum and the industry . . . without personal prejudice, biassed influence, or preconceived ideas". The task was a gigantic one, as the authors soon found, and if this volume is a foretaste of the others to come (the reviewer is not aware of their appearance in Great Britain yet), then it is truly a *magnum opus*. Even so, it is unwieldy, not so much on account of its bulk of more than a thousand closely printed pages, but of bulk of data.

The plan is to deal with petroleum in productive areas first, giving summarised statements of geology, development, technology and statistics of every field; so to non-productive areas (States) and extra-American possessions. Elaboration, particularly of statistical detail, is overwhelming; one wonders what purpose it all serves. In fact, in so far as this volume is indicative, we are unable to find anything strikingly new or outstanding from the wealth of technical and economic literature already available. If it is a case of geology of petroleum in America, not only is there more than one good modern textbook available, but also the publications of the U.S. Geological Survey and the American Association, to mention only two prolific sources, are easily accessible. If it is statistics or technology, we turn at once to at least half a dozen specialised volumes, and, of course, to the Bureau of Mines. Thus, while one can only marvel at the patience and enormity of labour represented by this particular book, from the point of view of a valued, permanent contribution to science, our reception of it is but lukewarm.

Aristotle. By G. R. G. Mure. (Leaders of Philosophy Series.) Pp. xi + 282. (London: Ernest Benn, Ltd., 1932.) 12*s.* 6*d.* net.

IT is a little more than a year since the admirable translation of the whole corpus of Aristotelian writings was completed under the editorship of Prof. J. A. Smith and Mr. W. D. Ross. It was amazing to think that it had never been done before, but very satisfactory that it was so well done at last. Then we have the full and useful book of Mr. Ross on "Aristotle" and another by Mr. J. L. Stocks on "Aristotelianism". Now Mr. Mure publishes a book which to a large extent combines the merits of both these, and is a model of skilful compression and arrangement. It is not quite easy reading, though very well written, but can be recommended to anyone who, knowing something of philosophy and interested in its general development, desires to see Aristotle's work surveyed as a whole and placed in its true position, in regard both to his predecessors and the subsequent trend of western thought.

Mr. Mure is a Jaegerite in the main, as every one must be, in tracing Aristotle's work back to Plato's, from which it springs, partly by suggestion, partly by criticism. But he treats the particular textual analysis of Jaeger with the caution that any such work demands in detail. The net result is a most enlightening study from which two main conclusions stand out. One, the most obvious, is that we must in future treat the conjunction Plato-Aristotle rather by way of complement than of opposition; the other, the most surprising, that, with his supreme and encyclopædic mind, Aristotle should have made so little of the mathematics which were flourishing in an advanced state around him. "Aristotle and Mathematics" should be the next monograph on the subject; it is the least fully treated in Mr. Mure's volume.

F. S. M.

Respiration in Plants. By Prof. Walter Stiles and Dr. William Leach. (Methuen's Monographs on Biological Subjects.) Pp. vii + 124. (London: Methuen and Co., Ltd., 1932.) 3*s.* 6*d.* net.

IN spite of the importance of respiration as a fundamental property of living protoplasm, there has been for a long time no really general and up-to-date treatment of the subject from the point of view of the botanist and of the non-specialist reader. The present authors have treated the subject particularly from this point of view. They have attempted to indicate the principles underlying modern studies of plant respiration rather than to present a complete summary of recent researches.

While no doubt opinions may differ as to whether the authors have chosen the best examples to illustrate the arguments, there can be no question that on the whole they have succeeded in their object of providing a readable and understandable treatment of a complex subject. They first discuss the respiration of plants in air; secondly, anærobic respiration; and thirdly, the mechanism of respiration. The third of these chapters is naturally the one offering the greatest opportunity of development. It reaches its highest levels, perhaps, in dealing with the bearing of sugar structure on the availability of hexoses, in discussing the rôle of cytochrome and in summarising Blackman's scheme for the respiration of apples.

Atomic Physics and Vital Activities*

By Sir F. GOWLAND HOPKINS, P.R.S.

THE success of the two discussions held during the current year has justified the policy which decided that such discussions should be organised from time to time. In particular they are valuable when they tempt distinguished workers from abroad to visit the Society as contributors to debate. In the discussion on the structure of atomic nuclei opened by Lord Rutherford, the revelation of new experimental results and of their great significance gave a dramatic character to the meeting. The atomic nucleus for a long time had seemed to be an impregnable fortress; but missiles of high destructive power have been gradually contrived by almost magical skill in the army of attack, and the fortress, in spite of its formidable potential barrier, is crumbling.

It is interesting for the spectator to realise how much is learnt by the commanders of the attack from the nature of the missiles (parts of itself) with which the fortress replies to the bombardment. One cannot help recalling the sense of progressive accomplishment which was conveyed in Lord Rutherford's opening address, as for example when he dealt with the nuclear origin of the γ-rays. Nor can one forget moments of actual excitement as when, recalling a twelve years' old prophecy of his own respecting the probable existence of neutrons, he referred to Dr. J. Chadwick's recent success in producing these entities (of which the mass is unity and the charge zero) by bombarding beryllium with α-particles from polonium. Exciting again was the account of the striking results obtained also in the Cavendish Laboratory by J. D. Cockcroft and E. T. S. Walton, who constructed an apparatus capable of providing a steady stream of protons, of energy up to 600,000 volts, and successfully employed the stream in the disintegration of the lithium nucleus.

It is not unjustifiable to say that before the moment of Cockcroft and Walton's success, man did not know how to release atomic energy on his own initiative, whereas now, though doubtless in a limited sense, he possesses that power. At the same time, the phenomenon of transmutation seems to be at hand in full reality. The occasion of this discussion cannot fail to stand out as of much significance in the annals of the Royal Society and in the history of Great Britain's contribution to science.

The second discussion dealt with the growth of knowledge at a different level of present accomplishment; but with phenomena that are very significant. It was concerned with recent studies of the nature and properties of those highly active catalysts—the enzymes—the presence of which in each living unit converts a system, which without them would be static, into an organism which is so characteristically dynamic. Anyone who reads in succession the records of these two discussions as found in our *Proceedings*, will perhaps be tempted to wonder how soon, if ever, intellectual concepts, based upon the phenomena which were the subject of the first, are fated to invade, and perhaps revolutionise thought in the great field of which the second covered part. Will the data of atomic physics ultimately illuminate the processes of life?

At present we know nothing to suggest a certain answer. I have indeed met not a few who had a strong *a priori* conviction that life, in some way, in some limited sense at least, makes use of atomic energy; that such ability might indeed be the special stamp of life. Some twelve years ago a distinguished Dutch physiologist, the late Prof. Zwaademaker, thought he had proved that the weak radioactivity of potassium is an indispensable stimulus to certain vital activities; but the importance of this influence would seem to be at most very small. Even Zwaademaker did not hold that it conditioned life. Its radioactivity is certainly not the main reason for the indispensability of potassium in living systems.

Certain recent experimental studies, however, seem to have proved that living tissues may be the seat of radiations able to produce effects at a distance, and to suggest that certain activities in one cell of a tissue can thus influence activities in neighbouring cells. It was claimed some time ago by Gurvitsch, a Russian biologist, that when growing cells divide they emit rays which accelerate the processes of division in other cells. The existence of these mitogenetic rays, so called because of the claim mentioned, met at first with general disbelief, and a year ago I might have been disinclined to mention the subject; but work by many during the last year seems to have brought satisfactory proof that chemical reactions in living tissues are indeed accompanied by radiations, and events in one cell may thus influence other cells without material transmission.

The phenomena as described are doubtless related to that of chemiluminescence which many non-biological reactions display, and may perhaps have affinities with the emission of more intensive radiations by specialised cells in the luminiferous organs of animals or by luminiferous bacteria. The much more general invisible radiations under reference have been now studied by physical methods. Their emission from active cells has been (it is claimed) demonstrated by means of Geiger's counter; their wave-length measured, and by methods which I must not stop to describe, their specific spectra in various cases duly mapped. It has even been claimed, for example, that a characteristic spectrum of a radiation from a tetanised muscle is identical with that yielded

* From the anniversary address to the Royal Society, delivered on November 30.

in vitro by a reaction (the breakdown of creatin phosphate) known to occur in active muscle.

Many published statements of this kind must be received with hesitation until fully confirmed; but that activities in living cells may be accompanied by radiations recognisable by physical means is now, I think, a fact which is proved. This alone will certainly lead to many fresh lines of inquiry. It is not yet proved, however, that the phenomena as described are of fundamental importance, or even that they associated with all forms of life.

What, on the other hand, we do know for certain, is that in all living systems in which dynamic events have been adequately studied, the influence of colloidal catalysts is found to be dominant. These catalysts ('enzymes' if you will) exert a specific control over complex chemical reactions, of which the exact co-ordination in time and space is one of the primary characteristics of an organism. It is, I think, difficult to exaggerate the importance to biology, and I venture to say to chemistry no less, of extended studies of enzymes and their action. Of the chemical reactions displayed in an organism few, if any, proceed uncatalysed; while they are reactions so completely and harmoniously organised that all are maintained in complex dynamic equilibrium. If chemical thought is to function with effect in helping towards a description of living systems, it must dwell especially on this chemical co-ordination which, like other aspects of organisation, illustrates that subservience of parts to the whole which characterises an organism.

The organising potentialities inherent in highly specific catalysis have not, I believe, been adequately appraised in chemical thought. The concentration of a catalyst or, alternatively, the extent of its active surface, will determine the velocity of changes due to its influence, but highly specific catalysts determine in addition just what particular materials, rather than any others, shall undergo change. In this respect they are like the living cell itself, for they select from their environment. Finally, the specific catalyst, in virtue of its own intimate structure, determines which among possible paths the course of change shall follow. It has directive powers. Even in a cell juice, or in an extract from living tissues from which all cell structure is absent, experiment has shown that a group of contributory reactions, including syntheses, may proceed in due and just sequence and so lead to the same end result as is normally reached in the intact living system. A striking degree of organisation may indeed be attained in such preparations under the directive influence of the more soluble enzymes derived from the cell or tissue. Much more then must a structured colloidal system, like the intact cell, in which a number of catalysts with such controlling powers are present in circumstances exactly adjusted to a final result, be one in which reactions are conditioned and organised to a high degree without the aid of unknown or any other influences.

I do not expect that all will feel able to admit as much as I myself would like to claim, namely, that the control of events by intracellular enzymes, exerted in the specialised colloidal apparatus of the cell, by itself secures the status of the cell as a system which can maintain itself in dynamic equilibrium with its environment. I am not denying for a moment that the cell has esoteric qualities which may call for organising influences of a greatly different kind; exerted maybe at some higher level. It is at any rate sure that the inter-related activity of highly specific catalysts represents a notable device of Nature which has supported during the course of evolution those dynamic manifestations which characterise living things.

Prof. R. Willstätter, together with members of his school, has done much to advance our knowledge of these agencies. I have sometimes heard it suggested that the advance in question, from a chemical point of view at any rate, represents a relative failure, apparently because no enzyme has yet been isolated in a state to conform with the classical criteria of 'purity'. If this be the reason for any suggestion of failure, there is surely some misunderstanding. Isolation, individualisation and purity are words which, if used at all in this domain, may well need to be given meanings differing not a little from those which are applicable in classical organic chemistry. Few will doubt to-day that the specific influence of a catalyst is due to its specific structure. All indications, however, point to the circumstance that the active structure of an enzyme is supported by a colloidal 'carrier' which stabilises it. It is indeed likely that in very many cases, if not in all, the active catalytic mechanism is a specific configuration at part of the surface of a colloidal particle, or, alternatively, part of a structural surface in the histological sense. If so, we should no more expect to isolate them in a pure state than so to isolate the active areas on a catalytic metallic surface.

It is true that enzymic activity may be displayed by agencies which are not all strictly of one type. It is not unlikely that in certain cases the specifically active groups may be inherent in the structure of a complex but relatively stable molecule, such as that of an exceptional protein. Cases are known indeed in which a protein many times recrystallised retains specific enzymic activity; in one such case at least it has been shown that the protein structure can be to a large extent destroyed without disappearance of the activity. Crystallisation in such a case does not yield an entity which would reveal its active structure to the ordinary methods of organic chemistry. What is essential for enzyme studies at their present stage is an assurance that a single entity alone is responsible for this or that observed activity. To this end the technique developed by the school of Willstätter has greatly helped. While we are waiting for the knowledge which may ultimately yield, on lines acceptable to current chemical thought, a method for characterising these exceptional entities as

units, the actual configuration which confers activity on this or that enzyme can be, and in many cases no doubt soon will be, determined by indirect methods.

I would like now to illustrate a little further the nature of current progress in animal biochemistry by a reference to investigations dealing with related, but somewhat different aspects of control of dynamic phenomena in living tissues.

From the researches published during the year I might select many to show that efforts to disentangle the complexities of these phenomena can in their own way be as profitable as any branch of chemical endeavour. I think it will be more useful, however, to refer more particularly to one research which is typical of many in respect of its methods and its success. In this the investigator approached on new lines a fundamental problem which for the last sixty years has been the subject of speculation, and no less of experiments which up to a point were informative. The problem was to discover the nature of the final chemical steps which lead to the production of urea in the animal body. That the mammalian liver can convert ammonium carbonate into urea has been many times experimentally proved, and it is equally sure that ammonia and, of course, carbon dioxide are continuously produced in metabolism. Therefore most of us have long been content to believe that urea arises by the direct removal of the elements of water from the molecule of ammonium carbonate.

That urea does indeed arise in the liver by a synthesis from ammonia and carbon dioxide remains certain ; but the research under reference, brilliantly carried out by Krebs, of Freiburg-im-Breisgau, has shown that its production is on no such simple lines as those mentioned. It calls for a mechanism involving a most interesting interplay among activated molecules. The facts as revealed have just that degree of unexpectedness—if I may use the phrase—which was to be expected in a biochemical phenomenon. I often find myself compelled to assert that though biochemical events are, of course, limited by chemical possibilities, they are not safely to be predicted by chemical probabilities, even when these are strong. That is why experimental biochemistry must remain an independent scientific discipline.

The essential results of Krebs's research include consideration of the molecular structure of three biological substances : ornithin, citrullin and arginin. In the presence of ammonia and carbon dioxide, and when activated by agencies in the hepatic tissue, ornithin is converted into citrullin which, as a ureido-acid, already carries the carbamide structure. Urea does not arise directly from this, however ; another stage intrudes. Citrullin takes up another molecule of ammonia (with elimination of water as at the first stage) and the structure of arginin with its guanidin grouping is thus established. Now arginin is the normal substrate for the well-studied and very active hepatic enzyme, arginase ; and under its influence the guanidin group is hydrolised. Urea thereupon splits off from the arginin molecule and ornithin is reproduced. The sequence is then re-established.

Urea is thus produced continuously from the ammonia which arises in the deamination of the amino acids of protein, and from the carbon dioxide of metabolic oxidations in general, but on lines which may seem strangely complex. It would be too much to say at present that this is the only line of origin for urea in the body, but we know now that it is the main line. In maintaining the sequence of reactions, ornithin can function in minute amounts ; acting therefore essentially as a catalyst. The nature of the relations involved in this mechanism is characteristic of the living cell.

In another respect this example illustrates the nature of current biochemical studies. The data were obtained by the methods of micro-analysis and only a few milligrams of hepatic tissue were employed in individual experiments. Yet the results were consistent and reproducible and experimental errors well under control. The high accuracy to be obtained in ordinary organic analysis by micro methods is now well recognised, but it is becoming clear that technique is so developing that kinetic studies can be made equally accurate on a similar scale. To studies of living systems this offers advantages which cannot be overestimated.

One further point : it is becoming more and more a matter for confidence that when tissues with cells intact are quickly removed from the animal after its death and placed straightway in a fluid medium of carefully proved adequacy, it only remains to provide an adequate supply of oxygen which shall reach each unit of the tissue, to secure the continuance of the events which had been proceeding *in vivo*. Indeed we are gaining sufficient knowledge of the requirements of such excised tissues to justify the claim that the course of metabolism observed in them during extensive periods of survival need differ in no way from the normal.

We can proceed, then, from the study of tissue extracts in which it is easy to deal with the kinetics of isolated reactions, each determined by its appropriate catalyst, to studies of other tissue extracts, made with discrimination, in which the progress of a variety of reactions retains not a little of the organisation which characterised them during life, and thence to other studies in which we follow the kinetics of reactions controlled by the intact and still living tissues or cells. Thus and otherwise has biochemistry escaped from the dilemma voiced in earlier dogma, namely, that since chemical methods must at the very moment of their application convert the living into the dead, they can do nothing to elucidate the dynamic events of life. The escape is more real than may seem on a superficial view, and especially real perhaps to those who are themselves applying modern chemical methods in the biological field.

Forests and Stream Flow

THE effect of the action of forests in conserving water supplies and regulating the flow of water in streams and rivers, whilst preventing erosion in mountainous countries with consequent disastrous floods, has been under discussion for several centuries. Attention was directed to this important matter in an article entitled "Forests, Climate, Erosion, and Denudations" in NATURE of April 4, 1931. The opinions commonly accepted by foresters and many engineers are to the effect that forests are beneficial (1) by retaining and storing water in the humus layer on the forest floor and allowing it to percolate gradually into springs and streams, thus retarding a rapid run-off; (2) retarding the melting of snow in the spring and thus prolonging the run-off from this source; (3) increasing precipitation; (4) preventing erosion on steep slopes. It may be admitted that direct proof of the actual effect of disafforestation of the catchment area of a river on the future water level of that river based on a prolonged series of measurements, has been so far wanting. But the ultimate results, both to the catchment area and the plains country below should reafforestation not take place, cannot be called in question. Europe itself, along the shores of the Mediterranean, and many parts of India offer numerous illustrations of the aftermath of reckless forest denudation, followed by the drying up of water supplies.

In a paper entitled "Forests and Stream Flow" delivered before the American Society of Civil Engineers at its annual convention in Yellowstone Park on July 6, 1932, Messrs. W. G. Hoyt and H. C. Troxall call in question, from the engineers' point of view, the usefulness of forests in maintaining and regulating water supplies. They base their conclusions on the following. An experiment by the United States Forest Service and the U.S. Weather Bureau was conducted from 1910 until 1926 on two contiguous tracts of land in Southern Colorado (Wagonwheel Gap area) of 222·5 and 200·4 acres respectively, having almost identical geographical, topographical and meteorological conditions. The forest cover in both areas was representative of the Rocky Mountain area as a whole. In 1919 the smaller area was disafforested and the slash burnt in 1921. By 1926 the area had become recovered by a growth of grass, herbs and aspen shoots which had reached a height of three to six feet. Throughout the period, accurate measurements of the run-off and meteorological observations were recorded.

A distinct investigation on stream-flow measurements was begun in 1916 under the auspices of the U.S. Geological Survey, in co-operation with the State of California and the County of Los Angeles on certain areas in California. In August 1924 a forest fire burnt some of the areas under observation, and one of them, Fish Creek, was selected to establish the effect of the fire and resulting disafforestation on the discharge of this creek. A new growth appeared over the area burnt, and by the autumn of 1930 it is said that little evidence of the fire remained, though a different plant association had developed.

The investigations recorded by the authors, and the deductions therefrom, are therefore based in the first case on the observations of seven years (1920–1926) and in the second on six years (1925–1930). It is impossible to do more than glance at the conclusions arrived at from the records and data, which are most ably dealt with in this monograph. They are, however, sufficiently startling to require more detailed investigations on the same lines and will merit careful consideration in many parts of the British Empire where forests, agriculture and commercial interests are so inextricably interwoven. Briefly, the authors hold that forests do not conserve the water supply; that the increase of run-off is not confined wholly to flood periods; that after disafforestation in the Wagonwheel area there was an increase of forty-six per cent in maximum daily discharge; that the belief that forests or vegetation covering will increase the summer run-off and shorten the low-level period through the exercise of storage functions is a fallacy, so far as the records on the two above widely differing areas are concerned. Further, that coincident with the increase in the summer run-off there was an increase in the average summer minimum and the period of low water run-off was considerably shortened; disafforestation made no appreciable change in the low flows which occurred during the winter in the Wagonwheel area.

The authors, who are hydraulic engineers, state that they are lovers of the forest, but in the interest of water supplies and the maintenance of water supply levels, they consider that "If the small growth that springs up immediately after disafforestation" (though this is not the case in all countries) "or denudation exercises practically the same effect as forests in reducing normal flood crests and in preventing erosion without the detrimental effect which forest cover is shown to have on annual flow and flow during the summer low-water periods—then in basins where shortages in water supply are becoming critical or where abnormal expenditures have to be made to augment water supplies, the maintenance of forests or reafforestation for the 'conservation of water supply' may have an effect exactly opposite to that desired."

The investigations, which have been carried out in so liberal a spirit by the United States, are of the greatest importance; and they certainly put a question mark to assumptions which have long been held. It is, however, difficult to believe that foresters and many others who have studied this matter will be able to accept all the deductions of the authors when they are based on records of so short a period as six to seven years.

Obituary

DR. WILLIAM PATTEN

DR. WILLIAM PATTEN, who died at Hanover, N.H., United States, on October 27, aged seventy-one years, will be remembered for his numerous contributions to our knowledge of the earliest fossil fishes, which are generally known as Ostracoderms. After graduating as B.Sc. at Harvard in 1883, and as Ph.D. in Leipzig in 1884, he studied at the Naples Zoological Station; and in 1886–89 he was assistant in the Lake Laboratory, Milwaukee, Wisconsin. He was then professor of biology in the University of North Dakota for four years, and in 1893 he became professor of zoology in Dartmouth College, Hanover, N.H., where he remained until his retirement in 1931.

Dr. Patten's researches on the existing *Limulus* and on the fossil Ostracoderms led him to formulate the theory that primitive arachnids were the ancestors of the vertebrate animals. In 1912 he elaborated this theory in a volume entitled "The Evolution of the Vertebrates and their Kin", which was illustrated with his own beautiful drawings. His facts and arguments, however, failed to convince other zoologists and palæontologists, and he accordingly proceeded with astonishing energy to collect new fossils which might illustrate the subject. He prepared the fossils with great skill and patience, and published a series of valuable papers which are filled with original observations. In the province of Quebec, Canada, he found the first specimens of the armoured *Bothriolepis* showing the tail and median fins. In the island of Oesel, Estonia, which he visited on three occasions, he collected numerous other Ostracoderms in a remarkable state of preservation, including new genera and species which still remain to be described. A. S. W.

PROF. A. BOSTOCK HILL

PROF. BOSTOCK HILL, who died on November 5, was educated at King Edward's School, Birmingham, and pursued his medical studies partly at Queen's College—at that time the Birmingham Medical School—and partly at Edinburgh, and he also obtained a medical degree at Giessen. The early part of his career was directed to chemistry and he became public analyst to the county of Warwick and afterwards, in 1879, professor of chemistry in Queen's College. Two years later he was appointed professor of hygiene in Mason College, and then in the University of Birmingham, when this was created in 1900. The whole of his life thereafter was spent in public health administrative work, and he held several appointments under various authorities.

Bostock Hill contributed many useful publications of public health interest, and wrote on the purification of sewage, water filtration, and the spread of scarlet fever by milk. In public lectures and addresses he dealt with such varied subjects as the history of sanitary development in Great Britain, the evolution of the county health department, and the relation of voluntary effort to State authority in sanitary and social reform.

Bostock Hill possessed considerable gifts as a teacher, and his lectures will long be remembered by his students. Since his retirement from Birmingham, he had been a valued member of the Board of Studies in Hygiene of the University of London. A sound administrator, a shrewd man of business, and an attractive personality, he will be missed by a large circle of friends. R. T. H.

WE regret to announce the following deaths:

Mr. Bernard Hobson, formerly lecturer in geology in the University of Manchester, secretary of Section C (Geology) of the British Association at Sheffield in 1910, on December 3, aged seventy-two years.

Prof. Marco Th. Lecco, emeritus professor of chemistry in the University of Belgrade, on November 4, aged seventy-nine years.

Canon John Roscoe, an authority on the ancient customs of the Baganda and kindred tribes, on December 2, aged seventy-one years.

News and Views

Electric Supra-Conduction in Metals

THE account given by Prof. J. C. McLennan, in our Supplement this week, of the discussion at the York meeting of the British Association on electric supra-conduction in metals, is most useful as it shows the progress made both by experiment and theory in elucidating this, at least at present, marvellous phenomenon. As soon as Dewar had succeeded in producing liquid oxygen on a large scale in 1892, he and Fleming made an elaborate research to find out how the resistance of metals varied at very low temperatures. They were led to the conclusion that at temperatures near the absolute zero the electric resistance of pure metals would be very small or even zero. Twenty years later, Kamerlingh Onnes, when experimenting with liquid helium, discovered that, when mercury was cooled down to about 4·2° K., it became suddenly and abruptly what is now called a supra-conductor. At and below this temperature it offers no measurable resistance to an electric current. The flow of electrons round the circuit is practically unimpeded. The importance of this from

the electrical engineering point of view was at once appreciated, for if resistance were annihilated, huge amounts of power could be transmitted great distances by very thin wires. Practical applications, however, are still few and engineers await the further elucidation of the phenomenon by physicists. The action of a magnetic field in delaying the appearance of supra-conductivity wants further explanation. The experiments with direct and alternating currents seem to justify the conclusion that a polarisation or orientation phenomenon of some kind is involved in the production of the supra-conducting state in metals. The electron lattice theory is a promising one but in order to verify it a further study of the conductivity of single crystals at very low temperatures is necessary.

Sir Thomas Purves

THE retirement at the end of last month of Col. Sir Thomas Fortune Purves from the post of engineer-in-chief to the Post Office came after ten years of unparalleled development in the art of electrical communications. During his term of office, he had to decide whether the future of telephony in Great Britain was to be manual or automatic. His decision to adopt the Strowger step-by-step automatic system has been proved by experience to have been of great benefit to the country. His pleasing personality was of great value in the development of international telephony. At the conclusion of the War, everything was favourable for the establishment of an extensive European system, provided that national boundaries could be disregarded. The problem therefore was one of politics rather than of engineering, and it was in this field that Sir Thomas's great gifts as a diplomatist had full play. The disarming charm of his manner, his wit and geniality broke down all barriers. In 1924 he met the representatives of the German administration at the Hague and was successful in persuading them to come to the first international telephone conference which took place in April of that year. Since then, conferences of the C.C.I. (Comité Consultatif International) have been held every year. The retirement of a figure of the type of Sir Thomas Purves from these international deliberations will be very seriously felt throughout Europe. When appointed engineer-in-chief in 1922, he prophesied that the coming ten years would see many remarkable developments—such as full intercommunication between the telephone systems of Great Britain and the United States—all of which have been duly accomplished. Great Britain has become the switching centre through which Europe and America communicate with each other and with the British Dominions. No radio centres in the world are comparable in magnitude with the Post Office transmitting centre at Rugby and receiving centre at Baldock. Sir Thomas is one of the most popular members of the council of the Institution of Electrical Engineers, of which he has been president. We hope he will be able to do equally valuable work for many years to come. His successor at the Post Office is Lieut.-Col. A. G. Lee, chairman of the Radio Research Board.

John Phillips and the Geology of Yorkshire

THE annual meeting of the Yorkshire Geological Society was held at Leeds on November 19. The president, Mr. T. Sheppard, took as the subject of his address the work of John Phillips, the pioneer of Yorkshire geology. As a nephew and companion of William Smith, Phillips had unique opportunities for applying the principles of stratigraphy, and his first book on the subject, "Illustrations of the Geology of Yorkshire. Part 1, The Yorkshire Coast", appeared in 1829 and went through three editions; but of Part 2, "The Mountain Limestone District", there is only one edition, 1836. His other book, "The Rivers, Mountains and Sea Coast of Yorkshire", is of a more popular type and includes an account of the "Ancient Inhabitants of the County". Both show his genius for conveying much solid and original geological work in eminently readable form and also his skill as an artist, the illustrations of scenery and fossils alike being from his pencil. It may here be mentioned that Phillips's fossil types, preserved in the York Museum, of which he was long the curator, have recently been carefully labelled and set out for study by Mr. S. Melmore. While at York, Phillips was one of the founders of the British Association, and Mr. Sheppard mentioned an occasion when he astonished the members by giving, without preparation, a surprisingly complete summary of the year's advances in all branches of science. His later work at Oxford and his well-known "Manual of Geology" were briefly mentioned, but Mr. Sheppard promised that when his address was published it should include a complete bibliography. The task of compiling it could not be in more capable hands.

Prof. Max Weber

IN NATURE for December 9, 1922, there was published a letter of congratulation that had been sent by British zoologists to Prof. Max Weber, of Amsterdam, on the occasion of his seventieth birthday. Of the thirty-five who signed that letter, only twenty-five now survive, and these repeated their congratulations on December 5 last, when the distinguished Dutch zoologist completed his eightieth year. Prof. Weber, who has been a foreign member of the Linnean Society of London since 1898, also received a letter of congratulations from the council of that Society. In the last ten years, Prof. Weber's record of work would have done credit to the vigour of a man of half his age. He has brought out a second edition of his monumental textbook, "Die Säugethiere": he is still producing the successive volumes of the "Fishes of the Indo-Australian Archipelago", in collaboration with Dr. de Beaufort; and the reports of the *Siboga* expedition, written by contributors all over the world, continue to appear under his editorship with a regularity that editors of reports of less important expeditions may well envy.

The British Dyestuffs Industry

THE third report of the Dyestuffs Industry Development Committee on the present position and development of the dyestuffs manufacturing industry

in Great Britain is not characterised by the unanimity of the previous report. While endorsing the general conclusions that the Dyestuffs (Import Regulation) Act is achieving its main objects, that the production of dyes during recent years has been satisfactory, especially taking into account the depressed state of some of the principal consuming industries, and the tribute paid to the extension of the range of products, the quality of the output and the standard of research maintained, as well as the technical and scientific progress, the users representatives dissent from the recommendation of the main Committee that the Act be continued on its present basis for a period of three years. On this point, however, independent representatives on the Committee, Profs. G. T. Morgan and Jocelyn Thorpe, make the reservation that the period of continuance should be five years. They base this reservation on the dependence of the industry upon a systematic application of research and the considerable interval of time which invariably occurs between discovery in the research laboratory of a promising dye and its commercial exploitation.

THE difference of opinion between the users representatives and the majority of the Committee appears to turn on questions of price, the formation of an international agreement and the imposition of a ten per cent tariff. The majority report observes that the effect of the recent agreement between Imperial Chemical Industries Ltd. and the continental makers has yet to be seen, but that there is no reason to anticipate a restriction of the output and activities of the British company. They consider, moreover, that the British makers are still implementing the undertaking to supply at world prices during the continuance of the Act. While the users recommend that the Act should lapse on December 31, 1932, there is no recommendation regarding the tariff, and the recommendation that arrangements should be made for British makers to obtain their supplies of benzene, toluene and xylene at prices corresponding to those paid by their foreign competitors is signed by all members of the Committee.

Land Drainage

THE paper on "Land Drainage in England and Wales", read by Capt. J. C. A. Roseveare, chief engineer of the Ministry of Agriculture and Fisheries, at the winter meeting of the Institution of Water Engineers on December 2, possesses a special interest at the present time by reason of the prominent place occupied by the subject of flood prevention in government and scientific circles, as well as among the general public dwelling in areas subject to inundations as disastrous as those which took place in the Midlands in the earlier part of the present year and in the area of the Don in 1931. The paper commenced with a concise résumé of the origins and constitution of land drainage authorities in Great Britain prior to the passing of the Land Drainage Act of 1930, and proceeded to detail the circumstances attending the institution of the Ouse Drainage Commission of 1925 and the Doncaster Commission of 1926, followed by the Royal Commission on Land Drainage in 1927, the recommendations of which formed the basis of the Land Drainage Act of 1930. The principal feature of this Act was the constitution of a series of catchment boards for the administration of drainage areas comprised within watershed lines to be laid down by the Ordnance Survey Department. The Report of the Royal Commission contained a list of 100 suitable catchment areas, but the Act of 1930 scheduled only 47 for immediate creation. Boards for 46 of these areas, covering 67 per cent of the total area of England and Wales, were actually set up before November 1931.

Catchment Boards

CATCHMENT BOARDS may consist of any number of members not exceeding 31, one member being appointed by the Minister of Agriculture and not less than two-thirds of the remainder by county councils and county borough councils, the whole or part of whose areas lies within the catchment area. As regards the functions of these bodies, Capt. Roseveare went on to state that the special sub-Committee on River Gauging of the Advisory Committee on Water, of which he himself was a member, reported that catchment boards were the proper authorities to undertake the systematic gauging of the rivers of England and Wales, and it advocated these investigations as a necessary preliminary for determining the provision required both for the conservation of water and for the voiding of surplus water in wet periods. Reference was made, in this connexion, to the leading article in NATURE of July 2 and to the discussion on the subject at the York meeting of the British Association in September, which has led to the formation of a special Committee, now sitting, "to inquire into the position of inland water survey in the British Isles and the possible organisation and control of such a survey by central authority". The remainder of Capt. Roseveare's paper was devoted to tabular data and general information, of great value for reference purposes, concerning the various catchment areas and their 'main rivers', with some detailed account of the engineering works recently executed in the basin and estuary of the Ouse.

Geography in Current Affairs

At his inaugural lecture in the chair of geography at Oxford on November 15, Prof. K. Mason, after referring to the development of the School of Geography under his predecessors, spoke more particularly of the geography of current affairs (Oxford: Clarendon Press, 1*s*. 6*d*. net). The subject should entail the study of the earth as the home of man, and a framework of geographical knowledge is an indispensable background in the conduct of human affairs. Many of our present-day troubles he traced to a neglect of the teachings of geography. Much of the guidance that we have for the future comes from a study of the historical past, but to be of use for the future it must be set in the geographical present. The geography of the past,

particularly of prehistoric times, is of less importance to the student than the geography of the world as it is to-day. The geographer can make a definite contribution to the solution of many urgent problems of the day in colonisation, trade, transport and agriculture. Scientific surveys of every aspect of man's environment are much needed and the basis of all this work must be an adequate map. Prof. Mason urged that the appointment of a trained geographical adviser in the government of any country would be invaluable in its development and control.

Lord Bledisloe's Cawthron Lecture

NEW ZEALAND is singularly fortunate in having in its Governor-General, Lord Bledisloe, a keen and distinguished agriculturist, thus representing in the highest governing and administrative circles one of the most important industries of the Dominion. On October 3, Lord Bledisloe delivered at Nelson the annual Cawthron lecture, his address being entitled "A Conspectus of Recent Agricultural Research with Some Reflections Thereon". This is the first time that a Governor-General of a Dominion has delivered within it the chief scientific oration of the year, and as one would have expected, in collating the agricultural research of the past three years, as Lord Bledisloe did in the lecture, the economic importance of agricultural research has been emphasised from an essentially broad though authoritative point of view, thus taking into consideration not only the British Empire, but also other countries. The amount of detailed facts, with commentaries, concerning agriculture which have been assembled into this lecture is scarcely short of amazing. Lord Bledisloe has left no stone unturned in his search for data. Every aspect of agricultural and horticultural research is reviewed and there is scarcely a research department, institute or station within the British Empire which is not considered and its recent work discussed. Other countries outside the Empire, such as Denmark, Germany, the United States, Holland, Finland and others, have been combed for results and duly considered. Apart from the general consideration of horticulture, arable and dairy farming and apiculture, and their more detailed aspects such as the study of the constitution of wool, vitamins, etc., researches in connexion with more specialised Empire products such as sugar and tobacco are also reviewed. The lecture has now been published and may be obtained from Messrs. Whitcombe and Tombs, 3 Addle Hill, London, E.C.4, price 1*s*.

Expansion of the Universe

AT the Friday evening discourse on November 25 at the Royal Institution, Dr. Knox-Shaw discussed the observational evidence for the expansion of the universe. The nebulæ lying beyond our galaxy stretch away into space farther than our present limit of penetration. Most of them can be studied only with our largest telescopes, and for our knowledge of their distances and motions we are indebted largely to the work of Dr. Hubble at the Mount Wilson Observatory. In some forty nebulæ he has been able to detect individual stars, and in a few cases to identify them as belonging to types already known in the galaxy. From the apparent luminosities of these stars he has derived distances for the nebulæ in which they are involved. In all other cases the distances are based on the apparent brightness of the nebulæ themselves. The scale of distance thus constructed is still very uncertain. The absorption lines in the spectra of the extra-galactic nebulæ are shifted towards the red in a way that suggests that they are all moving away from us with velocities which increase with the distance. Whether there is an alternative explanation of these shifts is a question for the physicist rather than for the practical astronomer, but if we assume that they actually indicate motions of recession, we find that the velocities of the nebulæ are proportional to their distances from us, as would be required in a uniformly expanding universe. Hubble's value for the rate of expansion, an increase of 560 km. a second for each million parsecs of distance, must be regarded as liable to revision as further observational material becomes available. A cluster of very faint nebulæ in Gemini, so remote that its light has taken some 135,000,000 years to reach us, has recently been photographed at Mount Wilson, and seems to be moving away from us at the immense speed of 24,000 km. a second.

Slaughter-Houses in Great Britain

THE eleventh Benjamin Ward Richardson memorial lecture was delivered, under the chairmanship of Sir James Crichton-Browne, before the Model Abattoir Society on November 30 by Mr. T. Topping, who chose for his title "The Slaughter-House Problem". He commenced by saying that had local authorities more generally carried out the advice given by Richardson when he founded the Model Abattoir Society fifty years ago, there would have been no slaughter-house problem to-day, and there would have been greater benefit for other public health protective measures. As it is, there is a very real problem owing to the fact that the slaughter-house provisions of the Act of 1847 are still the principal law on the subject to-day. No advance was made by the Public Health Act of 1875, so that many buildings quite unsuitable for the purpose came into existence as private slaughter-houses. The Rural District Council (Slaughter Houses) Order of 1924 gave State recognition to and largely increased the capital value of hundreds of unsuitable buildings that had been erected as slaughter-houses prior to the order. Thus for nearly sixty years, most local authorities steadily increased the financial difficulties of providing for the only effective means of supervision of slaughter-houses and of securing hygienic preparation of carcase meat. According to Mr. Topping, there are only about 110 slaughter-houses in Great Britain where the buildings and arrangements are satisfactory, whereas in a large percentage, complete supervision and inspection is extremely difficult if not impossible. As a solution of the problem, he suggested first that the Ministry

of Health should obtain either directly, or indirectly through the county councils, information as to the condition of all the private slaughter-houses in the country, particularly as to deficiencies in meat inspection and their cause, and secondly, that abattoir provision should be on a county basis, instead of allowing each local authority to have its own abattoir.

Ultra-Short-Wave Wireless Communication

IN his Friday evening discourse at the Royal Institution on December 2, the Marchese Marconi described the important results of his recent investigations into the properties and behaviour of very short electric waves. Numerous distance tests and a few official demonstrations have been given from time to time, and each has proved the availability and practicability of these waves for the purposes of radio communications. Soon after a duplex demonstration over a distance of twenty-three miles between Santa Margherita and Sestri Levante, the Vatican authorities decided to adopt the new system for telephonic communication between the Vatican City and the palace of the Pope at Castel Gandolfo, a distance of 20 kilometres entirely over land, and screened by intervening trees. In connexion with the establishment of this service, successful tests took place towards the end of April this year; during one of these tests waves had to pass through all the masts and aerials of the high power radio station of the Italo Radio Company at Terranuova. Following a series of experiments with waves of the order of 50 centimetres length conducted between Marconi's yacht *Elettra* and the station at Rocca di Papa, near Rome, the most outstanding result was the successful establishment of communication from Rocca di Papa to Cape Figari, Sardinia, over a distance of 168 statute miles (275 kilometres) on a wave-length of 57 centimetres. All previous distance records of communication by means of wave-lengths less than one metre were thus far surpassed, and it was effectively demonstrated that these very short waves can overcome the supposed obstacle presented by the curvature of the earth, the distance between the two stations being considerably in excess of the optical range. A new technique is thus developed which is bound to extend very considerably the already vast field of the applications of electric waves to radio communications. The new system is unaffected by fog, and offers a high degree of secrecy, by virtue, principally, of its sharp directive qualities.

Radio Equipment for Cross Channel Air Services

IN March 1931 a demonstration was given by the International Telephone and Telegraph Laboratories of radio telegraphic communication across the English Channel on a wave-length of about 17 cm. (see NATURE of April 11, 1931, p. 564.) According to a note in the *Electrician* and the *Electrical Review* for November 18, a somewhat similar equipment to that used in the above demonstration has been ordered by the Air Ministry for use in connexion with cross-Channel flying services. This equipment will be manufactured by Messrs. Standard Telephones and Cables Ltd. in their Hendon factory, and it will operate on a wave-length in the neighbourhood of 15 cm. The oscillations corresponding to this wave-length will be generated by special valves and will be led to the transmitting aerial, which is less than one inch long, situated at the focus of a circular reflector about 10 ft. in diameter. This reflector will be focused on to a similar reflector at the receiving station. The equipment ordered by the Air Ministry will be located at the Lympne air-port, near Hythe, and will operate in conjunction with a similar equipment ordered by the French Air Ministry to be situated at St. Inglevert aerodrome, nearly seven miles south-west of Calais. It will be used for announcing the arrival and departure of aeroplanes that are not fitted with radio, and for routine service messages. An interesting feature of this new service will be the use of teleprinters for both receiving and transmitting messages. In this way typewritten messages will actually be sent across the Channel by radio, thus providing a permanent record at each end. It is expected that the station will be in operation early next spring and its use will relieve the volume of traffic at Croydon and Lympne radio stations very considerably.

Scientific Expedition to Yunnan

IN the spring of 1932 a joint botanical and zoological expedition was sent to eastern Yunnan by the Fan Memorial Institute of Biology, Peiping, starting from western Szechuan and exploring the bordering regions of Szechuan, Kweichow and Yunnan. The party expects to spend the winter in Yunnanfu. The botanical staff will endeavour to explore regions formerly not thoroughly worked over and collect also specimens in the type localities. Besides collecting flowering plants, special attention will be devoted to mosses, liverworts, ferns and other cryptogams. The zoological staff will collect birds, fishes, other lower vertebrates and land shells. News has been received that the party succeeded in penetrating the forbidden territories of Ta-Liang-Shan Lolos, where probably no white man has ever entered before. These Lolos are very war-like tribes. They frequently kidnap Chinese and make them slaves. By a curious chance the present powerful chieftainess is the sister of the military governor of Yunnan, and hence much more enlightened in her view toward the purpose of scientific expeditions. The party was welcomed as honourable guests by the chieftainess. Oxen and pigs were slaughtered in their honour, and an elder of the tribe has been handed over to the district magistrate as the pledge of their safety. As two years ago the lamentable death of the eminent young Chinese palæontologist, Ya-Tseng Chao, at the hands of bandits had cost the district magistrate of Chao Tung Hsien permanent dismissal from office, such precaution is carefully taken by his successor. The party plans to explore the south-eastern part of Yunnan next year.

Popular Science

To apply the term 'popular science' to a book is generally sufficient to make a man of scientific training turn aside distrustfully. This is particularly unfortunate in these days of increasing specialisation, when it is more than ever desirable that specialists should be enabled to follow broad lines of advance in fields other than their own, but the fact remains that most popular science books are 'written down' and simplified to the point of sheer inaccuracy. There is also an increasing body of laymen interested in the advances of science who rightly ask to have accurate though plain accounts of current work. Davy and Faraday showed one way in which both needs can be met: the scientific worker can come from his laboratory and explain his investigations. Faraday's Friday evening discourses at the Royal Institution are still regarded as models of exposition, and it may justly be said that Faraday's mantle has fallen on the present occupant of his post, Sir William Bragg. Sir William's course of Christmas lectures of 1923–24, "Concerning the Nature of Things", forms an admirable introductory volume in a group of four published by Messrs. G. Bell and Sons, Ltd., in a new "Popular Science Series" (4*s*. 6*d*. net each). From that we may pass to "Engines", by Prof. E. N. da C. Andrade, another course of Christmas lectures at the Royal Institution, and then perhaps to Prof. J. Kendall's "At Home among the Atoms", described by its author as "A First Book of Congenial Chemistry", which with its quaint chapter headings and unconventional diction will amuse as well as inform. Finally, there is Prof. Andrade's "The Mechanism of Nature", a more ambitious work for the intelligent reader, surveying in plain language modern views on the structure of matter and radiation. All these books have been published before, but in their new and tasteful 'dresses', any or all of them might well serve to solve the problem of the selection of a Christmas present for a young or an older reader.

Electrically Heated Incubators

THE use of electrically heated incubators is steadily increasing. Some people think that the method is a risky one, as the interruption of the electricity supply even for a short period might involve a failure. We learn from the Electrical Development Association (the E.D.A.) that this risk is negligible. For example, a leading firm of poultry farmers and incubator manufacturers sent batches of eggs in its incubators to agricultural shows. In one case, two batches, 219 eggs in all, were sent to the Royal Show at Southampton. One batch had been incubated for thirteen days and the other for fifteen. After being taken out of the incubators at the farm they were packed in egg-boxes and carried in a loaded three-ton lorry a distance of sixty miles by road to the show. They were then unpacked and placed in the incubator. At the end of the normal periods 209 chicks were hatched. The eggs were out of the incubator for a very much longer period than any interruption in an electricity supply is likely to last. Another case is described where the half-incubated eggs were packed in the ordinary way and sent 240 miles by road and train without any apparent effect on the number of chickens hatched.

Institution of Automobile Engineers' New Journal

THE Institution of Automobile Engineers had its birth in 1898 at Birmingham, as the Cycle Engineers' Institute, and took its present title in 1906, when its headquarters were removed to London. In 1911 it had a membership of 530, while to-day it has a membership of 2,520, with seven provincial centres and a branch in New Zealand. Up to the present, it has only issued leaflets devoted to the papers read and other matters, while the *Automobile Engineer*, published by Messrs. Iliffe and Sons, Ltd., has been considered as its official organ. It has now, however, been considered desirable that the Institution should have its own monthly journal, and the first issue of this has recently appeared. The *Journal* is intended to include advance copies of papers to be read, summaries of the discussions which take place, abstracts of papers and articles from other sources and reviews of books of special interest to members. This is certainly a step in the right direction and one which will be generally appreciated. Last year the Institution formed a Research and Standardisation Committee and appointed a director of research and the first issue of the new *Journal* includes the annual report of the Committee for the year July 1, 1931–June 30, 1932.

Armstrong College Mining Society

THE July number of the *Journal of the Armstrong College Mining Society* has recently been issued. Probably the most important paper in it is one by Prof. Granville Poole and Mr. J. T. Whetton on "Skip Winding", showing how this method is being adopted in a number of German mines, even in certain collieries. It is doubtful to what extent this method of winding is applicable to British collieries, but its use should, no doubt, be carefully considered. It has, of course, been used for many years as the main method of winding in the metalliferous mines of Cornwall, although the authors of the paper appear to have overlooked this fact entirely. It may also be pointed out that they make no allusion to the methods which have been recently tried in Germany of constructing skips of material lighter than steel. Another interesting paper is one by Mr. M. T. Adamtchik on the so-called 'Aeroto' fan, which apparently is simply a multiple propeller fan. Curiously enough, the author makes no reference to the Steart fan, which was the first type of propeller fan ever employed; it would appear that the fan here described is simply a development of the latter fan. The *Journal* concludes with a glossary of mining terms, with French and German equivalents, which unfortunately are not always correct.

Taxonomy of the Hymenomycetes

THE presidential address of Mr. A. A. Pearson to the British Mycological Society reviews the European

(*Continued on p.* 887)

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Electric Supra-Conduction in Metals*

By Prof. J. C. McLennan, O.B.E., F.R.S.

THE discussion at the York meeting of the British Association on the electric supra-conductivity of metals was opened by a reference to the classical experiments of Dewar and Fleming[1] made in 1893 on the electrical conductivity of metals cooled to very low temperatures by means of liquefied gases, including air and hydrogen. These yielded results suggesting that the electrical resistances of all pure metals would vanish at the absolute zero of temperature.

This suggestion, however, proved to be wrong, for in 1911, Kamerlingh Onnes at Leyden, while carrying out researches at low temperatures with the aid of liquefied helium, discovered that mercury, when cooled down and solidified with liquid helium, suddenly and abruptly at about 4·2° K. became what is now designated as a supra-conductor of electricity. At temperatures below 4·2° K., mercury offers no measurable resistance to the passage of a current. Currents of electricity started in a ring of a metal in the supra-conductive state will continue apparently undiminished in intensity while the metal is in that state. The duration of these persistent induced ring currents seems to be limited only by the length of time the cooling agent, liquid helium, will last. In the course of a lecture on the evening of June 3 last at the Royal Institution on supra-conduction in metals, I exhibited to the audience a closed ring of lead immersed in liquid helium and carrying a current of more than 200 amperes. The current had been started in the supra-conducting lead ring some six hours earlier in the afternoon by Prof. Keesom in Leyden, and it persisted undiminished in intensity while being transported in liquid helium by aeroplane from Leyden to London by Colonel the Master of Sempill.

* From a discussion on electric supra-conduction in metals held in Section A (Mathematical and Physical Sciences) on Friday, September 2, at the York meeting of the British Association. Among those who took part in the discussion were Prof. J. C. McLennan, Prof. W. J. de Haas, Dr. W. Meissner and Prof. O. W. Richardson.

Supra-Conductive Metals

Metals in addition to mercury and lead that exhibit the supra-conductive property if made sufficiently cold are tin, indium, gallium, thallium, tantalum, titanium, thorium, and niobium. The transition temperature for the passing of a metal from the ordinary conducting to the supra-conductive state is not a constant but varies with the metal. For mercury it is 4·22° K., for lead 7·2° K., tin 3·7° K., tantalum 4·4° K., thallium 2·37° K., indium 3·37° K., gallium 1·05° K., thorium 1·5° K., titanium 1·75° K., and niobium 8·2° K.

Alloys and Chemical Compounds

Some alloys and chemical compounds of the metals also exhibit the supra-conductive property. Copper sulphate, for example, does so, though none of the constituent elements is a supra-conductor. The nitrides and carbides, borides and silicides of several of the metals, such, for example, as those of molybdenum, tungsten, tantalum, zirconium and niobium, are also supra-conductive at sufficiently low temperatures.

The addition of metals of the bismuth group to supra-conductive metals has been found, speaking generally, to raise their transition temperature. Bismuth added to lead raises the transition temperature from 7·2° K. to 8·8° K.; carbon raises that of niobium from 8·2° K. to 10·5° K. Gold

alloyed with bismuth becomes supra-conductive at 1·94° K., whereas neither constituent alone becomes supra-conductive even at the lowest temperatures obtainable.

With pure metals the transition from the ordinary conductive to the supra-conductive state generally occurs within a tenth or at most a few hundredths of a degree. With impure metals, with alloys or with chemical compounds, the transition is not generally so rapid. In the transition stages, in the case of most of the metals the variation of resistance can be readily followed by observing the vapour pressure of the liquid in which the metal is immersed. In the case of liquid helium, a variation in vapour pressure of about 40 mm. of mercury corresponds to about one tenth of a degree centigrade.

Recently McLennan, Allen and Wilhelm, in making a study of various alloys of the silver-tin, gold-tin, gold-lead systems, found three outstanding features to characterise the results. First, in alloys with the supra-conductive elements it was observed that gold and silver produced an effect on the transition temperature opposite to that produced by bismuth, antimony and arsenic. When one observes alloys containing the latter metals, one finds usually a pronounced elevation of the supra-conducting temperature, while in alloys with gold and silver one finds an equally pronounced depression of the supra-conducting temperature. Secondly, it was noted that a binary alloy system composed of a supra-conductor and a non-supra-conductor does not necessarily have a unique transition temperature. Thirdly, it was found that with the alloy systems, silver-tin, gold-tin, gold-lead, the transition temperatures were higher for eutectic mixtures than for chemical compounds of the two metals constituting the alloys. The data compiled in Table I will serve to illustrate these points. The element silver and the compound Ag_3Sn, it will be seen, have not been found to be supra-conductors at any temperature reached up to the present.

TABLE I

Tin-Silver Alloys

Substance	Mixture	Percentage of Tin	Transition temperature
Tin	Pure	100	3·76° K.
Silver and tin	Eutectic alloy	96	3·52° K.
Ag_3Sn + Sn	Eutectic alloy	50	3·57° K.
Ag_3Sn + 3 per cent Sn	Mixture	30	2·3° K.
Ag_3Sn	Compound	27	—
Silver	Pure	0·0	—

Mechanical Strains and Thermal Dilatation

The application of mechanical stresses such as those of torsion and tension raises the transition temperature of a supra-conducting metal, but observations made on the thermal dilatation of a lead rod showed no discontinuity when its temperature was lowered as it passed through the transition temperature, 7·2° K., from the ordinarily conducting to the supra-conductive state.

Action of a Magnetic Field

The application of a magnetic field delays the appearance of supra-conductivity and causes it to appear in a metal at a lower temperature than normally.

If a metal in the supra-conductive state be subjected to a gradually increasing magnetic field, a critical field strength is reached when electrical resistance re-appears in the metal. The strengths of the critical fields required for different supra-conductors vary; an alloy of bismuth and lead, for example, at 1·2° K. requires a magnetic field of 20,000 gauss to restore the property of electrical resistance, while metallic thallium at the same temperature requires a field of only 15 gauss.

Since the electrical resistance of supra-conductive metals is zero, no heat is produced when electrical currents are passed through them. Currents of high intensity can therefore be passed through supra-conductive wires of small diameter without melting them. Electric currents of more than 1,000 amperes have been so obtained in wires of small cross-section. The factor that imposes a limiting value upon the current strength is the magnetic field set up in the wire by the current itself. A critical value is reached when resistance is restored to the wire by the magnetic field.

Owing to the fact that metals in the supra-conducting state have no electrical resistance, currents of electricity induced in rings of metals in this state will persist with undiminished intensity so long as the metals remain supra-conductive. So far, it has been found impossible to detect with instruments of precision any diminution in the intensity of ring currents in supra-conductors even after the lapse of a period so long as thirteen hours.

Recently some experiments were carried out

by McLennan, Allen and Wilhelm on the intensities of persistent currents of electricity induced in rings having the same dimensions of lead, tin and tantalum, brought into the supra-conductive state by the use of liquid helium. The currents in the rings were induced by the magnetic field provided by electric currents established in a circular coil of wire placed in turn coaxial with and close to each of the supra-conducting rings. The results of these experiments are represented by the graph shown in Fig. 1. It was found that, for the weaker magnetic fields, equal changes of flux produced currents of equal magnitude in each of the three supra-conductors. The magnitude of the persistent current developed depended not on the substance of the supra-conductive ring but only on its dimensions and on the magnitude and form of the inducing magnetic field.

The case of tin is very interesting, since the values of the current in it agree with those of the current in the others only up to fields of about 25 gauss. For inducing fields higher than this amount the strength of the persistent current dropped off. Above this point, then, part of the ring must have been in a magnetic field, the strength of which had reached the critical value where resistance re-appeared, that is, an inner layer of the ring must have become non-supra-conductive. As the field was increased above this point, one can suppose the outside supra-conductive portion of the ring became thinner and thinner until the whole ring became non-supra-conductive.

The fact that the same flux engenders the same persistent current in different supra-conducting metals having the same size and form follows from an application of the equation

$$L\frac{di}{dt} = \frac{dB_A}{dt} \quad \text{or} \quad i = \frac{B_A}{L}$$

For rings of the same dimensions, the self-inductances would be identical; and in the supra-conducting state the resistances of the three metals would be vanishingly small. Self-induction and zero resistance were the two factors that made the magnitude of the induced current in different supra-conductors the same.

Looking at the matter in another way, we see that the induced currents in the three supra-conductors must be the same since the magnetic field of the persistent current must be equal in magnitude and distribution but opposite in direction to the flux of the exciting field.

Alternating Fields

Since the discovery of the phenomenon of supra-conductivity in metals by Kamerlingh Onnes in 1911, researches in this field have been until recently almost invariably carried out by the use of unidirectional electric currents. No systematic attempt appears to have been made hitherto to investigate the phenomena of supra-conductivity with alternating electric currents of high, medium and low frequencies.

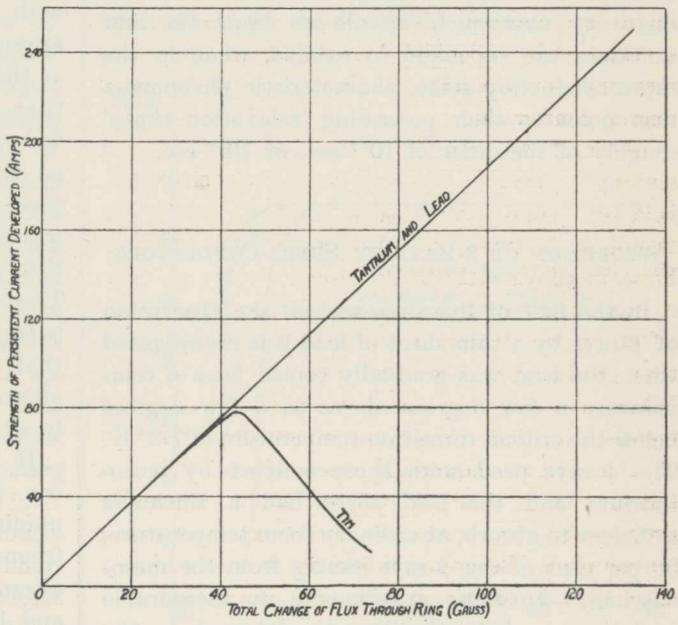

Fig. 1.

Some of the theories[2] put forward to explain supra-conductivity suggest that an orientation of some kind is involved in the production of the supra-conducting state in metals. If this suggestion should prove to be correct, one would expect some modification of the phenomenon for currents of high frequency. It need only be mentioned that all 'orientation' effects are considerably modified in an oscillating field with a time-period of the order of, or less than, the 'time of relaxation' of such orientation. A well-known example is that of the dielectric constant, which rapidly diminishes in value for very high-frequency electric fields. As to 'relaxation times', it will be recalled that in the case of ice, experimental evidence shows

that the relaxation time is of the order of 10^{-6} sec. at 0° C. and rapidly increases as the temperature is lowered.[3] It would not seem unreasonable then to expect to find 'relaxation times' exhibited by metals in the supra-conducting state, provided one used in one's experiments alternating fields of suitable and adequate frequencies. A short time ago an investigation was initiated in this direction by McLennan, and through a set of researches carried out successively with the collaboration of a number of his associates, namely, Niven, Wilhelm, Burton, Allen, Smith, McLeod and others, the work recently culminated in the discovery that such metals as lead, tin and tantalum can be made to exhibit, when in the supra-conducting state, characteristic phenomena that point to their possessing 'relaxation times' roughly of the order of 10^{-7} sec. or 10^{-8} sec.

Absorption of β-Rays by Supra-Conductors

In the first of these researches[4] the absorption of β-rays by a thin sheet of lead was investigated when the lead was gradually cooled from a temperature a few degrees above to a few degrees below the critical transition temperature of 7·2° K. The β-rays used were those emitted by mesothorium and the lead sheet had a thickness sufficient to absorb, at ordinary room temperature, 50 per cent of the β-rays issuing from the mesothorium. In these experiments no measurable variation or discontinuity was detected in the absorption coefficient as the temperature of the lead was lowered through the critical value 7·2° K. The high-velocity electrons from the mesothorium apparently encountered just as much resistance in their passage through the lead with the latter in the supra-conducting state as when the lead possessed the normal conductivity exhibited at the higher temperatures. This investigation gave definite proof that although resistance in the supra-conducting state is zero, or a very low value for currents carried by slow-moving electrons, it is not zero but maintains a normal value for currents carried by high-speed electrons.

Looking at the matter in another way, this result indicates, if the de Broglie wave equation $p = h/mv$ applies, that lead at the lowest temperatures cannot exhibit supra-conductivity when subjected to alternating electric fields with frequencies of the order of 10^{21} per sec.

Photoelectric and Light Absorption Experiments

In a second series of experiments,[5] thin films of lead were deposited on plates of glass and of quartz, sometimes by cathode spluttering and at other times by vaporisation of metallic lead. These films were subjected to a series of decreasing temperatures commencing a few degrees above 7·2° K. and ending at the temperature of liquid helium, 4·2° K. The photoelectric effect and the absorption of visible light were in turn investigated with these films and measurements were taken approximately by steps of a fraction of a degree as the temperatures of the films were lowered. In these experiments no measurable discontinuity was observed in the results of the measurements on the photoelectric effect, or in the results of those on the coefficient of absorption of the light waves when the lead films traversed were passed through the transition temperature of 7·2° K. These results were taken therefore to indicate that supra-conductivity with lead is a phenomenon that cannot be exhibited when electric fields alternating with a frequency approximately equal to or greater than 10^{14} per second are used.

It is clear, however, since supra-conductivity can be brought into evidence by the use of unidirectional fields, that is, with fields of zero frequency, that there must exist some critical alternating field with a frequency between zero and 10^{14} per second, by the use of which supra-conductivity should just be detectable.

Experiments with Electric Fields of Radio-Frequencies

Through the development which has taken place in recent times, it is a comparatively simple matter to arrange combinations of oscillating valve systems capable of providing alternating electric fields with frequencies so high as 10^{7} or even 10^{8} per second. Some experiments were therefore made with radio fields having frequencies approximating to 10^{7} cycles per second and corresponding to a wave-length of about 30 metres. With fields of this frequency, it was thought that the phenomenon of supra-conductivity might appear with lead at a lower temperature than 7·2° K., might even be only partial, or might not appear at all. The experiments[6] and apparatus used, together with the theory applicable, have been

fully described elsewhere and it will suffice to give here only a summary of the results obtained.

It was found that with currents of frequency $1{\cdot}1 \times 10^7$ per second a coil of lead wire showed an abrupt loss of resistance, of relatively large amount, at a temperature that appeared to be slightly lower than the critical temperature 7·2° K. characteristic of the transition to supra-conductivity, found for the same wire with direct current.

In a series of repeated experiments with a coil of tin wire, drawn to a diameter of 0·3 mm., it was found that with direct currents the resistance of the coil began to decrease abruptly at 3·76° K. and disappeared completely at 3·70° K. Experiments with the same coil with currents of frequency $1{\cdot}1 \times 10^7$ per second gave for the corresponding temperatures 3·67° K. and 3·61° K., that is, supra-conductivity did not begin to appear until a temperature was reached that was below the one at which it was complete in the case of the direct current experiments. Further experiments with higher frequencies revealed depressions of the critical transition temperature increasing in amount with the frequency. Extrapolation of the transition temperature – frequency curve, which appeared to be linear for the higher frequencies, gave 10^9 per second for the frequency corresponding to 0° K.

With tantalum wires and with wires of a bismuth-lead alloy, results were obtained similar in character to those found with wires of tin and of lead. Experiments with tin wire coils showed that the observed depression of the critical temperature was not dependent upon the magnitude of the high-frequency currents in the coils and was therefore attributable neither to the heating of the coils above the temperature of the surrounding liquid helium, nor to the effect of the magnetic field of the currents. Experiments with wires of different sizes made with currents of the same frequency showed that the depression of the transition temperature was not a direct function of the skin effect. It would appear, then, to be a function of the frequency of the current in the metal alone.

Experiments with Simultaneous Direct and Alternating Currents

Some interesting results have been obtained by passing direct and alternating currents simultaneously through supra-conductors.

In one of these experiments a tantalum conductor in the form of a solid wire was used. The graph given in Fig. 2 shows the results obtained. The magnitude measured was the direct current resistance, and the curves show that the presence of the high-frequency currents delayed the initial appearance of the approach to the supra-conducting state and enhanced the direct current resistance in the transition stages. The temperature at which supra-conductivity was complete according to the D.C. measurements was not, however, affected by the presence of the high-frequency current in the wire. This was due, of course, to 'skin effect', for the disturbing action of the high-

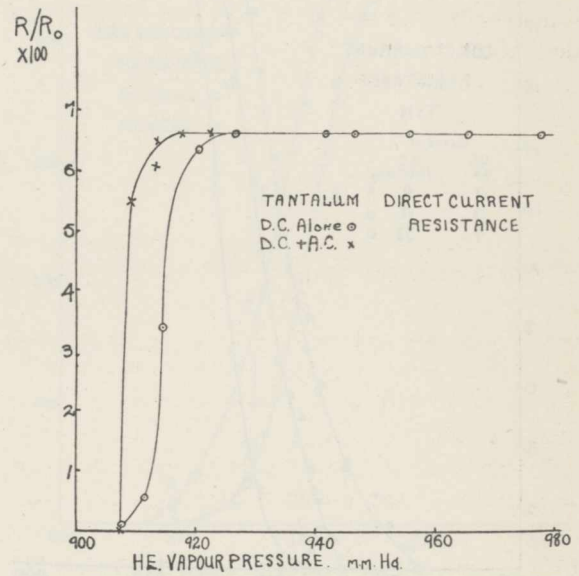

FIG. 2.

frequency currents when the wire was at a sufficiently low temperature to be supra-conducting for D.C. measurements was confined entirely to the outer layers of the wire.

In another experiment which was rather instructive, a conductor was constructed by 'wiping' a layer of block tin upon a constantan wire, of diameter 0·016 cm. The tin skin was of average thickness about 1/500 mm., and its presence decreased the resistance of the wire at room temperature by about seven per cent. Calculation shows that at the low temperatures just above the supra-conducting point the resistance of the constantan was then about thirty times that of the tin.

The results of measurements made with this wire are shown by the graphs of Fig. 3, which represent the relation between the direct current

resistance ratio R/R_0 and the temperature, both without high-frequency currents present, and with the high-frequency and direct currents flowing simultaneously in the metal.

It can be seen that when, in addition to the direct current, high-frequency currents were passed through the wire, the resistance was changed so that the curve AB first obtained was shifted to lower temperatures, becoming the curve $A'B'$. The switching on and off of the high-frequency generator changed the resistance reversibly from

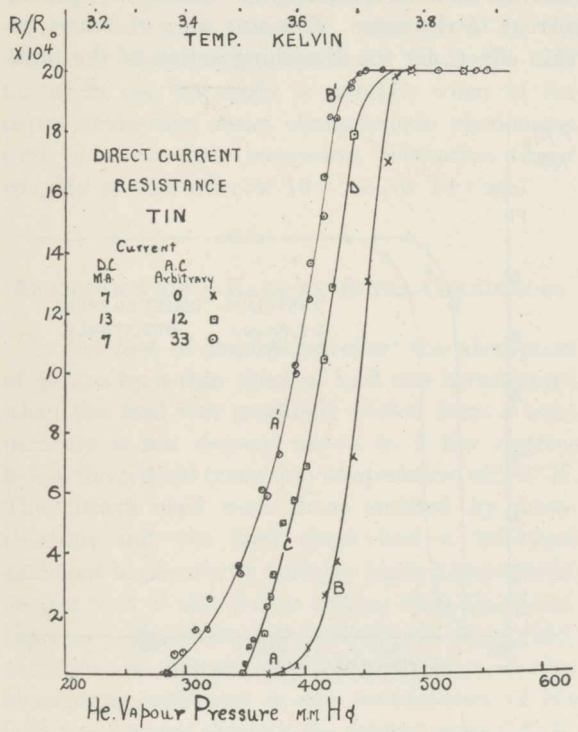

FIG. 3.

the point A to A', B to B' and so on. The magnitudes of the shifts A to A' and B to B' increased, as the curves show, with an increase in the ratio of the strength of the high-frequency current to that of the D.C. one. Even when the resistance had become zero on the undisturbed curve it could be partially restored to the tin layer by switching on the alternating current. Moreover, the curves clearly show that the presence of alternating high-frequency currents in the tin coating on the wire had the effect of lowering the temperature at which with D.C. measurements the tin layer became supra-conducting.

It may be of interest to state that when observations were made with this tin-coated wire on the resistance it offered to high-frequency currents, it was found that the addition to it of a direct current had the effect of removing partially or wholly the high-frequency resistance. The graphs in Fig. 4 illustrate this point.

The results of the experiments with high-frequency alternating currents would seem to justify the conclusion that a polarisation or orientation phenomenon of some kind must be involved in the production of the supra-conducting state in metals.

In the discussion, Prof. W. J. de Haas expressed the view that it seemed probable that the electrons go over into a new phase when the metals become supra-conductive, and in order to support this view certain experiments had been carried out by him and his associates on the conductivity of single crystals. Formerly the region of disappearance of resistance was about 0·03°, but he had found that for good single crystals and small measuring currents this region did not exceed 0·0005°. He and his associates had investigated the influence of the crystal lattice on grey and white tin, which differ only in this respect that grey tin does not show supra-conductivity, while white tin does. Gold-bismuth alloys show the same influence—the alloy becomes supra-conductive though neither of the components do. X-ray experiments, however, showed that this alloy has a crystal lattice of its own.

Investigations of the thermal conductivity of supra-conductors shows an influence of the supra-conductive state. At the transition point, indium shows a small sudden increase of thermal conductivity. When the supra-conductivity is disturbed by a magnetic field, the thermal conductivity is increased for pure metals. The results for $PbTl_2$ are very complicated, probably as a result of the lack of homogeneity of the alloy. The specific heat of tin increases when the metal becomes supra-conductive. In a magnetic field high enough to disturb supra-conductivity, this increase disappears.

Prof. O. W. Richardson pointed out that there is some resemblance, even though it may be only superficial or accidental, between supra-conductivity and ferromagnetism. Following this idea, Keesom and his associates at Leyden have measured the specific heat of supra-conductors in the neighbourhood of the critical point, where one might expect an abnormality similar to the abnormality in the specific heats of ferromagnetic substances in the neighbourhood of the Curie point; but no such effect could be detected. This, however, is not entirely conclusive. The

number of electrons concerned in the supra-conductive phenomenon may be too small a fraction of the total number, or of the number of atoms present, to exert any appreciable influence on the specific heat, or, alternatively, there may be some compensating effect on the atoms which may counterbalance any changes in the specific heat of the whole substance arising from changes in the energy of the electrons.

Dorfman has pointed out that a test which is in some respects a more direct one of this particular issue can be made if the specific heat of electricity (Thomson effect) in the supra-conductive region of temperature is considered. The magnitude of this effect can be deduced from the thermoelectric measurements of Keesom and his associates which refer to lead and tin. These show that there is such an abnormality in the Thomson effect. It is true that it does not occur exactly at the supra-conductive critical temperature. For example, in the case of lead this critical temperature is 7·2° K.; whereas the anomaly in the Thomson effect sets in at about 5° K. and rises to a maximum at a little above 10° K., after which it falls. This anomaly is quite similar to the corresponding anomaly in the case of ferromagnetic substances near the Curie point.

If it is admitted that this anomaly in the Thomson effect is associated with the establishment of supra-conductivity, it is a natural inference that it is a result of the change in the energy of an electron connected with this phenomenon. On this basis, the thermoelectric data enable the difference ΔW_0 between the energy of a supra-conducting and a non-supra-conducting electron to be estimated. The interesting fact then emerges that, approximately,

$$\Delta W_0 = \mu H_0 = h\nu_0$$

where μ is the spin moment of the electron, H_0 the magnetic field necessary to destroy the supra-conductivity, h is Planck's constant, and ν_0 McLennan's destructive frequency; ΔW_0, H_0 and ν_0 are all extrapolated to the absolute zero of temperature. In other words, the magnetic energy and the vibrational energy required to break up the supra-conductive structure are each approximately equal to the energy of the structure itself.

Dr. W. Meissner described experiments in which very slow-moving electrons are made to impinge upon a sheet of tin-foil at temperatures both above and below the transition temperature of tin, 3·7° K. His object was to see whether the foil when supra-conductive is transparent to such slow-moving electrons. It was found not to be so, although by his experimental arrangements the velocities of the impinging electrons after their entrance into the tin-foil were probably not greater than the velocities with which the conducting electrons in the metal, according to recent theories, are supposed to be endowed.

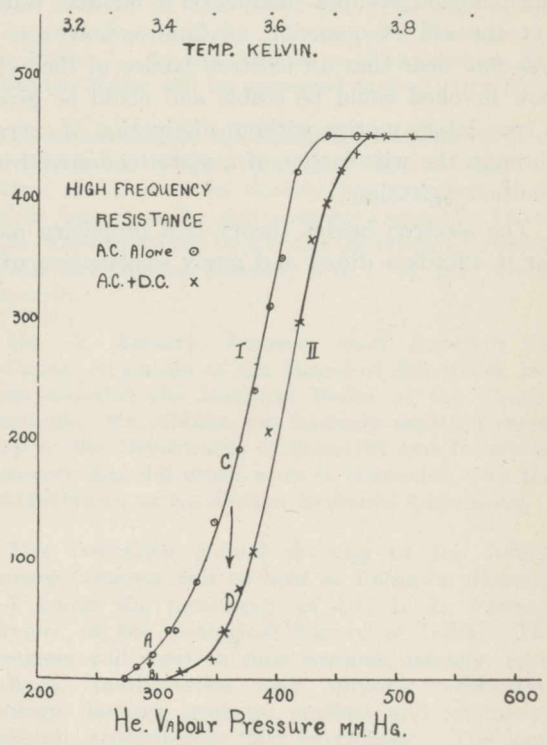

FIG. 4.

Electron Lattice Theory

Interest in the problem of supra-conduction in metals has been stimulated recently by a view put forward independently by Prof. Niels Bohr, of Copenhagen, and by Prof. R. de L. Kronig, of Groningen, in communications to McLennan. The essential feature of this view is that the conducting electrons in a metal are supposed to form a crystal lattice of their own in addition to that formed by the atom-ions of the metal.

According to quantum mechanics, it appears that this electron lattice can move through the wire lattice without dissipation of energy even when the wire lattice is in thermal agitation. In other words, the metal will be supra-conducting whenever the electron lattice exists.

On this view of supra-conductivity, the transition point or temperature at which the metal passes from the supra-conductive state to the ordinary conducting one may be interpreted as the melting point of the electron lattice. The view that the conducting electrons in metals may build a lattice has already been put forward by Prof. F. A. Lindemann[7] and the suggestion was made both by him and by Sir J. J. Thomson that this idea may provide a basis for an explanation of the phenomenon of supra-conduction in metals. Without the aid of quantum mechanics, however, it was not clear that an electron lattice of the type now invoked could be stable and could be given a translatory motion without dissipation of energy through the wire lattice of a metal endowed with thermal agitation.

The electron lattice theory is a promising one, for it affords a direct and ready explanation of a number of the phenomena associated with supra-conduction in metals. The final verification of the theory will probably be reached through a study of the conductivity of single crystals of metals at the lowest temperatures. As de Haas has indicated, investigations have been begun already in this direction.

[1] *Phil. Mag.*, 5, **36**, 271; 1893.

[2] For example, Sir J. J. Thomson, *Phil. Mag.*, 6, **30**, 192; 1915; and Richardson, *Phil. Mag.*, 6, **30**, 295; 1915. Ashworth, *Phil. Mag.*, 6, **27**, 357; 1914; and *Phil. Mag.*, 6, **36**, 351; 1918.

[3] Errera, *J. Phys.*, 6, **5**, 304; 1924; J. Granier, C.R. Acad. Sci., **179**, 1,314; 1924; Debye and Wentsch, see "Polar Molecules", by Debye, p. 102, pars. 20 *et seq.*

[4] McLennan, McLeod and Wilhelm, *Trans. Roy. Soc. Canada*, 3, **23**, Sect. III, 269; 1929.

[5] McLennan, Hunter and McLeod, *Trans. Roy. Soc. Canada*, 3, **24**, Sect. III, p. 3; 1930; McLennan, Burton, Pitt and Wilhelm (Footnote), *Phil. Mag.*, 7, **12**, 708; 1931; McLennan, Smith and Wilhelm, *Phil. Mag.*, 7, **12**, 835; 1931.

[6] McLennan, Burton, Pitt and Wilhelm, *Phil. Mag.*, 7, **12**, 707; 1931; *Trans. Roy. Soc. Canada*, 3, **24**, Sect. III, 191; 1931; NATURE, **128**, 1004; 1931; and *Proc. Roy. Soc.*, A, **136**, 52; 1932. *Proc. Roy. Soc.*, A, **138**, 245; 1932.

[7] *Phil. Mag.*, 6, **29**, 127; 1915.

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work on the taxonomy of Hymenomycetes. Mycological classification is emerging from a state of chaos, and the student or amateur will be able to orientate much knowledge which formerly puzzled him. The address is published in the *Transactions* of the Society (vol. 17, pp. 16–34, 1932) and will serve as a valuable guide to the most important literature on the subject.

Physical Society's Exhibition

THE twenty-third annual exhibition of scientific instruments and apparatus, arranged by the Physical Society, will be held on January 3–5 at the Imperial College of Science and Technology, South Kensington, S.W.7. It will be open in the afternoons from 3 P.M. until 6 P.M. and again in the evenings from 7 P.M. until 10 P.M. The leading manufacturers of scientific instruments will be exhibiting their latest products in the Trade Section. The Research and Experimental Section will contain contributions from most of the important research laboratories in Great Britain, and there will be a special sub-section devoted to experiments of educational interest. In addition, the work submitted for the craftsmanship competition by apprentices and learners will be on view. Discourses will be delivered each day at 8 P.M. as follows: January 3, Dr. Allan Ferguson: "Surface Tension and its Measurement"; January 4, Mr. R. A. Watson Watt: "Cathode Ray Oscillography"; January 5, Mr. F. Hope-Jones: "Time Measurement: Old and New". Members of institutions and scientific societies may obtain tickets from their secretaries; tickets may also be obtained from the Exhibition Secretary, 1, Lowther Gardens, Exhibition Road, S.W.7. Admission on January 5 will be free, without ticket.

Announcements

THE Buchan prize of the Royal Meteorological Society for 1933 has been awarded to Mr. David Brunt, for papers contributed to the *Quarterly Journal* and *Memoirs* of the Society during the years 1927–31.

PROF. G. ELLIOT SMITH, professor of anatomy in University College, London, has been appointed Fullerian professor of physiology at the Royal Institution to succeed Prof. J. B. S. Haldane, whose tenure of office expires next January.

THE Lawrence research studentship of the Royal Society has been awarded to Miss P. A. Clapham, who proposes to work at the London School of Hygiene and Tropical Medicine on helminthic infestation and nutritional deficiency.

A DISCUSSION on "The Chemistry of the Sterols and Bile Acids", to be opened by Prof. I. M. Heilbron, H. Harrison professor of organic chemistry in the University of Liverpool, will be held at the Chemical Society on Thursday, December 15, at 8 P.M.

DR. ULICK R. EVANS has been elected to the research fellowship in metallurgy of the Armourers and Brasiers' Company, in succession to Dr. W. Hume-Rothery. The award is made by a joint committee of the Royal Society and the Armourers and Brasiers' Company.

MR. COLIN HARDIE, fellow and classical tutor of Balliol College, Oxford, has been appointed to succeed Mr. Arthur Hamilton Smith as director of the British School at Rome as from January 31, 1933.

SIR HENRY DALE, director of the National Institute for Medical Research, will deliver the Harrison memorial lecture of the Pharmaceutical Society of Great Britain on December 13. The title of Sir Henry's lecture will be "Therapeutic Problems of the Future". At the conclusion of the lecture, the Harrison Medal will be presented to Sir Henry Dale.

To commemorate the bicentenary of the birth of Sir Richard Arkwright, inventor of the yarn spinning frame, the Newcomen Society has arranged for a public lecture to be delivered on December 14, at 5.30. The lecture will be given at the Science Museum, South Kensington, London, S.W.7, by Mr. Frank Nasmith.

MR. A. ABBOTT, formerly chief inspector for technical education at the Board of Education, has been awarded the Institute Medal of the Textile Institute. Mr. Abbott was formerly assistant secretary to the Department of Scientific and Industrial Research and did much work in connexion with the establishment of the Cotton Research Association.

THE twentieth annual meeting of the Indian Science Congress will be held at Patna on January 2–7 under the presidency of Dr. L. L. Fermor, director of the Geological Survey of India. The Congress will meet in nine sections, namely, agriculture, mathematics and physics, chemistry, zoology, botany, geology, medical and veterinary research, anthropology and psychology. The local secretaries are Dr. K. S. Caldwell and Prof. Kamta Prashad, both of the Science College, Patna.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant teacher of engineering science, handicraft and drawing at the Radcliffe Technical College—The Secretary of Education, Town Hall, Radcliffe, near Manchester (Dec. 14). An executive engineer and an assistant engineer (mechanical) to the Government of Madras for harbour works at Cochin—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Dec. 23). A public analyst to the City of St. Albans—The Town Clerk, Municipal Offices, St. Albans (Dec. 31). A principal at the Handsworth Technical College—The Chief Education Officer, Education Office, Margaret Street, Birmingham (Dec. 31). A University reader in psychology at Bedford College, London—The Academic Registrar, University of London, S.W.7 (Jan. 26). A University reader in physiology at Guy's Hospital Medical School—The Academic Registrar, University of London, S.W.7 (Feb. 17).

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hexuronic Acid as the Antiscorbutic Factor

A CHARACTERISTIC property of Prof. Szent-Györgyi's hexuronic acid is its behaviour towards iodine. Two atoms of iodine are taken up in aqueous solution (neutral or acid) with formation of two molecules of hydrogen iodide. We find that this is due to oxidation at a double bond. The intervention of water is essential and the product, which is not a di-iodide, can be reduced to hexuronic acid. Regeneration of hexuronic acid occurs only when the aqueous solution of the oxidation product is reduced, for example, by evaporation in the presence of hydrogen iodide.

The biological activity of the acid is probably due to this double function of oxidation and reduction which, unique among purely carbon compounds, is reminiscent of the behaviour of glutathione. The product obtained by the action of neutral iodine on the acid undergoes further oxidation by sodium hypoiodite. One atomic proportion of oxygen is absorbed, two new carboxylic acid groups are formed and oxalic acid (1 mol.) is produced quantitatively. Acid permanganate introduces one atom of oxygen into hexuronic acid with extreme readiness and thereafter oxidation proceeds more slowly with elimination of carbon dioxide until three atoms of oxygen have been absorbed. This leads to the formation of a trihydroxy butyric acid (possibly *d*-threonic) which has been isolated as the optically active crystalline amide $CH_2OMe.CHOMe.CHOMe.CONH_2$. When heated with hydrochloric acid hexuronic acid gives furfural in quantitative yield. These observations suggest that hexuronic acid (which, from analysis of its salts we have proved to be a monobasic acid $C_5H_7O_4.COOH$ and not a lactone of an acid $C_5H_9O_5.COOH$) has the structure $COOH.CO.CO.CH_2.CHOH.CH_2OH$.

The following observations which we have made are consistent with this view. Hexuronic acid forms a di-phenyl-hydrazone $C_6H_8O_4(:N.NHPh)_2$, also a hydrated di-(*p*-bromo-phenylhydrazone), and reacts slowly at 15° with *o*-toluylene diamine giving a well-defined condensation product. The sodium or calcium salt of hexuronic acid gives an intense violet colour with ferric chloride but with the free acid the coloration is fleeting. The sodium salt gives with sodium nitroprusside a deep blue colour, changing to green and then red. The acid and its salts show an intense absorption band with head at about 265 mμ.

Hexuronic acid contains one carboxyl and three potential hydroxyl groups (alcoholic or enolic) and gives a triacetate and a trimethyl ether which both reduce neutral permanganate. When heated at about 175° the acid loses carbon dioxide without darkening or melting (when heated rapidly the pure acid melts at 192°). Whilst the acid has $[\alpha]_{5780} + 24°$ in water the sodium salt has a much higher rotation, +105° in neutral solution, +135° in *N*/10 alkali, (keto-enol transformation). Hexuronic acid appears to be incapable of forming a lactone and its solutions do not display mutarotation. The slow change ($[\alpha]_{5780} + 24° + 31°$) which occurs with aqueous solutions in glass vessels is due to partial neutralisation of the acid by alkali dissolved from the glass. Alkaline solutions of the acid are stable in the absence of oxygen.

These observations indicate the presence of an optically active diketo-acid containing a $-CH_2-$ group. These groups must be united in such a way that the stringent requirements of the crystallographic and X-ray data are satisfied. It is essential, for example, that the carbon and oxygen atoms (with one exception) should lie in a plane and that the length and breadth of the molecule should be 8·8 and 6·1 A. respectively. A critical survey of various possibilities from the chemical, optical and X-ray data has led us to the conclusion that the properties of hexuronic acid are best accounted for by the above structure. This can react also in the enolic modification, $CO_2H.CO.C(OH)=CH.CHOH.CH_2OH$.

We have examined (with R. W. Herbert) the absorption spectrum of de-citrated lemon juice and have estimated that the hexuronic acid content corresponds with the recorded evaluation of the antiscorbutic activity of isolated hexuronic acid.

E. G. Cox.
E. L. HIRST.
R. J. W. REYNOLDS.

Chemistry Department,
The University,
Edgbaston, Birmingham.
Nov. 22.

A Peculiar Visual Experience

WHILE I was engaged in flashlight colour photography, using large charges of magnesium and the ordinary touch-paper method of ignition, the fuse on one occasion apparently failed to act, but, just as I was about to replace it, the flash took place. My head was less than a foot above the explosion point, and the flame must have reached my face, as my eyebrows and hair were singed, and my spectacles were completely coated with a dense, firmly adherent film of magnesium oxide.

My subsequent visual sensations were as follows: for an indeterminate period, which, after making generous allowance for subjective impressions, I would estimate at about twenty seconds, there was a complete 'black-out'. After this period (during which I removed my glasses and rubbed my eyes) I observed the filament of a 100 watt gas-filled lamp, about three feet distant and screened by a thin orange silk shade, which appeared as a bright red line. In about twenty seconds more (this and subsequent times were taken with a watch) I could distinguish general details of the furniture of the room, which was fairly well lighted, in red monochrome. The colour changed from deep maroon to light claret in about fifteen seconds, and then to an orange shade in about ten seconds more, but a prominent red object retained its normal shade. Then the background and white objects changed suddenly—too quickly for the time to be observed—to a green, at first olive, afterwards brightening to emerald. This stage lasted nearly twenty seconds, and it was noted that the red and orange objects appeared in their natural colours. The green shade then faded away rapidly, and the whites, after a slight intermediate yellow tinge, appeared for the first time. The total illumination appeared to

increase steadily over the whole period of about ninety seconds; examination of the pupils showed that they were still abnormally contracted at least two minutes after the flash took place. Owing to nervous reaction, I am unable to state whether further after-images or colour changes occurred.

I presume that the flash had reached its maximum intensity before the pupil or eyelid reflex could operate, and that the eye was exposed to a very powerful beam of strongly actinic light. The peculiarity was that colour sensation was regained discontinuously, and not in the spectral order that might have been expected. The failure to observe any blue phase in the after images, as described by Washburn[1] and McDougall[2] in their experiments where the eye was exposed to white light of moderate intensity, is readily explicable; but the change in the red shade and the sharp succession of the green, followed by the yellow, is much more difficult to comprehend. I should be interested to know if it can be satisfactorily explained on the existing theories of colour vision, and whether other experiences of similar causation and result have been observed.

University College, Gower Street, London, W.C.1. K. MACKENZIE.

Nov. 7.

[1] M. F. Washburn, *Psychol. Rev.*, **7**, 39; 1900.
[2] W. McDougall, *Mind*, **10**, 235; 1901.

Records of Pelagic Animals in Scottish Waters

IN their interesting letter to NATURE (Oct. 29), Dr. Stanley Kemp and Dr. F. S. Russell refer to the abnormal distribution of certain pelagic animals during the current year as pointing to unusual hydrographic conditions. In Scottish waters also, conditions seem to have been somewhat disturbed, judging by the occurrence of certain other animals.

Whales and dolphins appear to have been specially plentiful if the record of stranded specimens bears any relation to the actual numbers present in the adjacent sea. Already this year ten specimens have been reported,[1] while in 1931, 1930 and 1929 the numbers were four, none, and three respectively. The most interesting was a young white whale, *Delphinapterus leucas*, a rare arctic visitor, taken in the Firth of Forth.

Early in November, also, a long-finned tunny (*Thynnus germo*) was taken at Lochgoilhead in the Firth of Clyde. (Full details will appear in the next number of the *Scottish Naturalist*.) Apparently, this is only the second record of this southern species in Scottish waters.

The Royal Scottish Museum, Edinburgh, 1. A. C. STEPHEN.

Nov. 11.

[1] *Scot. Nat.*, p. 163, 1932.

Fixation of Mitochondria

IT has been known for many years that Carnoy, Gilson, Petrunkevitch, corrosive acetic, Bouin, and a host of ordinary fixatives will enable remains of mitochondria to be demonstrated with staining in alum hæmatoxylin or acid fuschsin. This applies especially to cytoplasmic inclusions when aggregated as in the spermatogonium, or in the mitochondrial *nebenkerne*. Mitochondria often show nicely after acetic acid containing fixatives such as the 'Susa' mixture or Flemming with acetic acid. This applies especially to all vertebrate tissues. With most invertebrate tissues such methods are deadly, and if mitochondria remain they are almost certainly badly distorted. Practically all the beautiful work of Meves was done with acetic acid containing fixatives. This is why he left so much to be done by those who followed.

Bouin's fluid contains formalin, which often enables surprisingly good results to be obtained with this fixative, and in the case of bulky insect or other testes, the concentration of acetic acid in this fixative becomes lessened as the innermost parts of the tissue are reached. In any event, the objection to acetic acid is that if it does not dissolve much of the cytoplasmic bodies, it distorts them badly ("Vademecum" § 697). Scorpion spermatocyte mitochondria are completely wrecked by Flemming with acetic and only occasionally properly 'set up' for passage through the alcohols and xylol, by using Flemming without acetic. Post-chroming for such objects is very necessary ("Vademecum" § 710). In some cases for staining, the post-chroming may be delayed until the sections are actually in the slide. This was done in the case of Duesberg's beautiful paper on the relationship between the organ-forming substances and the cytoplasmic inclusions in the ascidian egg. It might be possible, as Dr. John Baker has suggested[1], to develop the technique of post-chroming Bouin (without acetic) material so as to get material up to a research standard ("Vademecum" § 710). The advantage of this is that formalin and picric acid are cheap and easily transported, whereas the osmic and silver methods are tricky. Some years ago, I got a number of *Lepidosiren* sent over from the Chaco in a tin of Bouin without acetic. The fixation was splendid but there was no spermatogenesis in progress. The fluid had eaten the tin only slightly, and the discoloration of the Bouin, when the tin was opened, did not appear to have damaged the fishes. In the case of these *Lepidosiren*, post-chroming did not improve the staining of the mitochondria, nor did it bring out the Golgi bodies. For these the proper methods are the only satisfactory ones.

Trinity College, Dublin. J. BRONTË GATENBY.

Nov. 16.

[1] NATURE, **130**, 741, Nov. 12, 1932.

Hybridism in Eels

IN New Zealand there are two species of eel recognised by J. Schmidt.[1] These are the short-finned eel, *Anguilla australis*, and the long-finned eel, *Anguilla aucklandii*. Latterly I have shown that *Anguilla aucklandii* must become *Anguilla dieffenbachii* on the grounds of priority.[2] Sexes of eels keep apart in our fresh water and in the migration seawards of eels in the autumn this segregation of the species is usually most marked. The male in both species is small, while females are much larger, the last to migrate seawards being the large female *A. dieffenbachii*, which generally measure more than 5 ft.

Schmidt has noted that in *australis* the vomerine band of teeth is pear-shaped, and in *dieffenbachii* this band tapers well back on the roof of the mouth as far as the maxillary band. Another feature noted also by Schmidt is the fact that the angle of the mouth in *dieffenbachii* extends back beyond the eye whereas in *australis* this angle is stated to be approximately below the hind margin of the eye. Larval *dieffenbachii* sent to me some years ago from Mataura

Falls, Otago, have the angle of the mouth reaching only to under the centre of the eye. As this is the large-mouthed species of eel, it is possible that we have here a hybrid with the mouth of *australis* and the fins of *dieffenbachii*.

In April 1932, I had the opportunity of visiting Lake Ferry, Wellington, through which many eels run in the seaward migration. Among a number of male long-finned eels, I found a female of the short-finned species which was caught with them. This example is 35·7 in. long, and has the fins and small mouth as in *A. australis*; but the teeth are as in *A. dieffenbachii*. The vomerine band is widest about the centre and tapers well backwards reaching nearly as far back as the maxillary bands. While this tapering band of teeth does not reach quite so far back as it should to be exactly true to *dieffenbachii*, it is certainly not pear-shaped and is close enough to that species in this important respect. I can only conclude that the eel which I have mentioned is a hybrid between our two common species, thus shedding new light on the species problem of *Anguilla* throughout the world.

Dominion Museum, Wellington, New Zealand. W. J. PHILLIPPS.

[1] *Trans. N.Z. Inst.*, **58**, 379–388; 1928.
[2] *N. Z. J. Sci. and Tech.*, **13**, No. 4, 228; 1932.

Priapulus caudatus in New Zealand Waters

THE antarctic variety of this northern species of *Priapulus*, whether it be called *tubercule-spinatus* Baird or *antarcticus* Michaelsen, is confined, according to recent authorities, to the most southern seas; for example, off Tierra del Fuego, Patagonia, South Georgia, Falkland Is., Graham area, Cape Adare, Kerguelen.

Early in this year I received from Mr. A. B. W. Powell, the conchologist at the Auckland Museum, a collection of polychætes dredged in the harbour at that city, and in one of the phials I found to my intense surprise a small specimen of *Priapulus* measuring about one inch in length. It is well preserved and exhibits the characteristic arrangement of the spines or teeth described by Theel and so beautifully figured by his artist. It was obtained at a depth of 8 fathoms in Islington Bay, Auckland Harbour, associated with *Terebellides stroemi*, *Lanice conchilega*, and *Lagis australis*; the bottom was of black gritty mud.

As the variety has never been recorded from so far north it seems worthy of record in NATURE.

University Museum, Dunedin, N.Z. WM. B. BENHAM.

Oct. 12.

Chemical Composition of the Animal Body

IT is customary to express the results of an ultimate analysis as mass percentages, thus: oxygen, 65 per cent; carbon, 18·25 per cent; hydrogen, 10 per cent, and so on. But, on modern views, the chemical activities of these elements do not depend on the nuclear masses of the atoms but on their outer valency electrons. Therefore the chemical composition of, say, clupein (the protamine of the testis of the herring) is best expressed as $C_{30}H_{57}N_{17}O_6$, or by some such empirical formula. When the results are stated in this way it appears that the order of abundance of the chemical elements in an animal body *is directly proportional to their atomic numbers, so that the characteristic organic element is hydrogen.*

Some interesting speculations are suggested whenever one studies a recent statement of the Periodic Law with this relation in mind. Unfortunately there is no really good complete ultimate chemical analysis of the whole body of any one animal in the literature of physiology, and so it is impossible to be sure as to the order of abundance of oxygen and nitrogen, and of the elements sodium, potassium, etc., in the results. The empirical formulæ of most of the substances composing the tissues are known but it is difficult to 'weight' these numbers according to the proportions of the tissues in the whole body. Perhaps, also, the water in the tissues is really an organic constituent in the same sense as carbon is such a constituent. Is the order of abundance of the mass numbers of the isotopes of oxygen and nitrogen known in cases where these elements have been isolated from living organisms? Other questions immediately occur to one and it is plain that here there is something to be investigated.

JAS. JOHNSTONE.

University of Liverpool.
Nov. 19.

Magnetic Rotatory Dispersion and Absorption of the Cerous Ion in Solution

BECQUEREL and de Haas,[1] from their work on the magnetic rotation of the crystal tysonite, predicted that the Ce^{+++} ion possesses an intense paramagnetically active absorption band in the neighbourhood of λ 2370 A. This prediction was based on the assumptions that (1), although tysonite is a complex fluoride of Ce^{+++}, Pr^{+++} and Nd^{+++}, the only sensibly rotating ion is Ce^{+++}; (2) the rotation due to Ce^{+++} is controlled by a single absorption frequency. It occurred to us that it would be of interest to test the validity of this predicted property of the Ce^{+++} ion, by investigating the magnetic rotation of solutions of cerous salts in the visible and near ultra-violet regions of the spectrum.

By means of the polarimetric method of Bruhat and Pauthenier[2] (without using double monochromator) we have investigated at room temperature the magnetic rotation of three solutions of cerous sulphate in water, of strengths approximately 0·7, 2·7 and 4·4 per cent, for the mercury lines 5780, 5461, 4358, 4046, 3652, 3341 and 3128A. Our results for the dispersion of the specific magnetic rotation of cerous sulphate indicate the existence of two paramagnetically active absorption bands; a weak one in the neighbourhood of 300 mμ and a strong one in the neighbourhood of 240mμ. Our results are not sufficiently precise to determine with accuracy the wave-lengths of both these active bands; recourse must be made to absorption data.

Recently, the absorption of the Ce^{+++} ion in solution has been investigated by Bose and Datta,[3] who find in solutions of cerium trichloride in water a weak band at 2960A. and a strong band at 2550A. If we assume in our calculations the wave-length of the weak active band to be 296mμ, we find the value 239mμ for the effective wave-length of the strong band. It must be pointed out that this absorption band alone, although having a wave-length in close agreement with that obtained by Becquerel and de Haas, will not account for the ultra-violet dispersion of cerous sulphate as determined by us.

In comparison with the value 255mμ given by Bose and Datta for the position of the strong absorption band, the value 239mμ seems to indicate the presence of other absorption bands of the Ce^{+++} ion

having shorter wave-lengths than 255mμ. At our request, Dr. R. A. Morton kindly investigated the absorption spectrum of a solution of cerous sulphate in water. In addition to bands occurring at 296mμ and 254mμ, he found strong bands at 240mμ and 223mμ. As our value 239mμ is to be regarded only as an effective wave-length, and as, according to the absorption measurements, the intensities of the bands 254mμ, 240mμ and 223mμ are of the same order of magnitude, it would appear probable that all these bands are active. It must be mentioned that absorption bands with roughly these wave-lengths have already been found by Freed[4] in a mixed crystal of lanthanum and cerium ethyl sulphate.

In our calculations, we have neglected the dispersion due to the sulphate ion. As the characteristic frequency of this ion is very high compared with the frequencies considered, we should expect the contribution of this ion to the magnetic rotation to be very small. By means of further experiments we hope to be able to estimate the effect due to the sulphate ion.

R. W. ROBERTS.
L. A. WALLACE.

George Holt Physics Laboratory,
University of Liverpool.
Nov. 2.

[1] *Z. Phys.*, **57**, 11; 1929.
[2] *Rev. d'Opt.*, **6**, 163; 1927.
[3] NATURE, **128**, 270, Aug. 15, 1931.
[4] *Phys. Rev.*, **38**, 2122; 1931.

Gyromagnetic Effect in Some Ferromagnetic Powders

BOTH the gyromagnetic effects, namely, the production of (1) magnetisation by rotation, and of (2) rotation by magnetisation, have been applied to deduce the ratio of angular momentum to magnetic moment of the elementary magnet in ferromagnetics. The theoretical value of this ratio R for an orbital electron is $2m/e$ and for a spinning electron m/e. Results of observations on all ferromagnetics by the method of rotation by magnetisation gave values[1] of R exactly equal to m/e within very narrow limits of experimental error, which is less than one per cent for the metallic rods, and about five per cent for the powders investigated. Making use of the first effect, Barnett[2] found for the ferromagnetic metals values of R which, according to his estimate, are several per cent higher than the orthodox value for the spinning electron. This may mean that the orbital moment is also partly effective in producing ferromagnetism.

At the suggestion of Prof. D. M. Bose, I undertook in his laboratory the gyromagnetic study of a number of substances, among them some ferromagnetic powders. The method employed was the resonance method of Einstein and de Haas, and the apparatus was very similar to that used by Sucksmith.[3] The material was packed in a thin glass tube of length about 6 cm. and of diameter varying from 1·3 mm. to 2·3 mm.; the field applied was about 230 gauss and the vacuum method was employed to get increased resonance amplitude, which for the thinner tubes was about 3 cm. at a scale distance of 130 cm. The following results have been obtained:

	R
Fe_3O_4 (precipitated)	1·008 m/e
Fe_2O_3 (ferromagnetic)	1·016 m/e
NiO, Fe_2O_3	1·022 m/e

The error in all probability does not exceed two per cent, so that for these substances, as for the others investigated by the same method (that is, rotation by magnetisation), the value of R realised is the exact value for the spinning electron.

D. P. RAY-CHANDHURI.

Ghose Physical Laboratory,
University College of Science,
Calcutta. Oct. 12.

[1] An excellent summary of the methods and results is given by S. J. Barnett in the "International Critical Tables", vol. 6, p. 345, 1929.
[2] S. J. Barnett, *Proc. Amer. Acad.*, **66**, 273; 1931.
[3] W. Sucksmith, *Proc. Roy. Soc.*, A, **128**, 276; 1930.

Anthropology of Veddahs

IT may interest many readers of NATURE to hear of the results of my recent expedition into the Veddah territory in the interior of this island. The expedition took place on September 18–25 of this year. The part visited was the Nilgala division of the Uva Province, where probably the best Veddahs in Ceylon still live. The track lay through the Sinhalese villages of Hamapola, Pitakumbura and Bulupitiya. In some of these the inhabitants betrayed very obvious traces of Veddah admixture. From the last-named place the track led on to the Veddah settlement of Dhanigala. Practically all the Veddahs of this area were collected together and photographed, whilst all the males were measured anthropometrically. The one-time chief of this group, Tuta, whose photograph is given in Seligmann's "The Veddas" had died some time previously. His grave was pointed out to me and I personally removed the skeleton. It was not in a very good state of preservation, but the skull, at any rate, was removed without appreciable damage to the very fragile facial portion.

After spending a night here the expedition was carried on over a range of hills to another Veddah settlement at Henebedda. The living Veddahs were examined and measured as before, and in addition I was fortunate in securing two very complete skeletons. One, a male, belonged to Poromala, probably the one pictured in Seligmann's book. This was comparatively recent, and in perfect preservation. The other was that of a young female named Handhi, who, judging from her skeleton, had suffered severely from yaws. This had caused some atrophy of the bones of the left upper limb, and had left large spindle-shaped swellings on both tibiæ. Apart from these points the skeleton is in very good preservation, and compares favourably with the others.

All the skeletons agree in certain important points that are probably characteristic of the race. In the two males the tibiæ are markedly platycnemic. The pathological condition in the female skeleton precludes a judgment on this point. In only one humerus (in the old man, Tuta) was there a perforated olecranon fossa. This is contrary to the Sarasins' statement that it was common in Veddahs. As a matter of fact, one finds the condition in almost every Sinhalese and in many Tamil humeri, so that it is of little diagnostic importance. All the skulls agree well in general character with one another and with certain others labelled as Veddahs which have been loaned to me by the Colombo Museum through the kindness of the Director. It is interesting to note that two of these three skeletons present each an unusual anomaly. The female skeleton has a marked sacralisation of the last lumbar vertebra, associated with complete absence of the last pair of ribs. The skeleton of Poromala presents a complete degree of non-union of the neural arches in the sacral vertebræ.

It is proposed to publish a preliminary report on the three skeletons in the *Ceylon Journal of Science*. Detailed consideration will be left until a more complete study has been made, and opportunity for comparison with other reputed Veddah material in the various museums in Europe has been taken. It is also hoped that further new material will shortly be forthcoming from the Bintenne and Tammankaduwa districts of the Veddah country.

I may add that a complete collection of hair from various parts of the body in both sexes and at several ages was taken from the Dhanigala Veddahs. This will be studied and compared with the hairs of other Ceylon races. Further hairs were obtained from graves of Poromala and Handhi. I should be delighted to exchange samples of this for hair of other races with any anthropologist in possession of such material.

Anatomy Department, Medical College, Colombo, Ceylon. Oct. 27.

W. C. OSMAN HILL.

Dimensions of Fundamental Units

PROF. W. CRAMP has suggested[1] that the quantities Q, L and T have better claim to be regarded as fundamental than M, L and T. His argument is based on the assumption that Q shall be a function of M. Such an assumption would be a bombshell in modern physics. M, in common with L and T, is a quantity which varies with the velocity of the observer; Q does not so vary.

The wiping out of all fractional indices from the dimensional expressions for the electrical quantities, current, flux, E.M.F., etc., by leaving Q in those expressions is scarcely noteworthy. Fractional indices come into the dimensional expressions for electrical quantities at the outset when, by writing $(Q \times Q/kL) = F = MLT^{-2}$ we find $Q = k^{\frac{1}{2}}M^{\frac{1}{2}}LT^{-1}$. If Q were left in, no fractional indices would appear and also no k; and since, if we neglect both k and μ the ratio of the electromagnetic units to the electrostatic units is always a velocity, or a velocity squared, or the reciprocal of one of these—that is to say, contains no fractional indices—it follows that the presence of Q wipes out fractional indices from dimensional expressions in both the electromagnetic and the electrostatic systems.

F. M. DENTON.

Department of Electrical Engineering, University of New Mexico, Albuquerque. Oct. 19.

NATURE, **130**, 368, Sept. 3, 1932.

MY old student, Prof. F. M. Denton, has, I know, given a good deal of attention to the theory of relativity, and this no doubt has led him to question the possibility of any dimensional relationship between M and Q. While not pretending to have the same knowledge of Einstein's theory, it does seem to me that there is little experimental evidence for the assumption that M varies with the velocity of the observer while Q does not. It would be interesting to know upon what grounds Prof. Denton makes so positive a statement.

The University, Birmingham. Nov. 8.

WILLIAM CRAMP.

Recalculation of Mass Defects

THE well-known mass defect curve of the old nuclear scheme calculated with regard to α-particles and protons presented a difficulty with its minimum of binding energy for tin and an increasing portion between tin and lead. On the other hand, the mass defect values against protons give a rather smoothly decreasing curve.[1] As has already been pointed out,[2] the number of α-particles must be considerably reduced from the point of view of the new scheme, which does not admit any electrons in nuclei, but only neutrons and protons (presumably joined as α-particles). The curve of mass defect against protons and neutrons (perhaps with a single 'central' α-particle) is very similar to the old curve against

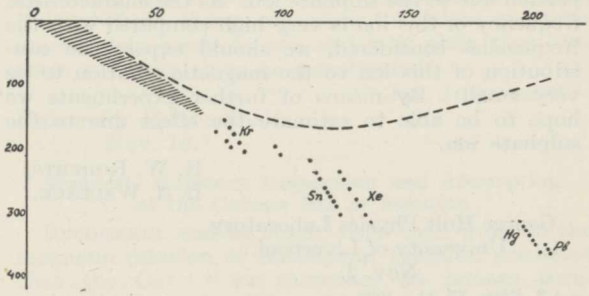

FIG. 1.

protons, but decreases less rapidly. Clearly the new mass defect values relatively to α-particles, neutrons and protons must lie somewhere between the old values computed relative to protons and α-particles respectively (because the number of α-particles is decreased). We may emphasise that this new mass defect curve shows no increasing portion between tin and lead. For illustration we give two typical values:

Old: $50Sn^{124} = 31\alpha + 12\varepsilon$; mass defect = 0·158 (in mass units);
$82Pb^{208} = 52\alpha + 22\varepsilon$; mass defect = 0·035.

New: $50Sn^{124} = 25\alpha + 24\omega$ (ω = neutron); mass defect = 0·304;
$82Pb^{208} = 41\alpha + 44\omega$; mass defect = 0·366.

On the accompanying graph (Fig. 1) are plotted the new mass defect values; the dotted line shows the old smoothed curve.

The significant result mentioned above depends not on the doubtful decimals in the value of neutronic mass but only on the fact that the number of α-particles is diminished in comparison with the number usually admitted, some being split to neutralise the 'nuclear electrons'.

Phys. Tech. Institute, Leningrad-Lesnoi. Oct. 19.

D. IWANENKO.

[1] F. Houtermans' article on the constitution of nuclei in *Ergebnisse d. exakten Naturwiss*, *Bd.* 9, p. 124.
[2] D. Iwanenko, *Sow. Phys.*, 1, 820; 1932.

Process of Space Quantisation

THE following note is a report of researches into the process of space quantisation, carried out during the last two years in the Institute of Physical Chemistry in Hamburg.

The problem may be stated as follows. When a ray of potassium atoms is sent through an inhomogeneous magnetic field, it is split into two rays (space quantisation). If one of the rays is then screened out, all atoms in the remaining ray have the same

axial direction (that is, the same component of magnetic moment in the direction of the field). The ray is then sent through a homogeneous magnetic field, the direction of which is changing with time (for example, a rotating field). After the ray has passed this rotating field, it goes through a second inhomogeneous field. This last field serves to determine whether all the atoms still have the same orientation (in which case they would be deviated towards the same side) or whether some of them have been re-oriented (*umgeklappt*).

The proportion of re-oriented atoms to those having the original orientation depends upon the ratio of the Larmor period, T_l, to the period of rotation of the field, T_f. If T_f is large compared with T_l, that is, if the atom completes many Larmor precessions during the interval required for an appreciable change of field direction—then the process is an adiabatic one and no re-orientation occurs. If an appreciable fraction of the atoms is to be re-oriented, T_f and T_l must be of the same order of magnitude.

Under usual experimental conditions, $T_f >> T_l$; that is to say, the adiabatic case is realised, and no re-oriented atoms are observed. In order that the non-adiabatic case may be realised, the Larmor period T_l must be made as large as possible (that is, very weak fields must be employed), and T_f must be as small as possible. We have succeeded in producing these non-adiabatic conditions in the following manner. The ray passed through a region enclosed in an iron shield where there existed a very weak magnetic field, constant in space and in time. Its strength was a few tenths of a gauss. The variation of the field with time was brought about by causing the ray in its course through the shielded region to pass close to a wire. Atomic ray, wire, and lines of force were at right angles to one another. When a current flowed through the wire, its magnetic field was superposed upon the constant field inside the iron shield. In this way the field was made inhomogeneous in space, and atoms which passed near the wire experienced a change of field direction from point to point; this was equivalent to a variation of the field with time.

We found that with weak currents through the wire (that is, with no appreciable rotation of the field) there were no re-oriented atoms—just as was the case with a strong field (the adiabatic case). But when the constant field was only a few tenths of a gauss, and when the current in the wire was so adjusted that the field of the wire in the region where it was traversed by the ray was also of this order of magnitude, a noticeable part of the atoms (as much as one-third) was re-oriented. The number of re-oriented atoms, and the dependence of this number upon (1) the current in the wire, (2) the distance of the ray from the wire, and (3) the velocity of the atoms, agreed with the theoretical prediction.[1]

R. FRISCH.
T. E. PHIPPS.
E. SEGRE.
Hamburg, Aug. 15. O. STERN.

[1] P. Güttinger, *Z. Phys.*, **73**, 169; 1932; and E. Majorana, *Nuovo Cim.*, Nr. 2, 1932; where the theory is still better adapted to our experimental conditions.

Fundamental Frequencies of the Group SiO_4 in Quartz Crystals

THE particular properties of quartz crystals (SiO_2), as compared to those of carbon dioxide (CO_2) have led Sir William Bragg to the conception of considering a quartz crystal as one single molecule.

An analogous constitution is shown by the polymeric homologue series of silica esters, the Raman spectra of which I have recently investigated.[1] It has been observed that in these compounds four characteristic scattered frequencies must be attributed to the group SiO_4. Of these frequencies two are independent of the degree of polymerisation, while the other two show a continuous shift with the degree of polymerisation. The line 642 cm.$^{-1}$ of the monomeric ester which is shifted so far as 518 cm.$^{-1}$ is a conspicuous example of the last mentioned behaviour. The latter corresponds to a line of the decameric ester.

Making use of the above mentioned results, the fundamental frequencies of the SiO_4 group in quartz can be located. The results are seen from the following table.

	ν_1	ν_2	ν_3	ν_4
ν cm.$^{-1}$	502	800	1062–1086	1170–1208
$\lambda\mu$	19·92	12·5	$9\cdot4_1$–$9\cdot2_1$	8·54–8·28

With the aid of these four fundamental frequencies, the entire ultra-red spectrum of quartz below 10μ can be interpreted as a system of combination bands of the second to the fourth order. Attempts to determine the fundamental frequencies and to arrive at a system of combination bands have been made by Plyler[2] and Parlin.[3] The frequencies assumed by them differ partly from those arrived at above and consequently the values of the frequencies of the combination bands calculated by them agree less well with those observed than in our case.

A more detailed paper will appear in the near future.

Phys. Institute, University, Freiburg i. Br., Germany. J. WEILER.
Nov. 5.

[1] J. Weiler, *Helv. phys. Act.*, **5**, 302; 1932.
[2] E. K. Plyler, *Phys. Rev.*, **33**, 48; 1929.
[3] W. A. Parlin, *Phys. Rev.*, **34**, 81; 1929.

Spectrum of Cosmic Radiation

IN the note published by me in NATURE of September 24 under the above title, I find I made a numerical error in the observed limits of the 'soft band'. The observed and calculated values should be:

n	1	2	3	4	5	6
$h\nu$ (calc.)	475	160	80	48	32	23
$h\nu$ (obs.)	~450*	~180	~100	~50	(~30)	~25

Thus, the observed values given under $n = 4$ and $n = 6$ (not 5 and 7 as stated before) are the limits of the 'soft band'. They are estimated approximatively from its penetrating power, measured by Prof. R. A. Millikan[1] in comparison with that of γ-rays of thorium C″, the observed ratio being between 12 and 6.† The value ~ 30 million volts is an average, being at the same time the energy of formation of helium: $h\nu = 0\cdot032\ H.c^2$.

With this correction the agreement becomes more complete, the lack of the observed value under $n = 4$, noted in the preceding letter, having disappeared.

ADAM ST. SKĄPSKI.
Institute of Physical Chemistry,
Mining Academy,
Krakow–Poland,
Oct. 17.

* The probable value of the 'iron constituent'.
† The energy of γ-rays of thorium C″ being 2·5 million volts, the ratio 6 corresponds—from the Klein-Nishina formula—to 25 million volts.
[1] R. A. Millikan, NATURE, **128**, 709, Oct. 24, 1931.

Research Items

Animism and Child Psychology.—It is often maintained that the personifications of inanimate objects which are characteristic of the thought of the child in civilisation belong to a stage of mental development corresponding to that which is responsible for the animistic beliefs of peoples of lower culture. Ignoring the refinements of animistic belief, it may be said broadly that the reaction of the civilised child, in speaking of 'the naughty table' against which it has hurt its head, is regarded as comparable with the belief of the savage who holds that some spiritual force or power animates a block of wood or stone, for example, and may act, or be influenced to act, for good or ill. It has, therefore, been only reasonable to conclude that the same attitude of mind would be found, possibly even in an intensified form, in savage childhood; but a recent investigation raises some doubt as to the validity of the whole argument. Miss Margaret Mead has recorded the results of an investigation among the children of the Manus people of Admiralty Islands, New Guinea, with special reference to this point (*J. Roy. Anthrop. Inst.*, 62, pt. 1). Her investigation was conducted both by observation while the children were engaged in free activities, and by question. She found no evidence of animistic personification, although some of her experiments were directly provocative, had there been any tendency in this direction. The drifting of a canoe was attributed not to the innate perversity of the canoe, but to the carelessness of the person who failed to tie it up properly. The evidence, it is true, is drawn from a single people, among whom indeed conditions may be peculiar; but it suggests to Miss Mead, and will suggest to others, the need for a careful reconsideration of this theory of child psychology.

Early Migrations into America.—The evidence collected by a number of expeditions sent out by the Smithsonian Institution in recent years to the far north-west of the American continent has been reviewed by Dr. Aleš Hrdlička in its bearing on the problems of the early migration of man from north-east Asia to America (*Proc. Amer. Phil. Soc.*, 61, No. 6). The expeditions during the last six years have been engaged in systematic work in physical anthropology and archæology over an area extending from Point Barrow to Kodiak Island, and on the principal islands of the Bering Sea. A very large number of sites of ancient habitation have been located, a vast amount of skeletal and cultural material collected and a number of anthropometric observations made on the present inhabitants. Unsuspected rich old cultures have been revealed around the Bering Straits, on St. Lawrence Island, on the lower east coast of the Bering Sea and on Kodiak Island. The work is not yet finished; but it will not be long before the main question at issue shall have been cleared and ascertained fact substituted for the jungle of possibilities which has held the field until recently. The first two points which emerge are negative. Nothing has been found up to the present which indicates a very high antiquity, while it is evident that the Bering Sea region is continuously changing and that one or two thousand years ago the coastal map was quite different from what it is now. Therefore all hope of finding traces of earlier migrants to America must be abandoned. On the positive side, it is evident that once man arrived on the coast of north-east Asia, passing over to the visible coast on the American side was inevitable. Nor is it necessary to postulate a land bridge. Even had it existed man would have used the easier water route. Secondly, the migrations were gradual and disconnected. Thirdly, that man brought with him differences in type, language and culture; and fourthly, that he did not proceed to people America across the mainland, but by skirting the western and eastern coasts of Alaska. The Eskimo, a blood relation of the Indian, was the last comer.

Economic Exploitation of the Birds of Novaya Zemlya.—The transportation of chemical elements through food-chains terminating in the birds of such an area as Novaya Zemlya takes place on a vast scale. The elements of continental soils, transported by rivers, reach the sea, where some are assimilated in the organisms of the plankton. Thence they reach the bodies of fishes and so pass to the bodies of birds to be distributed afresh perhaps in places very far distant from their origin. The possibilities of such transference are suggested by the calculation that the daily catch of marine fishes approximates to a million kilograms, and the weight of fish caught by guillemots during their 120 days sojourn in Novaya Zemlya amounts to about 120,000 tons (L. A. Portenko, *Trav. Lab. biogéochimie Ac. Sci. U.R.S.S.*, Leningrad, 1931, pp. 52). The author describes 36 colonies of birds on the west of the island, and of these the guillemots occupy a coast line of 20 km. Probably they lay about 200,000 eggs, some of which are used by the inhabitants for feeding their blue foxes, while the flesh of the birds is eaten by the people and their dogs. The author also made a special investigation of the eider-down resources of the island, and found that in 1930 the total quantity exported to Gostorg was 457·5 kgm. He is of opinion that the quantities of guillemots' eggs and the production of eider-down offer opportunities for economic exploitation on a considerable scale.

Rapid Development of a Frog.—Dr. M. L. Sethi, of Government College, Hoshiarpur, India, has made some interesting observations on the rapidity of cellular development and of the attainment of the larval stage of *Rana tigrina*. Dr. Sethi states that the frogs spawn in the early hours of the day during the breeding season; the morula stage is reached within an hour and a half after the eggs are laid; epibolic gastrulation at the end of six and a half hours; and the neural plate and folds appear in about ten hours. The larvæ hatch out within twenty-four hours. This should be compared with the developmental history of the English frog, which takes usually a fortnight to reach the corresponding larval stage. Dr. Sethi further mentions that the external gills appear within a day after hatching and hind-limbs sprout three days after and fore-limbs two days subsequent to this period. The metamorphosis is completed in thirty-eight days while in Great Britain frogs take from seventy-seven to eighty-eight days. The development in a species of *Bufo* found in Hoshiarpur is similarly rapid.

Chromosome Constitution of *Sphenodon*.—Mr. R. D. Keenan (*J. Anat.* 72, pt. 1, 1932) has investigated the chromosomal formula of *Sphenodon* and concludes that it has 36 chromosomes, 12 atelomitic chromosomes which are V-shaped, 18 telomitic chromosomes which are rod-shaped and six microsomes. Applying the theory of Robertson concerning the formation of V-shaped chromosomes to those of *Sphenodon*, the author concludes that the primitive number of chromosomes in Reptilia is 48, and he shows how the chromosomal formula of the living members of this group, which have been investigated, can be derived from this primitive number, principally by a reduction in the size of the individual elements and by a fusion of the elements in pairs or threes. The work of Painter has led him to the conclusion that the primitive number of chromosomes in the eutherian mammals is also 48, and that, though the type number in the marsupials appears to be 24, the total amount of chromatin seems to be about the same in the two groups. The significance of the number 48 as the typical primitive number in both Reptilia and Mammalia is commented on.

Effect of Length of Day on the Flowering of Plants.—Dr. M. A. H. Tincker, of the Wisley Laboratories, has two papers in the *Journal of the Royal Horticultural Society*, vol. 57, pt. 2 (pp. 321-325 and 326-331) dealing with the effect of the length of the daily light period on the growth of various plants. *Sedum spectabile*, *Saxifraga decipiens* var. *bathoniensis*, *Anchusa italica* and the tulip 'William Pitt' all behave similarly. They are 'long day' plants and flower earliest when exposed to the normal length of day in summer. A series which had twelve hours of daylight supplemented by five hours of weak artificial light behaved very similarly to the full daylight controls, but it was demonstrated that the weak artificial light was of no direct value for the formation of food in the leaves. Two other series which were exposed to twelve hours and six hours daylight respectively remained vegetative or flowered later than the controls. The other paper reports the results of studies on the rate of tuber formation. Several plants are mentioned which produce tubers when the daily period of light in summer is reduced to 10–12 hours. When the rate of translocation of foodstuffs to the tubers is represented as 100 for the controls, it is 60 for plants exposed to 12 hours daylight and 5–7 hours weak electric light, 130 for 10–12 hours daylight and 22 for 5–6 hours daylight. The effect of potassium economy is considered along with photo-period in its relation to the formation of tubers.

Igneous Complex of the Bushveld.—The great Bushveld complex of the Transvaal is universally recognised as the most spectacular manifestation of igneous activity to be seen anywhere in the world. The memoir on which Dr. A. H. Hall has been engaged for many years is now published (Geol. Survey S. Africa, Mem. 28, pp. 554, with coloured geological map) and a vast collection of field and laboratory data which petrologists have been eagerly awaiting is now available for digestion and discussion. Minor outpourings of felsitic rocks are found in the Rooiberg series at the top of the Transvaal system. A widespread felsite-granophyre composite followed, the upper extrusive portion remaining roofless. It is not yet clear whether the norite came next, to be followed in turn by the Red Bushveld granite, or whether the granite was emplaced before the norite. This is the outstanding problem that remains unsettled. More or less *pari-passu* with the intrusion of the norite magma the floor, made up of the Pretoria series, was injected by basic sheets. During the cooling and consolidation of the norite, thoroughgoing differentiation occurred with consequent highly developed pseudo-stratification of the crystalline accumulates, and at the same time slow and long-continued basining of the floor took place as a result of load above and magmatic adjustments in depth. Intense metamorphism of the rocks of the roof and floor is ascribed mainly to the action of the norite. Following widespread erosion of the complex, eruptive activity began afresh during the period between the close of the Waterberg and the beginning of the Karroo. The products included basic and alkaline sheets and dykes culminating in a number of plugs, stocks or ring-intrusions of alkali rocks of which the Pilandsberg is the most famous. The final chapter of the memoir is devoted to the mineral resources of the Bushveld, most attention being given to the occurrences of platinum.

Subsidence of London.—The various factors that may be involved in the subsidence of London as revealed by recent re-levelling have been enumerated with comments in a paper by Capt. T. E. Longfield (Ordnance Survey. Professional Papers No. 14. "The Subsidence of London". 2*s*. 6*d*.). These influences are as follows: (1) a general and gradual lowering of the land surface in the south-east of England, of which there is some evidence from the level of Roman remains of habitation. (2) A more local subsidence of the London area, especially in central London, of which there is measurable evidence at least since 1865. This appears to be confined to the thickly built-over areas where gravel or alluvium overlies the clay and may be due to the waterproof covering of stone, cement and asphalt that allows the underlying surface to drain and so contract. (3) A seasonal subsidence and uplift caused by changes in the water-content of the London clay. This is evidenced in disturbances in walls after a long dry spell. (4) Subsidence caused by the draining or pumping of water and sand from the gravel, which is known to disturb adjacent buildings. (5) Rhythmic land movement due to fall and rise of tide. Records show that Waterloo Bridge and the County Hall, Westminster, thus rise and fall. (6) Possible subsidence due to underground tunnelling, which may cause local sinking but not a widespread subsidence.

Limiting Static Friction between Lubricated Surfaces.—A paper by Sir William Hardy and M. Nottage (*Proc. Roy. Soc.*, Nov.) describes measurements of the limiting static friction between lubricated surfaces applied to the study of the behaviour of adsorbed layers. The measurements were made using a spherical sliding face of mild steel on a mild steel plane, and it is assumed that the lubricant is reduced to two primary layers with the surface of slip between them. The lubricants were solutions of wax or palmetic acid or hexadecyl alcohol in medicinal paraffin, and the temperature variation of the limiting friction was observed. The behaviour is different for the case in which the surfaces and the lubricant are brought together at the temperature of measurement and for the case when the lubricated surfaces are heated or cooled through a temperature range. In the latter

case, the curve depends on the temperature at which the oil is first applied to the surfaces. The authors discuss their results in terms of the 'availability' and 'accessibility' of the dissolved component to the surface. The former is the fraction of the surface covered by solute molecules when the surfaces are brought together; the latter represents the power of the solute molecules to seize adsorption surface when the conditions are changed. The accessibility depends upon the previous history of the system.

History of Terrestrial Magnetism.—*Terrestrial Magnetism and Atmospheric Electricity* for June contains an article of great interest, by Dr. A. Crichton Mitchell, entitled "Chapters in the History of Terrestrial Magnetism". It consists of a very condensed discussion (25 pages) of the discovery of the directive property of a magnet in the earth's field, and of the application of this property to the nautical compass. The discussion is based on the author's re-examination of the very extensive literature bearing on the subject: it is followed by more than three hundred bibliographical references and notes (occupying 15 pages of small print), referring, as a rule, only to original sources of information, almost all of which have been consulted or verified. The final conclusions arrived at are as follows: (*a*) while it is possible that the Chinese were acquainted with the directive property of a magnet by A.D. 1093, they made no further use of that property for at least two hundred years thereafter. (*b*) There is no evidence of the origin of any such knowledge among the Arabs, and it is improbable that they transmitted any information on the matter to Europe, their earliest mention of the compass being nearly half a century after its first mention in Europe. (*c*) The compass was in use in western Europe by A.D. 1187, and taking into consideration the fact that the directive property must have been discovered much earlier, it is most probable that a knowledge of that property, and its application, in western Europe was of independent origin and as early as, if not earlier than, that in China. A specially interesting passage describes the strange historical episode of the attribution of the invention of the mariner's compass to a non-existent person, Flavio Gioja, in 1302; a statue to the mythical Gioja has been erected in the Exchange at Naples, and the six hundredth anniversary of his supposed discovery was celebrated at Amalfi in 1901. The exposure of the legend, it may be added, is due to a distinguished Italian historian, Bertelli.

Astronomical Topics

Origin of the Planetary System.—Dr. H. Jeffreys has published a further paper on this subject (*Mon. Not. Roy. Ast. Soc.*, Oct.). He replies to some criticisms raised by Prof. F. Nolke on the theory that the system arose from the collision of a star with the sun; as regards the probability of such a collision, he shows from Prof. Nolke's own figures that such a collision should occur about once in 10^8 years, so that there may be about twenty systems younger than our own. Dr. Jeffreys points out that his revised theory is the only one that gives quantitative results for the rotations of the sun and planets that are of the right order of magnitude. He quotes a statement made last year by Prof. E. W. Brown that the accepted planetary theories as regards secular variations cannot be treated as valid for periods exceeding (say) ten million years; as the planetary system is probably thousands of millions of years old, it is quite possible that the present eccentricities of orbits might have been brought about by purely gravitational methods, without having recourse to resisting medium. He notes the difficulty in explaining the origin of the satellites of Mars, and suggests that they may be captured asteroids. But he makes a slip in stating that "this hypothesis has been strengthened by the discovery of a number of asteroids with mean distances less than that of Mars." There are many asteroids with *perihelion* distances less than that of Mars, but Eros, and possibly the newly discovered 1932 *HA*, are the only ones with smaller mean distances.

A Spectroscopic Study of the Brighter Stars of Type *Be*.—Vol. 4, No. 13, of Publications of Michigan Observatory contains a paper on these stars by Mr. D. B. McLaughlin. They are stars that have bright emission lines; many of the stars are either known variables or suspected of variability. One of the aims of the present investigation was to test whether the ratio of brightness of the emission lines to that of the neighbouring continuous spectrum is constant in each star; another test applied was to compare the intensity of the red and violet components of bright double lines. Some of the stars on the list show variation in both the above ratios (they are denoted in the paper as the E/C and the V/R ratios) but as a rule, marked variation in one of the ratios is accompanied by steadiness in the other. Some of the stars lose their emission lines altogether for a portion of their cycle. Pleione in the Pleiades is stated to have had them in 1906, but they have not been observed since then; f' Cygni lost them for a time and then regained them. The question whether the variation in these stars is due to binary character is examined. One star on the list, Beta Lyrae, is a known binary. Another one, Upsilon Sagittarii, was supposed for a time to be a very massive binary; this was, however, questioned by Prof. Plaskett, and the present paper supports his view; it is suggested that the broad lines are widened by rotation, while the sharp ones originate in an outer shell of gas, at some distance above the photosphere. The article is accompanied by some enlargements of spectrograms, to illustrate the changes described.

Nautical Almanac Tables.—The Nautical Almanac Office is publishing a series of tables, which will be of great use to astronomical computers. Heliocentric co-ordinates of all the planets except Mercury are given from 1900 to 1940; for Jupiter and Saturn they go back to 1797. All positions are referred to the equinox of 1950, this uniformity being a great convenience in dynamical investigations. There are also extended precession tables for reducing data to the equinox of 1950. Coefficients are given for commencing investigations on the motions of heavenly bodies by the method of mechanical quadratures. This was the method used by Dr. P. H. Cowell for Jupiter's eighth satellite, and for Halley's comet.

Anniversary Meeting of the Royal Society

AFTER reference, according to "pious custom", to the work of the two foreign members and fourteen fellows of the Royal Society who died during the past twelve months, Sir Frederick Gowland Hopkins, in his anniversary meeting address on November 30 as president of the Society, made a plea for the establishment of chairs in the history of science. Individual scientific achievement is stored in fewer memories than is great literature, partly because it is but a step in the progress of knowledge. The perspective of history is specially valuable in maintaining sound judgments in these days of revolutionary views. Christopher Wren provides an example of a man whose services for experimental science have been overshadowed, except for the few, by other achievements. The tercentenary of his birth occurred during the past year, and also that of Antony van Leeuwenhoek and of Marcello Malpighi, both of whom were also associated with the Royal Society during its early years. The number of tercentenaries of original and early fellows of the Society falling during a small span of years makes it impossible to organise a public celebration of each such event.

Sir Frederick stated that the Society is to receive an important benefaction for the support of qualified investigators. Shortly before his death, Mr. Gordon Warren allocated to the Society the sum of £1,400 a year for seven years for the maintenance of a research professorship or two research fellowships. Two Warren research fellows, Dr. A. J. Bradley and Dr. W. Hume-Rothery were accordingly appointed last June. Mr. Warren died suddenly, leaving a large sum of money, subject to a life interest, which is ultimately to be devoted to science, and the Royal Society is to be consulted as to its disposal.

The Royal Society Mond Laboratory at Cambridge (NATURE, Feb. 13, 1932, p. 224) is practically complete and will be opened in February.

We print below extracts from the president's remarks in bestowing this year's medals.

Presentation of Medals

COPLEY MEDAL, awarded to DR. G. E. HALE

Dr. Hale's first notable achievement was in 1892, when he brought the spectroheliograph to success. This instrument gives a picture of the sun by the light of one spectrum line, and allows the bright clouds of hydrogen and calcium in the upper regions of the sun's atmosphere to be photographed as projected on the disc. The idea had been suggested and tried much earlier, but Hale was the first to make a workable automatic instrument of this kind. About the year 1895 Hale organised the building of the Yerkes Observatory and of the great refracting telescope there, to which an improved spectroheliograph was adapted. To this period belongs also a masterly investigation of the spectra of certain faint red stars. This was the precursor of a much larger enterprise, the Mount Wilson Observatory, with many unique instruments, such as the 150 ft. tower telescope and the 100 in. diameter reflector.

At the Mount Wilson observatory Dr. Hale made his great discovery of the Zeeman effect in sunspots by observing the circular polarisation of the edges of the broadened spectrum lines, where they cross the spot. Regions of thousands of miles across were thus shown to be the seat of intense magnetic forces, comparable in strength with those used in the dynamo machine. This discovery has been developed in many important directions.

In recent years Dr. Hale has developed the spectrohelioscope, an instrument depending on the persistence of vision, which allows us to observe transient phenomena scarcely accessible to the spectroheliograph. We may confidently expect that it will contribute to clearing up the mysterious relations between terrestrial magnetism and solar phenomena.

RUMFORD MEDAL, awarded to PROF. FRITZ HABER

Alike at Karlsruhe, where he went in 1894, and at Dahlen from 1911 to the present time, Haber has inspired schools of great and highly productive activity. His own early studies of the oxidation and reduction of organic substances by electrochemical methods, and the numerous electrochemical studies which followed this important work, such as his researches on gas cells, on the rate of ionic reactions, on the electrolysis of solid salts, on the velocity of reaction at electrodes, and on the use of the glass electrode, have enormously advanced progress in this branch of science.

Haber's profound study of the thermodynamics of gas reactions culminated the synthetic production of ammonia. With van Oort, he carried out a preliminary investigation on the ammonia equilibrium, but owing partly to discrepancy with figures obtained by application of the Nernst theorem, further experiments were made with le Rossignol in 1906. In 1908 satisfactory catalysts had been found and the synthesis of ammonia achieved. The far-reaching technical results of these careful thermodynamical studies are in themselves a monument to Fritz Haber; one of the German factories alone can produce more than 1,000 tons of ammonia daily. The influence of this on the food supply of the world is of the highest importance.

Haber's wide interest, combined with his insight and grasp, made possible the application of modern physical principles to a wide range of problems of physical chemistry, such as the determination of molecular structure and calculation of lattice energies, the nature of the amorphous state, chemiluminescence, reaction kinetics and electron emission during chemical reaction. During the past few years, Haber has been successfully making manifest the rôle of the hydrogen atom in combustion processes.

ROYAL MEDAL, awarded to PROF. R. ROBINSON

Prof. Robert Robinson has won world-wide distinction by his work in many branches of organic chemistry, particularly by his elucidation of the structure of plant products and of their phytochemical synthesis. No living organic chemist has displayed a greater versatility of thought and of method. His more recent researches on the distribution, the constitution and the laboratory synthesis of the anthocyanins, the pigments of flowers, fruits and berries, have excited the keenest interest of chemists and biologists. His work on the structure of alkaloids and the syntheses to which it has led

him are classical in character. The synthesis of tropinone has been referred to as the most elegant in chemical literature. On the mechanism of chemical reaction he has contributed theoretical ideas which, of interest both to chemists and physicists, have opened new avenues of investigation.

ROYAL MEDAL, awarded to PROF. E. MELLANBY

Prof. Edward Mellanby showed that the central factor in the development of rickets is a defective diet. He introduced experimental methods, produced rickets by feeding animals on a deficient diet, and showed that the missing factor was of the nature of a fat-soluble vitamin. Previously only clinical observations had been recorded, on the effect of sunlight, and on other supposed factors; there was no sound evidence that a material substance regulates the calcification of bone. It was Mellanby's fundamental work which during the last decade made possible numerous and important researches by others, culminating a year ago in the recognition of the material substance (vitamin D) as an isomeride of ergosterol.

Mellanby's later researches suggest hitherto unsuspected problems, though their very novelty has so far precluded the clear definition and finality which is now the outcome of his earlier works. Thus he has shown the adverse effect, in certain circumstances, of an excessive amount of cereal germs. In the absence of vitamin A the latter, and particularly ergot of rye, produce a degeneration of the spinal cord. Incidentally, this observation provides a satisfactory explanation of the peculiar and hitherto obscure incidence of convulsive ergotism in man.

DAVY MEDAL, awarded to PROF. R. WILLSTÄTTER

Prof. Willstätter's earlier studies gave us our present complete knowledge of the molecular structure of atropine and cocaine, and his analytic and synthetic studies of these alkaloids have had important sequels in systematic organic chemistry and in pharmacology. He then proceeded to a series of ingenious researches bearing on the problem of quinonoid character and on the benzene theory and these led in succeeding years to further work on cyclic compounds of much general interest. He early showed himself to be a master of method in organic chemistry. His name will, in the future, bring most readily to mind the discovery of magnesium in chlorophyll, and this, along with the painstaking and monumental investigations of the structure of chlorophyll and the blood pigment, represents the high-water mark of his achievement. Coupled with this work was a series of valuable contributions to the study of carbon assimilation. Equally novel and brilliant were his researches on the anthocyanin pigments of flowers and blossoms; a whole new chapter of organic chemistry was written. Finally, the studies on the enzymes have added greatly to our positive knowledge, enabled us fully to estimate the difficulty of the task, and laid down the lines on which future work must proceed.

DARWIN MEDAL, awarded to DR. C. E. CORRENS

Dr. Correns was one of the three botanists (the other two being Tschermak and de Vries) who in 1900 independently brought to the notice of biologists the fundamental work of Mendel, which had remained neglected since 1865. Since 1900 he has been actively engaged in developing the science of genetics.

In 1902 Correns was the first to elucidate the remarkable phenomenon of the production of red flowers in the first cross between two white-flowered races of *Mirabilis*. He was also the first to show in the crossing of two species of *Mirabilis* that if very numerous genetic factors relating to small morphological differences are present, it is impossible to establish segregation in the F_2 generation, unless very large numbers are available. This explains the appearance of supposed 'constant' hybrids, as has since been shown by other observers in numerous instances.

Correns was also the first experimenter clearly to establish inheritance which did not follow Mendelian rules. Thus he showed in *Mirabilis* and other plants that variegation of the leaves depending on the failure to develop chlorophyll, is inherited only through the mother because the plastids which carry the chlorophyll are present in the egg cell and not in the sperm. Again, he demonstrated that paternal characters shown by extra-embryonal parts of fruits produced by crossing (so-called 'xenia') were always limited to the endosperm, that is, to the food tissue formed by the fusion of a second sperm with nuclei belonging to the maternal parent. But his most important work is probably the elucidation of the inheritance of sex. By crossing a monœcious with a dicœcious species of *Bryonia*, he showed in 1907 that the females were all homozygous and the males heterozygous for the sex factor. The generalisation that one sex is always homozygous and the other heterozygous corresponds with the normal approximately equal distribution of the sexes in the offspring of unisexual individuals and with the differences between the chromosomes of the sex-cells, and is now well-established. Deviation from the equal distribution of the sexes Correns showed to be due in *Melandrium* to the more rapid action of the male-determining sperms, and this is a principle of wide application. Again, he was the first to explain the differential fertility of a generation of plants with their parents and with one another by the assumption of two distinct and inherited inhibiting substances in the stigmata of the flowers.

BUCHANAN MEDAL, awarded to PROF. T. MADSEN

Dr. Madsen's best known scientific work has been on the toxins and anti-toxins of diphtheria and tetanus bacilli and on other animal, vegetable and bacterial toxins and antigens and their antibodies. He initiated and published with Arrhenius, classical work on the theory of toxin and antitoxin combination, showing that the process resembled the combination of a weak acid and base rather than the union of a strong acid and base, as had been held by Ehrlich.

Madsen was largely concerned with the origin of the Commission on Hygiene, which he directed in Eastern Europe during the latter part of the War. Since then he has been president of the Health Committee of the League of Nations and president of the Permanent International Committee on Biological Standards, which was in great part due to his initiative.

HUGHES MEDAL, awarded to DR. J. CHADWICK

Dr. Chadwick is distinguished for his contributions to radioactivity and nuclear physics. Amongst a number of other investigations on α-, β- and γ-rays, he was the first to show explicitly about 1920 that the charge on the nucleus was equal to the atomic

number, by a quantitative study of the large-angle scattering of α-particles by selected elements, thus verifying by direct experiment the correctness of Moseley's deduction. He was associated with Rutherford, 1922–30, in a long series of investigations (1) on the anomalous scattering of α-particles by light elements, which threw the first light on the size and structure of the nucleus, and (2) on the artificial transmutation of the elements by α-ray bombardment. These experiments showed that at least twelve of the lighter elements were transmuted with the ejection of a proton, and laid the foundations of a study which has recently so rapidly accelerated.

In 1928 efforts were started to improve the technique of these experiments by using automatic electrical counting, and methods were perfected by the end of 1930. Dr. Chadwick applied the new methods to a more detailed study of the groups of disintegration protons, especially from boron and aluminium, for which he established clearly for the first time the existence of definite nuclear α-particle and proton levels. Finally, this year, when the observations by M. and Mme. Curie-Joliot had indicated certain curiosities produced by the supposed γ-radiation from beryllium bombarded by α-particles, Dr. Chadwick immediately recognised that the effects observed could only be adequately explained by the assumption that the radiation from beryllium was of a new type—the ejection of a neutron—and by a brilliant series of experiments he confirmed this conjecture, and with the collaboration of Dee and Feather was able to establish its essential properties.

The Place of Biology in Education

THE National Conference on the Place of Biology in Education, organised by the British Social Hygiene Council, which met at the British Medical Association House on November 1–December 3, may well prove a landmark in the history of education in Great Britain. When five Ministries, the chairmen of the Advisory Council to the Department of Scientific and Industrial Research, of the Medical Research Council, and of practically every educational body of importance, appear among the patrons, and when administrators and leaders of research such as Viscount Chelmsford, Sir Walter Fletcher, Sir Richard Gregory, Sir William Hardy, Prof. A. V. Hill, Sir Michael Sadler, Sir Amherst Selby-Bigge, and Sir Stephen Tallents appear side by side with men of high standing in the educational world, the public cannot dismiss their arguments as unimportant.

Since the purpose of the Conference was not to pass resolutions but to drive home the fact that competent judges in the spheres of national and imperial affairs, of research, of teaching, and of sociology are agreed upon the urgent necessity of providing the administrator, the social worker, and the ordinary citizen with a biological background, it would be difficult to imagine a gathering of greater weight, or one more likely to produce results.

Since it is hoped that a full report will shortly be available, it is as unnecessary as it would be impossible to attempt a detailed summary; but such an utterance of authoritative opinion certainly calls for a record of the general impression it left behind. The earlier speeches laid a firm foundation. Lord Chelmsford's account of the Prime Minister's committee over which he presided fittingly reminded those attending the Conference that they were deliberating matters of world-wide importance. Besides dealing with the specialist, the report of that committee emphasises the cultural value of biology, and states that no boy should leave school without some knowledge of it. Sir Michael Sadler, setting evolution against the background of the absolute, widened the horizon, and insisted that biological education demands a philosophy of life. Sir Walter Fletcher carried the theme further in a noble progression. Biology is essential in a mechanical age because it answers the human needs of utility, beauty, and worship. By putting utility lowest and then proceeding to show how neglect of biological research has lost us the sugar trade of the world, destroyed the trade in vegetable dyes, and brought us up against social problems even more anxious, while English wheat-growing has been saved by such research, he gave fitting emphasis to the higher needs. Prof. A. V. Hill laid stress on the fact that all science is one, and urged that since civilisation expresses the activity of a living organism, man, biological knowledge is essential to its understanding. Then speaker after speaker, from many-sided experience, while emphasising the danger of such specialisation as has overtaken chemistry and physics, impressed the truth that to be totally ignorant of biology is to be an incompetent citizen and a dangerous legislator.

More and more clearly emerged the demand for two kinds of biological training. The specialist is required for many purposes and the need is a growing one despite the economic set-back which has temporarily narrowed or closed some avenues; though if the specialist is not thoroughly trained in chemistry and physics his usefulness is greatly restricted. But unless every single citizen is educated in the understanding of biological ideas, then problems of industry, economics, population, and the mentally unfit, may prove too much for us. On every side the biological aspects of citizenship grow more significant and the need for biological education more urgent.

The fundamental note of the Conference was the recognition of this need, and of the corollary that in every stage of education, and for girls as well as for boys, biology must have its place. In the primary schools there has been little progress. Here Sir Richard Gregory wisely stressed the need of natural interest rather than of the illustration of scientific laws in the early stages. Other speakers showed how eagerly young children respond to teaching about the living organism.

The situation in teachers' training colleges, in central and secondary schools, in preparatory and public schools came under review, and the cry for more and better biology, biology on broader lines, was everywhere the same. Not least significant was the complaint of the headmaster of a preparatory school that there would be time for natural history if many parents did not so neglect early education that their sons reached the preparatory school unable to write grammatically or to do simple arithmetic. Nevertheless, it became clear that, in the opinion of the Conference, the preparatory schools could do an immense amount for the public schools by

encouraging Nature study. Not only the biological teaching, but also that important element, the school natural history society, would derive immediate benefit.

The representatives of the Headmasters' Conference spoke with a divided voice, suggesting that insofar as any unfavourable or reactionary views were expressed, they were individual rather than collective. While every sympathy attached to the warning against an over-loaded curriculum, and to the claim that to neglect chemistry and physics would be disastrous to biology, the general sense of the Conference seemed to be that rearrangement without overloading is both possible and necessary. Dr. Vaughan's timely warning that demands for biology should not be based on moral grounds found acceptance; on the whole, the Conference, while impressing the gain of biological teaching in which reproduction fell into its right perspective among the other functions of the organism, seemed to feel that any bias of the ordinary biological work in the direction of sex instruction is undesirable, though in some cases *ad hoc* courses, specially safeguarded, may prove helpful in day schools.

In fine, the National Conference on the Place of Biology in Education has pointed to a grave omission in the cultural training of citizens with a unanimity and an authority which cannot be disregarded. The situation must be put right; and the schemes submitted by Sir J. Arthur Thomson and others suggest a method for the earlier stages.

The nation owes a debt of gratitude to those who have helped in thus directing attention to a failure which is little short of disastrous, and in supplying a hope for the future. S. A. McDOWALL.

Alchemy and Alchemists*

IN a narrow sense, alchemy may be interpreted as the pretended art of transmuting the baser metals into silver and gold. In a wider sense it may be defined as the chemistry of the Middle Ages: according to Liebig, indeed, alchemy was never anything but chemistry. In its broadest aspect, it appears as a system of philosophy which claimed to penetrate the mystery of life and the formation of inanimate substances: it was thus a complex and indefinite blend of chemistry, astrology, philosophy, magic, mysticism, theosophy, and other ingredients.

To the philosophic alchemists, the efforts made by the adepts to transmute metals were mainly of interest as attempts to prove the truth, on the material plane, of an all-embracing philosophic system. The despised 'puffers', at the other end of the scale, were materially-minded seekers after gold. There were still others who interpreted the doctrines of alchemy in terms of mystical theology: thus, the celebrated Canon Ripley of Bridlington, in the prologue to his "Twelve Gates" (1471), wrote: "O Unity in the substance, and Trinity in the Godhead . . . as Thou didst make all things out of one chaos, so let me be skilled to evolve our microcosm out of one substance in its three aspects of Magnesia, Sulphur, and Mercury."

Heinrich Khunrath's quaint illustration of the alchemic citadel (1609), and Mylius's elaborate representation of the analogy of the alchemic microcosm to the macrocosm (1620) are examples of alchemy in its broadest interpretation, as are also the numerous illustrations which were collated in the "Viridarium Chymicum" in 1624 by Daniel Stolcius, a young Bohemian student. From such examples of its literature and iconography, alchemy appears as a jumble of natural and moral ideas, a confusion of objective facts and subjective notions, incorporating the fundamental principles of animism, and exhibiting ill-defined connexions with the story of the Grail and other confused records of forms of worship, superstitions, occultism, and the like.

Among the reputed adepts, none had a more circumstantial and romantic history than the Scottish alchemist, Alexander Seton, who has been termed "the chief martyr of alchemy". A century before his time, James IV of Scotland was interested in alchemy as a means of gold-making and of healing disease. His chief alchemical assistant was John Damian, who was created Abbot of Tungland in Galloway, in 1504, "so that he might have more leisure to carry on his experiments". Details of the expenses incurred in these experiments, many of which were conducted in the Castle of Striveling (Stirling), are still extant and form very interesting reading. The poet Dunbar said of Damian that "this Dignitary never chose to go to Mass though warned by the holy Bell"—apparently because he feared the defiling effect of the laboratory smoke upon his costly religious vestments.

"This tyme," says an old record, "thair wes ane Italiane with the King, quha wes maid Abbott of Tungland, and wes of curious ingyne. He causet the King believe that he, be multiplyinge and utheris his inventions, wold make fine golde of uther mettall, quhilk science he callit the quintassence; quhairupon the King maid greit cost, bot all in vaine. This Abbott tuik in hand to flie with wingis, and to be in France befoir the saidis ambassadouris; and to that effect he causet mak ane pair of wingis of fedderis, quilkis beand fessinit apoun him, he flew of the castell wall of Striveling, bot shortlie he fell to the ground and brak his thee bane; bot the wyt theirof he asscryvit to that thair was sum hen fedderis in the wingis, quhilk yarnit and covet [yearned and coveted] the mydding and not the skyis."

*Substance of a paper presented by Prof. John Read to the Folk-Lore Society on November 30.

University and Educational Intelligence

BIRMINGHAM.—Mr. Frank Postlethwaite has been appointed James Watt fellow for the current session.

CAMBRIDGE.—Prof. B. L. van der Waerden, of the University of Leipzig, has been appointed Rouse Ball lecturer for the year 1932–33, and Prof. Hans Geiger, of the University of Tübingen, Scott lecturer for the year 1933.

The General Board recommends that an Alfred Marshall lectureship be established in the Faculty of Economics and Politics.

Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, formerly scholar and fellow, has been elected to an honorary fellowship at King's College.

Dr. H. R. Hulme has been elected to an unofficial Drosier fellowship at Gonville and Caius College for research in mathematical physics. Dr. Hulme was placed in the first class of Part I of the mathematical tripos in 1927 and was a wrangler with distinction in 1929. He won a Smith's prize in 1931 and was elected an Isaac Newton student in 1932.

LONDON.—A University postgraduate travelling studentship of the value of £275 for one year has been awarded to Mr. W. B. Mann, Imperial College of Science and Technology, who proposes to carry out research on rarefied gases, in particular to determine the molecular conductivities, at Copenhagen.

THE opening ceremony in connexion with building extensions at the Northampton Polytechnic Institute, St. John Street, E.C.1, was performed by H.R.H. Prince George on the evening of December 2. Nearly 90 per cent of the 3,000 students of the Polytechnic attend evening classes. There are also important day departments providing courses in engineering and ophthalmic optics. The former are recognised by the University of London for the purpose of internal degrees, as are also courses of similar type conducted in the evening. The extension occupies part of a site with street frontage on three sides facing the main Polytechnic building. In addition to further lecture rooms and class-rooms, accommodation is provided for the chemistry and horological sections; there are also a large workshop for instruction in lens-making and automobile laboratories. The building, which, apart from site, furniture and equipment, has involved an expenditure approximating to £45,000, comprises basement, ground floor and four stories above. The total floor area is approximately 28,000 sq. ft., of which nearly 20,000 is directly 'useful'. Rooms occupied by the chemistry section include lecture room and two laboratories for general chemistry on the first floor, with laboratories for fuels, electro-deposition, metallurgy and metallography immediately above. The watch and clock-making department occupies the fourth floor and comprises separate workshops for clock-making and watch-making, timing laboratory, master clock station and drawing office. The provision of these additional premises is designed to permit of considerable expansion within the main building of laboratory and workshop accommodation for engineering and physics.

Calendar of Geographical Exploration

Dec. 12, 1639.—Exploring the Amazon

Pedro de Teixeira arrived at Pará after his journey to Quito. Teixeira had become Governor of Pará in 1618 and had ascended the Amazon and its tributary, the Tapajos, in quest of slaves. In June 1637 two friars had launched a boat on the Napo and thence sailed on the Amazon to its mouth. Their adventure suggested the possibility of navigating the Amazon, and Teixeira set out late in 1637 to explore the river route to Quito. The Portuguese explorer slowly and with difficulty accomplished the journey against the current. From Quito he again returned by the river, noting the confluences of its tributaries. Information was also gained of the connexion with the Orinoco by means of the Cassiquiari, though this news was received with incredulity.

Dec. 13, 1577.—Sir Francis Drake

Sir Francis Drake sailed on his circumnavigation of the globe, the first carried out by an Englishman. He was apparently commissioned to examine the coast of Terra Australis as shown on the map of Ortelius 1570. But he certainly knew of the insular character of Tierra del Fuego and quite probably rounded Cape Horn; thus his journey disproved the map. He also reported a good bay on the west coast of America in lat. 43° N. This report, like that of Juan de Fuca, who was said to have discovered, in 1592, a strait in 47° N., greatly stimulated the search for a north-west passage.

Dec. 13, 1835.—Exploration of the Irrawaddy

Capt. S. F. Hannay arrived at Katha on the Irrawaddy. He proceeded to Bhamo and explored the Mogaung River. From Mogaung he went to the amber mines of the Hukawng valley, but the miners distrusted his Burmese escort and he returned by the route along which he had come to Ava. Until his time Ava had been the farthest point reached on the Irrawaddy. Hannay's voyage suggested that there was little possibility that the Tsang-po (Brahmaputra) flowed into the Irrawaddy, as was supposed by some to be the case; in 1886 Needham definitely proved that there was no connexion between the two rivers.

Dec. 14, 1911.—Roald Amundsen

Roald Amundsen, the famous Norwegian explorer, reached the south pole and remained there taking observations until Dec. 16. In 1903–6, Amundsen had achieved the navigation of the north-west passage, which had for centuries baffled explorers. A small sealing sloop, the *Gjöa*, was fitted with a motor and strengthened to withstand ice. She left Christiania on June 17, 1903, with six men only, passed through Lancaster Sound down the west side of Boothia Felix and wintered in Gjöa Harbour, King William Island. Here the ship remained for two years and sledging excursions were made to the magnetic north pole and the coast of Victoria Island was charted to 72° N. The *Gjöa* proceeded westward, but was frozen in off King Point, where a third winter was passed. On July 11, 1906, she got free and then sailed through Bering Strait into the Pacific. Thus at last was realised the dream of early mariners. In 1918–21 Amundsen made the north-east passage, wintering three times on the Siberian coast. On May 11, 1926, two days after Commander Byrd had flown from Spitsbergen to the north pole and back, Amundsen flew in the airship *Norge* from Spitsbergen across the pole to Teller, Alaska, a distance of 3391 miles in 72 hours. Amundsen left Bergen in an aeroplane on June 17, 1928, to search for Nobile after the wreck of the airship *Italia*, and was never heard of again.

Dec. 17, 1837.—Sir George Grey in Australia and New Zealand

Sir George Grey started an inland journey from Prince Regent River in an endeavour to reach the Swan River, but was unable to do more than explore the Glenelg and Prince Regent Rivers, owing to a wound received in a struggle with natives. In 1838 he attempted an exploration of the coast north and south of Shark's Bay, but his three boats were wrecked and the party had to tramp overland from Cantheaume Bay to Perth, a distance of 300 miles. Grey pushed on ahead to bring relief to the party and walked into Perth on April 20, so changed by suffering that his friends did not know him. The expedition resulted in the discovery of some ten rivers, including the Gascoyne, Murchison, Greenough and Irwin, as well as parts of the Darling and Victoria Mountains. In 1841 Grey became Governor of New Zealand where he took a keen interest in the Maori, who in turn were devoted to him. His scholarly collection of their legends and myths has become a classic.

Societies and Academies

LONDON

Geological Society, Nov. 9.—C. T. Madigan: The geology of the Western MacDonnell Ranges, Central Australia. The sections of previous investigators, including those of the Horn Expedition, H. Y. L. Brown, and L. K. Ward, are correlated, and the formations are traced and mapped throughout the area. The stratigraphical position and actual location of the very important Horn Valley, with its Ordovician fossils, are finally established. A new Ordovician fossil locality in the James Ranges is recorded, and the first geological account of the Waterhouse Range is given. The Central Australian formations are reclassified and the age of the beds is fully discussed.—T. N. George: The Carboniferous Limestone series in the west of the Vale of Glamorgan. The stratigraphical sequence in the Avonian is comparable with that established in Gower to the west by Dixon and Vaughan, and in the district around Ruthin and Miskin to the east by Dixey and Sibly. The normal succession of zones is displayed, without any marked departures from the characteristic lithological types of each. As a whole, the series was probably deposited in slightly deeper water than the Gower Series, and dolomite is poorly developed. The rocks over the greater part of the area are folded into a pitching anticline, the Candleston anticline, the axis of which falls eastward. Over the western part of the area, around Porthcawl, the strata are almost horizontal, only D_1 being exposed. A number of minor north-and-south faults traverse the rocks, at least one of which is a tear of post-Triassic age.

Physical Society, Dec. 2.—Lewis F. Richardson: Time-marking a kathode-ray oscillogram. Time marks have been arranged as little blurs or gaps in the trace, by periodically unfocusing the electron stream. The current in and voltage across a conductor can thus be recorded together with the time on a single oscillogram. — J. F. Herd: The generation and reception of wireless signals of short duration. In the use of short-duration signals for investigation of the ionosphere, it is convenient to emit the signal pulses at a controlled rate and to receive them on an oscillograph giving temporal discrimination between the arrival of the ground ray and that of subsequent echoes. Simplification of recording technique can be obtained if, at the receiver, an oscillograph of the cathode ray type is used in conjunction with a time-scale voltage of which the rate of recurrence is exactly the same as that of the emitted impulses. The paper describes methods of utilising the common frequency of an A.C. supply network to secure such synchronisation.—R. Naismith: A comparison of the frequency-change and group-retardation methods of measuring ionised-layer equivalent heights. Measurements are conducted under as varied conditions as possible. The results appear to confirm the theoretical investigation recorded by Appleton in 1928. The apparatus used to measure the amount of the frequency change employed in the measurements is described.—H. L. Wright: The influence of atmospheric suspensoids upon the earth's magnetic field, as indicated by observations at Kew Observatory. Changes in the electrical resistivity of the air and in the potential gradient may be associated with changes in the concentrations of gross particles and of condensation nuclei. Observations of these four quantities made at Kew Observatory over a period of three years indicate that resistivity depends upon the number of gross particles and of condensation nuclei, while potential gradient varies with resistivity and the number of nuclei.

DUBLIN

Royal Irish Academy, Nov. 14.—L. B. Smyth: *Cleistopora geometrica*, Milne-Edwards and Haime. Specimens of this curious Devonian coral from the type locality, Sarthe, France, were studied. Tabulæ, said by Nicholson (1888) to be absent, are demonstrated. The mural pores are shown to be straight, not tortuous. A wrinkled epitheca appears where the corallum extends beyond the supporting brachiopod shells. Separation of the index fossil of the Lower Carboniferous *Cleistopora* zone from this form is fully supported by the investigation.—R. Lloyd Praeger: Some noteworthy plants found in, or reported from, Ireland. Careful investigation during 1931–32 has proved in the author's opinion, that *Arbutus Unedo* is native on Lough Gill in Sligo—heretofore it has been known only from Kerry and West Cork, though place-names point to its former extension as far north as Mayo. *Cochlearia anglica* is present everywhere round the Irish coast. The claims of *Arctostaphylos alpina* and *Selaginella Kraussiana* reported from Ireland to a place in the flora are not admitted.—R. Patten: Observations on the cytology of *Opalina ranarum* and *Nyctotherus cordiformis*. The endoplasmic bodies in *Opalina ranarum* are flattened disc-like bodies, with the flat side generally parallel to the flattened surface of the organisms; the rod or dumb-bell-shaped forms and the irregular or spherical bodies are but two aspects of the same structure. Mitochondria are present as small spherical structures revealed by chrome-osmium techniques, and also by intra-vitam staining with Janus green. Blackened bodies, shown by Da Fano's silver method, in the outer regions of *Opalina* may be Golgi elements. *Nyctotherus* bacteria, both bacilli and cocci, are seen by various fixatives, in the cytoplasm. No Golgi apparatus has been revealed. Large numbers of smaller bodies are preserved by many methods. These as well as bacteria are Gram positive, but in spite of resemblances the former are not bacteria—they are probably modified mitochondria.

PARIS

Academy of Sciences, Nov. 2 (vol. 195, pp. 725–740).—Paul Pascal and Jean Grévy: The action of ammonia and amines on the viscosity of collodion. The effect of ammonia on the viscosity of solutions of gun-cotton in ether-alcohol mixtures is a function of the time. There is, at first, a rapid increase in the viscosity followed by a decrease. Viscosity time curves are given showing the effects of increasing quantities of ammonia. The fatty amines produce a similar but more marked effect and a diagram is given showing the comparative effects of ammonia, methylamine, dimethylamine and ethylamine.—André Haarbleicher: Some new properties of the trajectories of points linked *à un trois barres*.—Henry Girerd: The measurement of the aerodynamical characteristics of a supporting wing in a plane current.—L. Malavard: The fundamental problem concerning the (aeroplane) wing of finite spread.—Jacques Bourcart: The marine deposits of the second Miocene cycle of western Morocco.—Marc Simonet: Chromosome counting in the

genera *Baptisia*, *Thermopsis* and *Lathyrus*. Twenty-four species of *Lathyrus* give the same number of chromosomes, 7 : *Baptisia* and *Thermopsis* have the same number, 9.

ROME

Royal National Academy of the Lincei, June 19.—L. Petri : A photoelectric method for demonstrating Gurwitsch's mitogenetic radiations. Results obtained by a new method confirm Rajewsky's conclusion, that the radiation discovered by Gurwitsch is emitted even in complete darkness. They show, moreover, that a paste made from the germinating caryopsids of grain is less active in this respect than the whole caropsids and continues to yield the radiation for only about thirty minutes instead of for several hours.—P. Clemente : New majoration formulæ for the periodic solutions of an ordinary linear differential equation of the second order.—M. Ghermanesco : Laplace's equation. The application of Laplace's equation for a plane to a space of n dimensions is considered.—Hans Hamburger : Ribaucour's transformation and spherical representation. (1) Remarks on the general theory of Ribaucour's transformation.—M. Picone : Integral equation translating the most general linear problem for the ordinary linear differential equations of any order.—U. Cassina : The pendulum of variable length.—L. S. Da Rios : Auto-rotating rotor cylinders.—E. Martin : Method for calculating the orbit of a visual binary.—G. Agamennone : The presence of slow waves in the preliminary phase of certain seismograms.—G. A. Barbieri and A. Tettamanzi : New complex compounds of silver cyanide with sodium cyanide. The presence of the complex $Ag(CN)_3$ in crystalline compounds has been shown by the preparation of additive products of sodium, magnesium, and calcium argentocyanides with hexamethylenetetramine. It is now found that sodium and silver cyanides form, besides $NaAg(CN)_2$, also the compounds $Na_2Ag(CN)_3$, $3H_2O$ and $Na_3Ag(CN)_4$, $5H_2O$, both of which are obtainable in the crystalline condition.—A. Corbellini and M. Angeletti : Stereoisomerism of 2 : 2′-disubstituted derivatives of diphenyl (2). Fractional crystallisation from alcoholic solution of the brucine salt of racemic 2-[bis-phenylhydroxymethyl]-2′-diphenylcarboxylic acid yields, in larger amount, the less soluble lævo-rotatory salt.—G. Devoto : Magnetic susceptibility of the carbamides, isocarbamides, and sulphamide. Investigation of these compounds in the solid state reveals again the negligible effect of isomerism on diamagnetism, the empirical formula being of fundamental importance in this respect.—F. Garelli and G. Racciu : Triphenyl phosphate as a solvent in cryoscopy (1). Although certain compounds exhibit somewhat anomalous behaviour, the value 120 may be taken as the value of the molecular freezing-point depression of triphenyl phosphate ; the value calculated by means of van 't Hoff's equation is 117·6.—A. Boni : The Miocene of Monte Vallassa.—R. Redini : The geology of Monte Pisano. Observations are described which are at variance with the conceptions of previous investigators on the stratigraphy and tectonics of this region.—Giuseppina Dragone-Testi : A new microchemical method for the separation of the cellulose in vegetable membranes. Paternò's method for dissolving cellulose for industrial purposes—digestion of the fibrous material with copper acetate solution, precipitation with sodium carbonate, dissolution of the precipitate in aqueous ammonia, and reprecipitation by acid—may be applied to the microchemical analysis of vegetable membranes.—G. Montalenti : The embryogenesis of hybrids of *Bufo vulgaris* and *Bufo viridis*.—Constantino Gorini : The coagulation of milk by the action of *Bacillus typhi* and other bacteria regarded as inactive towards milk. Chymase is widely distributed in parasitic bacteria, its formation being a normal function of the micro-organisms, independently of the presence of milk and casein. When milk which has been subjected to gentle sterilisation is poured on to vigorous agar cultures of *B. typhi*, *B. morgani*, and *B. hypolyticum*, coagulation occurs, although these bacteria are considered to be without action on milk. The enzyme occurs also in various bacteria which do not liquefy gelatine.—M. Mitolo : Action of vapours of vegetable essences and of animal aromas on medullary reflex excitability.

SYDNEY

Royal Society of New South Wales, Sept. 7.—V. M. Trikojus and D. E. White : The chemistry of the constituents of the wood-oil of the 'Callitris' pines. (1) The constitution of 'callitrol'. Chemical investigation of the wood-oil of the typical native pine of Australia, the 'Callitris' species, has shown that the substance 'callitrol' chiefly responsible for the anti-termite properties of the timber is identical with *l*-citronellic acid, this being the first record of its occurrence in Nature. H. G. Smith had considered 'callitrol' to be a phenol, but its constitution has now been proved beyond doubt. Chemical investigation of the other constituents of the oil, particularly of the sesquiterpene alcohol, guajol, is proceeding.—Burnett Mander-Jones and V. M. Trikojus : The synthesis of bases allied to coniine. (1) The preparation and pyrolysis of the allyl ethers of *N*-heterocyclic enols. The migration of the allyl group in the *o*-allyl ethers of *N*-heterocyclic enols has been studied with the object of synthesising substances allied to the alkaloid, coniine. The ethers of 4-oxy quinaldine and its derivatives have been chiefly investigated, and it has been found that the allyl group wanders invariably to carbon in various positions in the ring, rather than to nitrogen, which is contrary to the prediction of other workers. The constitutions of the re-arranged products have been proved by synthesis, and reduction has led to the preparation of bases, the physiological properties of which are being studied.—V. M. Trikojus and D. E. White : A note on the constitution of tasmanol. 'Tasmanol', occurring in the cineol-phellandrene-bearing class of eucalypts, was considered by Smith and Robinson to be a phenol. The substance isolated from the leaves of *Eucalyptus Risdonii* has now been shown to be an acid, $C_{13}H_{22}O_3$, yielding a crystalline *p*-toluidide, and a silver salt. A methoxyl group is also present. The characteristic blood-red colour yielded by the substance with ferric chloride is due to the formation of a coloured ferric salt. The elucidation of the structure is not yet complete.—F. P. J. Dwyer, D. P. Mellor, and V. M. Trikojus : The use of potassium dichromate and sodium nitrite in aromatic nitrosations. A mixture of potassium dichromate and sodium nitrite in the molecular proportions of 1 : 2, or of sodium nitrite, with a trace of the dichromate or chromate associated with a stream of carbon dioxide, can be used to introduce the nitroso group into organic molecules under extremely mild conditions. The conditions can be so arranged that the reaction occurs entirely under neutral or slightly alkaline conditions. The

reaction has been carefully followed electrometrically, using the glass electrode, for the rapid production of pure diazo-amino benzene.—A. R. Penfold and J. L. Simonsen: The essential oils of three species of *Geijera* and the occurrence of a new hydrocarbon (2). The new substance to which the name 'geijerene' has been given, possesses the formula $C_{12}H_{18}$. Unfortunately, it does not yield any crystalline derivatives. Despite the large number of experiments, no evidence has yet been obtained which would enable the authors to suggest a constitution for the hydrocarbon.

Forthcoming Events

SATURDAY, DEC. 10

BRITISH PSYCHOLOGICAL SOCIETY, at 3—Annual General Meeting at Bedford College, Regent's Park, N.W.1.

MONDAY, DEC. 12

ROYAL SOCIETY OF ARTS, at 8—(Fothergill Lecture).—Maurice E. Webb: "The Design and Construction of Buildings in Relation to Fire Risks".

ROYAL GEOGRAPHICAL SOCIETY, at 5—Dr. J. Georgi: "The Scientific Results of the Wegener Expedition to Greenland".

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION), at 7.15—(Jubilee Memorial Lecture).—Dr. E. F. Armstrong: "Alcohol through the Ages" (to be repeated before other Sections).

TUESDAY, DEC. 13

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.30—(Harrison Memorial Lecture).—Sir Henry Dale: "Therapeutic Problems of the Future".

WEDNESDAY, DEC. 14

ROYAL SOCIETY OF ARTS, at 8—S. P. B. Mais: "The Work of the National Trust".

INSTITUTION OF CHEMICAL ENGINEERS, at 5.30—(at the rooms of the Chemical Society, Burlington House, W.1).—Conference on "Testing of Chemical Plant". Papers by A. L. Bloomfield, Prof. W. E. Gibbs and Dr. A. J. V. Underwood.

NEWCOMEN SOCIETY, at 5.30—(in the Science Museum, South Kensington, S.W.7).—Public Lecture by F. Nasmith to commemorate the bicentenary of Sir Richard Arkwright.

BRITISH PSYCHOLOGICAL SOCIETY (MEDICAL SECTION), at 8.30—Dr. John Rickman, Mrs. E. Brackenbury, Dr. William Brown and E. Glover: Symposium on "Psychology and Psychical Research".

THURSDAY, DEC. 15

UNIVERSITY OF BRISTOL, at 5.15—(Henry Herbert Wills Memorial Lecture).—Lord Rutherford: "Atomic Transformations".

CHEMICAL SOCIETY, at 8—Discussion on "The Chemistry of Sterols, with Special Reference to Ergosterol", to be opened by Prof. I. M. Heilbron.

FRIDAY, DEC. 16

ROYAL INSTITUTION, at 9—Sir George Macdonald: "Roman Wall in Scotland".

Official Publications Received

GREAT BRITAIN AND IRELAND

Two Lectures on an "Outline of an Electrochemical (Electronic) Theory of the Course of Organic Reactions". By Robert Robinson. Pp. 52. (London: Institute of Chemistry.)

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Thirty-sixth Session, adopted at the Meeting of Governors held on the 18th October 1932. Pp. 73. (Glasgow.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Forestry Society. Vol. 46, Part 2, October. Pp. xvi+97–216+25–34. (Edinburgh: Douglas and Foulis.) 7*s*. 6*d*.

The School Certificate Examination: being the Report of the Panel of Investigators appointed by the Secondary School Examinations Council to enquire into the eight Approved School Certificate Examinations held in the Summer of 1931. Pp. 161. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

Census of India, 1931. Abstract of Tables giving the Main Statistics of the Census of the Indian Empire of 1931; with a Brief Introductory Note. Pp. 16+2 maps. (London: H.M. Stationery Office.) 9*d*. net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1481 (T.3230): Estimation of Wing Surface Area for Evaporative Cooling. By C. Anderton Brown and A. W. Morley. Pp. 23+12 plates. 1*s*. 6*d*. net. No. 1488 (T.3276): Slipstream Effect on the Downwash and Velocity at the Tailplane. By F. B. Bradfield. Pp. 7+15 plates. 9*d*. net. (London: H.M. Stationery Office.)

Report of Delegates of the United Kingdom of the 25th Meeting of the International Council for the Exploration of the Sea, held in Copenhagen from June 20th–25th, 1932. Pp. 10. (London: Ministry of Agriculture and Fisheries.)

OTHER COUNTRIES

Transactions of the San Diego Society of Natural History. Vol. 7, No. 16: Descriptions of Heretofore Unknown Mammals from Islands in the Gulf of California, Mexico. By William Henry Bury. Pp. 161–182. Vol. 7, No. 17: A Southern Race of the Spotted Screech Owl. By A. J. van Rossem. Pp. 183–186. Vol. 7, No. 18: Notes on the Desert Tortoise (*Testudo agassizii*). By Prof. Loye Miller. Pp. 187–208+plates 10–11. (San Diego, Calif.)

University of Michigan: School of Forestry and Conservation. Bulletin No. 1: Foods of some Predatory Fur-bearing Animals in Michigan. By Prof. Ned Dearborn. Pp. 52+4 plates. (Ann Arbor: University of Michigan Press.) 25 cents.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 12, 1930. vi. Aerologiska iakttagelser i Sverige. Pp. 40. 3 kr. Meddelanden, Band 5, No. 6: Lancers de ballons-sondes d'Abisko de 1921 à 1929. By Bruno Wolf. Pp. 42+9 planches. 3 kr. (Stockholm.)

Publications of the Observatory of the University of Michigan. Vol. 4, No. 14: The Spectrum of b^2 28 Cygni. By Hazel Marie Losh. Pp. 199–216. Vol. 5, No. 1: Elements and Ephemeris of Comet Peltier-Whipple (1932k). By Allan D. Maxwell. Pp. 4. (Ann Arbor, Mich.)

New Zealand: State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March, 1932. Pp. 16. (Wellington, N.Z.: W. A. G. Skinner.)

Forest Bulletin No. 79: Calorific Values of some Indian Woods. By S. Krishna and S. Ramaswami. Pp. 27. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s*. 3*d*.

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1932. (No. 2315.) Pp. iii+50. (Ottawa: F. A. Acland.) 25 cents.

The South African Journal of Science. Vol. 29: Being the Report of the Thirtieth Annual Meeting of the South African Association for the Advancement of Science, Durban, 1932, 4 July to 9 July. Pp. vi+lii+866. (Johannesburg.) 30*s*. net.

Paleontologiese Navorsing van die Nasionale Museum, Bloemfontein. Deel 2, Stuk 4: Vrystaatse Wilde Varke. By Dr. Ir. E. C. N. Van Hoepen and H. E. Van Hoepen. Pp. 39–62. (Bloemfontein.)

India: Meteorological Department. Scientific Notes, Vol. 4, No. 44: Thunderstorms in the Peninsula during the Pre-Monsoon Months April and May. By S. P. Venkiteswaran. Pp. 145–152+6 plates. 1.10 rupees; 2*s*. 9*d*. Scientific Notes, Vol. 5, No. 46: On Solitary Gusts associated with Reversals of Pressure Gradients. By S. Atmanathan. Pp. 10+1 plate. 10 annas; 1*s*. (Calcutta: Government of India Central Publication Branch.)

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Observations on the Size and Growth of two Egyptian Mullets, *Mugil cephalus* (Linn.), the "Bouri", and *M. capito*, Cuv., the "Tobar". By R. S. Wimpenny. Pp. ii+53+4 plates. (Cairo: Government Press.)

Japanese Journal of Geology and Geography. Transactions and Abstracts, Vol. 10, Nos. 1 and 2, October. Pp. iii+82+11+5 plates. (Tokyo: National Research Council of Japan.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 393: Tensile Properties of Copper at Low Temperature. By Masawo Kuroda. Pp. 163–167. 15 sen. Nos. 394–397: The Change of Wave-Length and Intensity in Iron, Nickel and Titanium Lines by Disruptive Discharge, by Hantaro Nagaoka, Tetsugoro Futagami and Iwajiro Machida; On the X-Ray Study of the Density Distribution in the Discharge Tube, by Yoshio Ishida and Toyotaro Suetsugu; Researches on the Anodic Film of Aluminium, 1: Effect of Concentration of the Electrolyte on the Formation of Anodic Film, by Shoji Setoh and Akira Miyata; Researches on the Anodic Film of Aluminium, 2: Anodic Behaviours of Aluminium in Aqueous Solutions of Oxalic Acid, by Shoji Setoh and Akira Miyata. Pp. 169–291+plates 16–21. 1.35 yen. Supplement No. 16: Study on the Corrosion of Gray Cast Iron by Nitric Acid—The Exothermic Phenomenon of Gray Cast Iron Piece in Nitric Acid Solution and at its Surface in Atmosphere after Corrosion by Nitric Acid. By Yōichi Yamamoto. Pp. 11. 15 sen. (Tokyo: Iwanami Shoten.)

Department of Agriculture: Trinidad and Tobago. Flora of Trinidad and Tobago. Vol. 1, Part 5: Rosales (concl.); Myrtales (pars). By R. O. Williams. Pp. 309–332. (Trinidad: Government Printing Office.) 1*s*.

Memorias del Consejo Oceanográfico Ibero-Americano. No. 12: Procedimientos para fondear un navís a grandes profundidades para medida directa de corrientes. By Dr. F. Spiess. Pp. 48. No. 13: Problemas principales de la Oceanografía del Pacífico. By Dr. Thomas Wayland Vaughan. Pp. 31. (Madrid.)

CATALOGUES

Beck Luminex Magnifier. Pp. 6. (London: R. and J. Beck, Ltd.)

Catalogue of Astronomical Telescopes and Accessories. Twenty-third edition. Pp. 24. (London: W. Watson and Sons, Ltd.)