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CONTENTS.

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Broadcasting as an Aid to Scientific Study.

"THE modern world," wrote the author of "Arnold of Rugby" in a more recent work, "with its democratic temper which holds in small esteem the traditions of a learned caste, realises that the society of a university may embrace many groups within the State who possess capacity and energy for the serious pursuit of knowledge, even though they are not concerned to complete the courses prescribed for degrees. It [the university] thus becomes an organ for extending the resources of science beyond the limits of the school, it becomes 'an instrument of the people,' placing its resources at the disposal of all members of the State who need its aid. No doubt this ideal is easier to describe than to fulfil: the duty is not fulfilled by merely distributing lecturers or books to miscellaneous audiences; still less by offering instruction of an elementary grade, such as the schools should provide; nor is the ideal attained by ministering only to one class of the community, artisan or other, which can make its voice heard. The university of the future will place at the disposal of all classes, for the common benefit, both the methods of study and the result of research which give to it its special character; and it will discover manifold means by which such a purpose can be achieved." When one considers the potentialities of broadcasting, this description of Prof. J. J. Findlay's seems almost prophetic, though he could not have foreseen the possibility of "taking the mountain to Mahomet" when he wrote "The School."

Broadcasting offers unique opportunities for the encouragement of scientific study. In spite of anti-highbrow campaigns in the daily press, there is undoubtedly an audience of some millions who are finding an interest in the broadcast science talks. In some cases it is the professional interest of a garage mechanic in talks on metallurgy, and in others it is a purely intellectual interest, in talks on, say, astronomy. In any event the audience is certainly there, and it is an audience which cannot be reached in the first place by other means. A small proportion of its members habitually buy scientific reference books or go to public lectures, but large numbers can and do listen to the unseen lecturer. This is probably accounted for by reason of the fact that the value of the broadcast lecture lies in its capacity for awakening and sustaining interest rather than its capacity for supplying information.

The exposition of science in popular periodicals

and in the daily press has not always been in the right hands. There have been notable exceptions, of course, but many articles appear in print which do little more than appeal to a sense of the marvellous. Scientific exhibits also are often regarded as like unto conjuring tricks; and their meaning is not understood. There is a demand for sensationalism and 'latest theories' from an overcredulous public, ready to believe all conclusions without having any idea of the sort of evidence behind them—the experimental work, etc.—and often without any knowledge of the scientific method. We are living in a new age of faith. As a result the conscientious scientific worker is apt to shrink from popular exposition, and too often others have rushed in where he feared to tread.

From time to time there emerge from amongst workers in science, men who combine scientific ability with a gift for the interpretation of experimental work and its dependent theories, in lucid and non-technical language. Such men are all too rare. A great task confronts them, and no opportunity for the dissemination of their influence should be lost. It is of growing importance that there should be a widespread and intelligent understanding of the work of science. Research work is, of course, often carried out by individuals working at the universities, or in their own laboratories, quite independently of public support. The situation is, however, now changing. The extreme specialisation which is becoming the rule necessitates team work and a multiplication of the actual number of workers. Much work will be needed to consolidate the new ground which has been broken so rapidly of late years, and there are signs that an expansion of the research world is actually taking place. The growth of organised State-aided research work and the foundation of research laboratories by large industrial firms will, before long, make it much to the advantage of science to have a sympathetic electorate. It is important that the public should have a sense of proportion of the utility of research work. Work must not be thought worthless because it has no obvious practical application; nor, on the other hand, must research work in pure science be expected to put atomic energy and the transmutation of metals on an economic basis forthwith. A widespread knowledge of scientific principles would, in addition, be of great value to the community.

There is, then, an important field for broadcast lectures of an introductory character which will awaken interest, give a grasp of the fundamental principles involved, and provide sound guidance for further study of a serious nature.

A considerable number of science talks have already been broadcast, but these have so far been of an experimental nature and were intended to investigate the demand for such talks. In the early days of broadcasting, single talks on a variety of scientific subjects were given, but more recently connected series of six or a dozen talks of a more advanced and serious nature have been the rule. (The names of Sir Oliver Lodge, Prof. H. H. Swinnerton, Prof. W. Cramp, Prof. A. V. Hill, and Prof. C. H. Desch are to be seen in the B.B.C. list of lecturers for the past year.) The number of interested listeners is encouraging and seems to justify the development of regular short courses, in spite of the growing competition for programme space.

In a report on Natural Science in Adult Education (Paper No. 8 of the Adult Education Committee of the Board of Education) the comparative neglect of science in adult education is deplored. The explanation given for this neglect is that, in comparison with subjects such as history and economics, there is a shortage of suitable lecturers; that provision for experimental work is always a matter of difficulty; and that in the minds of those attending adult schools science courses savour of technical instruction. When once half-hearted classes have discovered that the science course is intimately related to daily life, and that it stimulates their powers of reflection and judgment, the success of the course is assured. The report cites the interest shown in broadcast science talks as evidence of the great latent interest which is believed to exist.

Attention has recently been directed in these pages to the teaching of science in schools. It has been said, apparently with considerable justification, that the "teaching of science in our schools is parrot work, confined to special subjects, and failing to impart any notion of the scientific method." All the conditions obtaining in the smaller secondary schools combine to produce this state of affairs. The laboratory equipment is inadequate, and there are insufficient supplies to make the construction of apparatus and glass-blowing possible. Stereotyped and exacting syllabuses determine largely the scope and character of school text-books and make insistent demands upon the time available for instruction. Yet a large number of pupils who will go on to science courses at a university are trained under these conditions. The state of affairs is due in part to the school certificate and university scholarship

syllabuses, and in part to limited finance, which leads to inadequate staffing and equipment. Broadcasting, perhaps, can be of assistance here. Some thousands of elementary schools are finding that their staff can virtually be increased by means of the broadcasts to schools that are given daily from the B.B.C. stations, and this year, as an experiment, the B.B.C., in consultation with teachers, has started to give weekly talks for secondary schools. The talks deal with subjects of general interest, on which it is unlikely that there will be authoritative exponents among the school staff, and in science an attempt is being made to give short courses of an introductory character on subjects which are not normally in the school curriculum. The virtual neglect of all sciences other than physics and chemistry in boys' schools, and botany in girls', is much to be deplored. It is not suggested that a number of branches of science should or could be taught in detail, but it should not be possible for pupils to leave school with no more familiarity with science than accrues from the mechanical performance of the usual experiments in physics and chemistry.

There is no doubt that the distribution of university entrants among the various branches of sciences suffers an artificial bias to physics and chemistry. Undergraduates faced with a choice of subjects are chary of embarking on an unfamiliar science, and frequently do so only to make up the requisite quota enforced by the university regulations. With the view of filling the gap in school science teaching, talks on geology and anthropology have been broadcast during the past term, and various other courses, including biology, are projected for the future. An attempt is made to link up the various courses and show how each branch of science depends on its related branches. The talks are given at 4.15 P.M. after the normal school hours, and it is found that groups of pupils stay behind voluntarily to listen.

The desire for intellectual adventure is characteristic of the adolescent, and broadcasting can give the right amount of guidance for private study without destroying the sense of independence which is such a rich source of energy. Both in adult and in adolescent education, broadcasting has a useful sphere of activity, but the extent to which it can be effective depends upon the co-operation and support given by other educational bodies. We ourselves have no doubt as to its potentialities as a means of creating interest in science among the general public and affording a valuable educational aid to the work of the school.

The Societies of Ants.

The Social World of the Ants compared with that of Man. By Dr. Auguste Forel. Translated by C. K. Ogden. Vol. 1. Pp. xlv + 551 + 10 plates. Vol. 2. Pp. xx + 445 + 16 plates. (London and New York: G. P. Putnam's Sons, Ltd., 1928.) 63*s.* net.

AUGUSTE FOREL is one of the grand old men of science, a survivor from the heroic heyday of Darwinism, and a welcome reminder, in this epoch of specialisation, that a man can excel in several branches of learning. To the general biologist he is known (not to mention his contributions to comparative physiology, such as his "Senses of Insects") as one of the greatest authorities on ants, both their systematics and their behaviour; he was one of the notable pioneers of neurology and brain anatomy (I recollect, when I visited him in his home above the Rhone Valley, his showing me some brain sections: "You see those," he said, "those were the first microscopic sections of the human brain to be made. I made them, in the 'seventies."); to the medical profession he is a very distinguished psychiatrist; to the sociologist, the author of that arresting book, "La Question sexuelle."

The lover of natural history will rejoice to learn that all these activities had their root in Forel's passion for observing ants. At the age of ten he made an interesting original discovery—that certain small ants lived as thieves in the nests of other larger species; and when only seven he had, without knowing of Huber's classic work, gone far towards an independent discovery of the famous slave-making habits of *Formica rufa* and *sanguinea*. Then came the happy accident. His grandmother gave him a book. It was Huber's publication of 1810, "Recherches sur les mœurs des fourmis indigènes"; Huber himself had been an old flame of hers, and had presented it to her! However, as she said, she had never been able to get through the book: "It was not her style"; but the eleven-year-old Auguste devoured it, and it became his Bible.

Out of Forel's passion to know the habits of ants there came the desire to know more of their structure and physiology; this led him to take up the study of biology; from this in turn he was led to medicine, and thence (with his love for studying behaviour) to psychiatry.

The English-speaking world will be grateful to Mr. Ogden for translating Forel's summary of his main life-work, and to the publishers for the

admirable way in which it is turned out. For it is indeed a classic. W. M. Wheeler's "Ants" is the only book with which it can be compared, and that is perhaps, for all its fascination, a shade stiff for the non-biologist. This is not to say that the layman will by any means always find Forel's pages easy going; but the personal touch and the enthusiasm with which the book is written will carry him over many hard passages.

The whole ant-world is here: and a strange world it is. Here is a classification of the five thousand or so ant species, with the fossil record and probable evolutionary history of the ant stock. Here is their geographical distribution, their anatomy, the physiology of their senses. But more than two-thirds of the two volumes is taken up, as is fitting, in describing and discussing their ways of life—their nest-building, their nuptials and the founding of new colonies, their daily routine, labour and sleep, toilet and games, feeding and language. Then come their diverse specialisations, how some tend cattle, others store grain, others make of themselves living honey-pots, others use child-labour in building their nests; how some are thieves, and others parasites, some predatory nomads, and others base their communities on slavery. Then there is an admirable résumé (Wheeler has put it vividly before us already in his "Social Life Among the Insects," but it is good to have another survey at a somewhat different angle) of the food-economics of the ant-community and of the extraordinary guests and parasites of ants, which include several thousand species of animals not found elsewhere than in ants' nests, some of them with habits unparalleled in strangeness in the whole of the rest of the animal kingdom, save perhaps in man alone. The perversion of instinct occasioned in the ants by the secretions of some of these guests, sometimes leading to the neglect of the ants' own brood, has its only parallel in the abuse of alcohol and other drugs by human beings.

Nor finally must we omit to mention the valuable appendix by Prof. Bugnion on "The War between the Ants and the Termites"—a most interesting study of the competition between the two different types of terrestrial social insects. There will be no biologist who will not gain new facts, new ideas, and new points of view from this storehouse of first-hand knowledge on the most successful type of invertebrate organism; it has obvious interests for the sociologist, for the psychologist, and the student of the origin of language; and it will well repay the general reader.

It would be both impossible and impertinent to attempt any detailed criticism of the book in such a review as this, and I propose to confine myself to some general reflections, inspired by the author's epilogue and the translator's foreword.

Mr. Ogden begins his preface with the words, "There are scientists who hold that in due course Man will yield to the Ant the mastery of a planet grown less hospitable to the relatively idle and unorganised." The author near the close of his work writes, on the resemblances and differences between ants and man, "Among ants we find weavers, butchers, cattle-rearers, masons, road-makers, harvesters, bakers, mushroom-farmers, excellent nurses of various kinds, gardeners, warriors, pacificists, slave-makers, thieves, brigands, and parasites; but we find no professors, orators, governors, bureaucrats, or generals, nor even corporals, nor do we find capitalists, speculators, or even swindlers. Think carefully about that, dear reader, and it will give you the key to the mystery."

The key to the mystery is of course, as Forel points out a few pages later, that, in spite of their antennal language, ants have no tradition in the broad biological sense, no transmission of experience from generation to generation, no real education; and this because their whole behaviour and existence is on a different plane from ours, being based primarily on instinct, while ours owes its distinctive qualities and its biological success to the capacity for conceptual thought or reason, and to the power of rapid learning. Once this is grasped—and, in spite of the lucubrations of non-scientific popularisers, of whom Maeterlinck on Termites is a recent flagrant example, there is no doubt of the reality of the difference and of its fundamental biological significance—it is difficult for anyone, scientist or no, to believe that man will yield his supremacy to ants unless there were to be some very radical and peculiar changes in the conditions of this planet.

Consider the vital differences which this one original difference brings in its train. Man, through tradition, is capable of rapid change in the organisation of his societies, rapid improvement in his control over Nature: ants are confined to the slow changes of random variation sifted by the wasteful hand of natural selection. Man can consciously envisage improvement in his conditions, and deliberately set about the control of his racial destiny; ants can do nothing of the sort. Ants have probably been in existence since the Secondary period; since the Oligocene, perhaps fifty million

years ago, they have not progressed or even changed in any essentials: man did not become man until the Pliocene at earliest, and even since that time, first he and then his societies and traditions have been evolving at an ever-accelerated rate, which shows no sign of slowing down. His species is thus still in its youth, while ants have long reached evolutionary stability. Then there exist some five thousand quite distinct species of ants, biologically separate and mutually sterile: man exists in but one species, whose races are all fertile *inter se*. Man has the longest infancy and the longest period of dependence and education of any organism: ants, after their larval existence as 'growth-machines,' followed by the radical remodelling of their passive pupal period, emerge fully-formed, ready at once to undertake their most elaborate actions, and never grow or moult again. A society of men is based primarily upon a common tradition, and is built round a scaffolding of authority and obedience: a society of ants is based primarily upon a differentiation of instincts, and lacks any central government or system of authority, the obedience of ants being obedience to their own instincts instead of to leaders. The patriotism of men is based upon ideas and tradition: the patriotism of ants is based upon smell.

Finally, and perhaps in a way most striking, the division of labour in human society depends chiefly upon learning to use different tools and technical methods, and there is no structural differentiation into well-marked castes; while that in ant communities depends upon differences present from the moment of emergence, differences not only in the structure of the brain and consequently in the instincts, but also in the general structure of the body. The ant-soldier hatches predestined from its cocoon, with head and jaws already turned into weapons; the human infantryman, however, is not born with one hand in the form of a rifle and the other in that of a lance, but weapons have to be manufactured for him by society, and he has to learn their use. Again, the range of size in normal human adults, including pigmies, is from about 50 lb. to 250 lb. But there are ants (*e.g. Carebara*) in which the members of one caste—the queens—are at least 2000 times as bulky as the worker individuals.

The ants were already in their present position of dominant land invertebrate in the Oligocene. But they were powerless to prevent the evolution of the higher mammalia and of man, or man's subsequent rapidity of progress. There seems no reason whatever why they should, after so long a stable period, re-acquire the capacity for rapid evolutionary change, or suddenly succeed where they have previously failed.

If we ask what is the secret of this failure to attain complete biological dominance, in spite of such large measure of success, the probable answer lies in their small size. This is inherent in the very nature of insectan organisation. The arthropods in general are limited to sizes far below those attained by cephalopods and vertebrates, owing to the necessity of shedding and re-forming their skeleton in order to accomplish each step in growth. The insects are limited to a much smaller maximum size, as Mr. J. B. S. Haldane has pointed out, owing to their system of respiration. The transport of air direct to the tissues by tracheal air-tubes is extremely efficient for small organisms; but it depends upon diffusion, and diffusion will not be efficient in tubes of more than a certain length. No insect attains more than an ounce or so in weight; and the more active ants are mostly far smaller. This small size limits the number of cells in the brain, and this in turn limits the development of mental faculties; for it appears to be necessary to have many more cells to be capable of rapid learning than for even the most elaborate of instinctive reactions. Had ants been capable of attaining the size of dogs, or even of rats, the course of evolution might well have been very different. . . .

It is to be regretted that Forel has not kept in touch a little more with recent work in heredity, sex, and kindred subjects, for some of his generalisations and explanations are marred by being quite out-of-date: we may cite particularly his discussion of sex-mosaics among ants. In evolutionary theory, he attempts to combine natural selection with Lamarckian views based on Semon's "Mneme." But, as Bateson once put it, to explain heredity by memory is to attempt an explanation of the less in terms of the more complex—as well, be it added, as having no foundation in experimental fact. He asserts with extraordinary dogmatism (vol. 1, p. 15) that those who claim that the castes of ants are determined (as he admits is the case in bees) by feeding, are in error. "They are wrong: polymorphism in ants takes place in the egg." But no proof is given of this, and the evidence that does exist is certainly not against that natural hypothesis. Bugnion's assertion, by the way, which Forel cites on the same page, that the *nasutus* soldier of Termites emerges fully-differentiated from the egg, has since been shown to be erroneous, and the Italian school is making

it quite possible that even Termite castes owe their origin to diet-differences.

However, these are minor points. The book is a great book, full of the meat of fact and the wine of thought, and fragrant with the personality of the author. We are happy that he has lived long enough to crown his eighty years of labour with this monument. J. S. HUXLEY.

The Almagest of Ptolemy.

Composition mathématique de Claude Ptolémée. Traduite pour la première fois du grec en français, sur les manuscrits originaux de la Bibliothèque Impériale de Paris, par M. Halma, et suivie des notes de M. Delambre. (Réimpression facsimilé.) Tome premier. Pp. lxxvi + 476 + 48. Tome deuxième. Pp. viii + 448 + 40. (Paris: J. Hermann, 1927.) 2 vols., 210 francs.

THE publication of this facsimile of Halma's handsome edition of the Syntaxis of Ptolemy shows enterprise on the part of the publishers and will no doubt be welcomed by mathematicians and astronomers interested in the history of their subjects, as copies of the original book have long been scarce. Until the issue of Heiberg's definitive text in 1898 and 1903, Halma's was the only modern edition of the whole of the Greek text, and it has the merit of containing, in addition to a French translation facing the text, a large quantity of notes by Delambre as well as an elaborate historical introduction. Halma also had only one predecessor, Simon Grynæus, the editor of the *editio princeps*, containing the full Greek text with the commentary of Theon of Alexandria, which was published at Basel in 1538, previously to which date scholars had to be content with translations from the Arabic or epitomes of such versions.

The Abbé Nicolas Halma (1755–1828) studied first at the College of Sedan, his native place, and afterwards at Paris. Besides Greek and Latin, he learned Hebrew, German, English, and Italian; he also studied mathematics, geography, theology, medicine, poetry, and even drawing. Principal of the College of Sedan from 1791 until its suppression, he moved to Paris and, after holding various other posts, became professor of mathematics and geography at the Prytanée in Paris, professor of geography at the École Militaire at Fontainebleau, librarian to the Empress, and her instructor in history and geography. It was Delambre who, knowing that Halma combined with his accomplishments as a Greek scholar the necessary mathematical ability, urged him to undertake a work which would, he knew, be difficult but would be as honourable to him as it would be useful to science. After several years of hard work he produced the first volume in 1813. The times were not propitious, and he had to pay the cost of its production (about 30,000 francs) out of his own pocket. The second volume appeared in 1816; it was dedicated to Louis XVIII., with a preface in which that monarch was compared to Antoninus Pius, the patron of Ptolemy; the Ministry of the Interior subscribed for 225 copies and, with this encouragement, Halma decided to add to his edition certain minor Greek astronomical treatises as well as the commentary on Ptolemy by Theon. Of the latter commentary, however, only two Books actually appeared, in 1821 and 1822.

The *editio princeps* of Grynæus had been based on a MS. of the sixteenth century (Paris. 2393), a copy, at second hand, of another written in the ninth century which is the first of those used by Heiberg as the basis of his text. Halma used Grynæus's text as his groundwork, but consulted, in addition, four of the MSS. which are the main foundation of Heiberg's text. Unfortunately, Halma's philological qualifications were not quite adequate to enable him to produce a really authoritative text; while Manitius, the editor of the German translation of Heiberg's text (Teubner, 1912, 1913), says that in most of the difficult passages the French translation leaves us in the lurch. Nevertheless, with all its faults, Halma's edition will always retain its great historical interest. T. L. H.

Infection and Immunity in the Bee Mite.

L'Infection microbienne et l'immunité chez la mite des abeilles, Galleria Mellonella. (Monographies de l'Institut Pasteur.) Par S. Metalnikov. Pp. iv + 139. (Paris: Masson et Cie., 1927.) 18 francs.

THIS monograph gives an account of researches carried out at the Pasteur Institute over a period of more than ten years on the microscopic infection and immunity in the mite of bees. This insect, which has been of interest to scientific workers since Aristotle, is peculiar in that it is the only known animal which derives its nourishment from wax. The present work, in fact, shows that wax in some form is essential to its life and development. Ordinarily, the night-flying moth deposits its eggs in the hives of bees, where they hatch and pass through the successive stages to the fully-developed winged form. In the larval stage it

feeds upon the wax of the bees, and although experiments have been carried on with the insect in all stages, it is upon the larval one that the bulk of the present work has been done.

The author begins with an account of the biology and physiology of the insect. He has successfully cultivated it under laboratory conditions and made a minute study of its digestive apparatus and nutrition. It has, in fact, become in his hands a laboratory animal which lends itself to most types of experiments. Then the question of infection and immunity is dealt with. By injection of small and large doses into the body cavity, he has been able to determine whether and to what degree natural immunity exists. Immunity is hereditary, providing several generations have been immunised. A chapter on phagocytosis describes in detail the types of cells and the part played by each. The reaction is apparently specific for each organism, and is demonstrated by changes within the protoplasm of the cells. For example, an injection of tubercle bacilli brings about in a few minutes the formation of granules, followed in several hours by the formation of a giant cell. The leprosy bacillus, on the other hand, is clumped within single cells, and the cholera vibrion leads to formation of vacuoles.

The part played in immunity by the nervous system is striking. The third pair of thoracic ganglia is intimately concerned in that its destruction results in loss of ability to become immune. The remainder of the nervous system seems to have no such connexion and may be damaged without affecting immunity. A special chapter deals with tuberculosis. The fact that wax in some form is essential to the life and development of the larvæ makes it peculiarly suitable for experiments with the tubercle bacillus. The larvæ, also, have a complete natural immunity to this organism. The defence mechanism is shown to be similar to that of man and the higher animals, except that in the larvæ the process is much more rapidly brought about, being a matter of hours only. This rapid response is thought to be due to a cellular lipase, probably of the same order as that postulated by Metchnikoff and Koch. It is by an increase in this substance that favourable results in clinical tuberculosis are obtained, and, in the author's opinion, proper treatment favours such an increase.

In the final chapters the phenomenon of anaphylaxis and the factors in immunity are discussed. In connexion with the former it is interesting to note that anaphylactic shock cannot be induced by foreign proteins such as horse serum, but is brought about by blood from the same larva or one of the same or related species. The factor involved seems to be the altered state, apparently by oxidation, of the injected blood. In immunity the part played by the cell is stressed throughout as the factor of first importance, that of antibodies being secondary.

The subject is well presented and contains much useful material on a subject of importance to biologists generally. Throughout the monograph references are quoted and discussed.

The Basic Science.

A Short History of Physics. By H. Buckley. Pp. xi + 263. (London: Methuen and Co., Ltd., 1927.) 7*s.* 6*d.* net.

THE degree to which specialisation has been advanced in every branch of science, coupled with the not unnatural desire on the part of university teachers to equip their students with the necessary technical knowledge to encourage further advances in even more specialised fields, tends to discourage students of science from delving into the history of the earlier developments of their particular subject matter, particularly if this knowledge has to be culled from a large number of different works, not always easily accessible. For some time past attention has been given to remedying this defect. The University of London has founded a chair in the 'history of science,' and already several excellent volumes have been published giving a broad survey of the outstanding contributions of scientific investigators to the progress of scientific thought and the harnessing of natural forces in the service of men. The Cambridge University Press and other publishing houses have also printed series of volumes with the same object in view.

This "Short History of Physics" by Mr. Buckley is most welcome. It is to be hoped that he will be encouraged to write a long one, for this is a most stimulating production. Within the small compass of 250 pages the author ranges over the field of physics from the earliest recorded physical observations to the latest developments of the theory of relativity, the quantum theory, and the latest experimental work on the structure of the atom. Most of his chapters are models of compression and clarity, no salient fact escaping his attention, while his selected quotations from the writings of the great ones of physics are the quintessence of appositeness. Possibly he over-emphasises the influence exerted by the Greek philosophers, culminating in

Plato and Aristotle, and under-estimates the effect of great historical events in stemming the advancing tide of learning: but his tribute to the debt which civilisation owes to the Arabs is welcome at a time when we are apt to regard their descendants as crude barbarians.

The last chapters are the least satisfying from the point of view of historical study, though unquestionably of the greatest value to the advanced student of physics. Not that Mr. Buckley can be held responsible. Modern physical theory has not yet reached that stage of perfect clarity which characterised the work of the investigators of the preceding two centuries. Their work could be explained in terms of fairly familiar concepts, whereas some modern theories make almost impossible demands upon the imagination of those without more than a fair amount of mathematical knowledge. Eddington and Jeans, it is true, are making them plainer, but still not plain enough for the average well-educated member of the community to comprehend their full significance. It is interesting to speculate whether the intellectual gulf separating the great physical scientists from the rest of their fellows is not greater now than at any previous period in the world's history; whether they have not usurped the place of the metaphysicians. A. G. C.

Our Bookshelf.

Müller-Pouillets Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer, E. Waetzmann. In fünf Bänden. Band 5: *Physik der Erde und des Kosmos* (*einschl. Relativitätstheorie*). Zweite Hälfte: *Physik des Kosmos* (*einschl. Relativitätstheorie*). Herausgegeben von August Kopff. Pp. xii + 596 + 14 Tafeln. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1928.) 36 gold marks.

THE volume on the "Physik des Kosmos," which forms one number of Müller-Pouillet's "Lehrbuch des Physik," gives an interesting up-to-date account of astrophysics, looked at from the physicist's point of view. It is edited by Dr. Kopff of Berlin-Dahlem, with chapters by different specialists such as Prof. Emden, who writes on "The Sun." The German style is on the whole easy and readable, the descriptions of instruments and methods clear, and the work of a high standard of accuracy. As is perhaps inevitable in a work composed by a number of different authors, there is occasional overlapping and a lack of balance between the different branches of the subject. The work of the English mathematicians is very fully discussed, especially the theories of Prof. Eddington. References are freely given in some chapters, but more might have been given with advantage in other chapters, for example, Chap. iii., especially in the summary of theories of stellar radiation at the end. Many familiar photographs are to be found illustrating the chapters on clusters and nebulæ, two chapters which seem rather long for the scale of the book. On the whole, the book deals rather more with stellar statistics than would seem to be necessary if written primarily for the physicist.

The chapter on cosmogony is interesting. Prof. Kienle is, on the whole, somewhat too content to give the views of others and does not often express his own views. Where he does do so definitely, the reviewer is not generally able to agree with him, but it must be admitted that Prof. Kienle is both fruitful and suggestive in emphasising fresh points of view. The chapter on relativity is interesting both historically and as giving a reasonably short description of both the special and the generalised theories and their applications to astronomy. Very few mistakes have been noted, but the line of unknown origin of wave-length 5316·87 A. has long been known. It may be natural that the English reader and the German writer should feel different needs in the matter of references, but for at least one reader who wishes to go behind the text of the book, its value would have been enhanced considerably by a fuller use of references to original work.

F. J. M. STRATTON.

Religious Conversion: a Bio-Psychological Study. By Prof. Sante De Sanctis. Translated by Helen Augur. (International Library of Psychology, Philosophy and Scientific Method.) Pp. v + 324. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 12*s.* 6*d.* net.

THIS treatise on religious conversion by the professor of psychology in the University of Rome is of importance. The author defines conversion as "an exceptional process representing an intellectual and moral regeneration of the person in whom it occurs"; but its etiology is "far too complex to allow us to ascribe it to disease, age, endocrine variations, or the like." Of its psychic antecedents the experience of suffering, whether of illness, domestic misfortune, moral perturbation, or some similar condition, seems the most common. With regard to the suddenness of onset of conversion, this is probably less definite than appears to the patient, since "an emotional shock suffices to blot out mnemonic pictures nearest to the event itself." Yet Prof. De Sanctis does not regard the process as dissociated from the will of the patient. Lasting effects upon the consciousness cannot be produced "unless it has been adapted by preparation and unless it assumes a decisive attitude of action"; and Ruysbroeck's saying is quoted, "You are saints according to the measure of your desire to be such."

In short, Prof. De Sanctis does not pay to Freudian theories all that tribute of uncritical respect which has become customary. He uses the happy term 'mutation' to describe the process and results of conversion; old elements of personality are so recombined as to give birth to entirely new quality of life. It will be seen that this involves

the spontaneity of the *psyche*, which is to be regarded as a form of activity *sui generis* " regarding whose essence and origin psychology should remain entirely agnostic." This book displays an independent point of view and will be read with much interest. J. C. H.

Regeneration und Transplantation. Von Prof. Dr. E. Korschelt. Band 1: *Regeneration.* Pp. xii + 818. (Berlin: Gebrüder Borntraeger, 1927.) 60 gold marks.

PROF. KORSCHELT'S modest book of 1907 is now swollen almost beyond recognition. The second edition of " Regeneration und Transplantation " is a massive volume of eight hundred pages dedicated to the four hundredth anniversary of the University of Marburg. That the work of twenty years should involve the printing of some six hundred additional pages is no doubt evidence of progress; it is also a very depressing fact, for it tends to limit the interest in a definite and fundamental property of living animals to a select band of specialised individuals instead of providing for the needs of a more numerous public. At the same time, an encyclopædia has its uses, and when it is written by Prof. Korschelt, it will long remain a source of accurate information and instruction.

The arrangement of the book is good, and most of the illustrations are new and helpful. Without doubt, the author has provided by far the most comprehensive text-book available, and it is regrettable that some sections are strangely inadequate. The phenomena of autotomy and regeneration in the Crustacea are described as though they were in the same nebulous state as those of other groups. This is unfortunate, for the physiological mechanisms involved are now adequately known, and they should not have been omitted from a work of this nature.

Prof. Korschelt's second volume will deal with the more exciting results of transplantation, and it will be awaited with interest. At present we have to thank the author for collecting into one volume the scattered results of many researches, and for presenting them in a not too forbidding form.

The Journal of the Institute of Metals. Vol. 38. Edited by G. Shaw Scott. Pp. xii + 813 + 59 plates. (London: Institute of Metals, 1927.) 31*s.* 6*d.* net.

A FEATURE of the new volume of this Journal, containing the papers presented at the last autumn meeting of the Institute, is the attention given to the accurate determination of equilibrium diagrams, in which English metallurgists are now taking the lead. Mr. Hume-Rothery has re-determined the system magnesium–cadmium; this system has been included in all text-books on account of its unique constitution, but it now proves to be incorrect, although the system still shows several interesting peculiarities. A revision by Mr. Raper of one of the most discussed portions of the copper–tin diagram again shows the essential accuracy of the original work of Heycock and Neville, modified as it has been in minor details. Several papers deal with ternary systems. A memoir by Miss Gayler on some of the light aluminium alloys is of interest as containing the first determination of the supersolubility curve, as found by Miers in various non-metallic systems, for a series of alloys. It has importance in connexion with the modified structures of such alloys as those of aluminium and silicon. Age-hardening has been measured in alloys of magnesium as well as in those of aluminium, and a paper on this subject is contributed from the Berlin aircraft experimental station, whilst the Royal Aircraft Establishment contributes two papers on the anodic protection of aluminium against corrosion. The standard of the contributions is high. Dr. Aitchison has given an interesting lecture on the use of non-ferrous metals in transport, and the volume contains the usual very thorough abstracts of the literature.

Statistique mathématique. Par Prof. G. Darmois. (Encyclopédie scientifique: Bibliothèque de mathématiques appliquées.) Pp. xxiv + 363. (Paris: Gaston Doin et Cie, 1928.) 32 francs.

THIS is a very readable account of the applications of the theory of probability to statistics. A knowledge of the calculus is assumed. In England the treatment of probability except for specialists has suffered from an excess of amusing but useless developments, and as a reaction against this the subject has lately been neglected. Now that the calculus is learnt at a much earlier stage than was formerly customary, it is possible that an elementary course might be devised which would have its value as leading up to the kind of work dealt with in this volume. Apart from the question of educational value, a knowledge of the elements of probability might serve as a corrective against the extraordinary views held by the man in the street about chance, and the mathematician should not ignore a movement towards the re-introduction of the subject, however unwilling he may be to add to his syllabus. A. R.

Royal Botanic Gardens, Kew. Popular Official Guide to the Royal Botanic Gardens: including an Historic Notice and Descriptions of the Collections in the Botanic Gardens proper, the Glasshouses, Museums, and Arboretum. Second edition. Pp. 118. (Kew: Royal Botanic Gardens, 1928.) 6*d.* net.

THE plan of this new guide to the Royal Gardens at Kew is well described in the title. The material in it has been thoroughly revised and brought up-to-date and has been set in a new style. The guide contains an interesting account of the history and functions of the gardens, and each section is clearly described and the outstanding species noted. With this guide in hand, the visitor, whether botanist or layman, needs no other directions for an intelligent and profitable tour of the famous gardens. The key plan at the beginning of the book has been done in some considerable detail, and will be useful to those wishing to visit any particular spot or examine particular types of plants.

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.*]

X-ray Studies on the 'Nitrides' of Iron.

EXPERIMENTS made by Fowler, Baur and Voermann, White and Kirschbraun, and Tschischewski show that iron 'nitrides' with a maximum amount of about 11 per cent nitrogen are formed when ammonia is led over heated iron. The most favourable temperature for the reaction seems to be about 450° C. Some of the authors are of the opinion that definite chemical compounds, that is, nitrides, are formed, while others consider the products to be

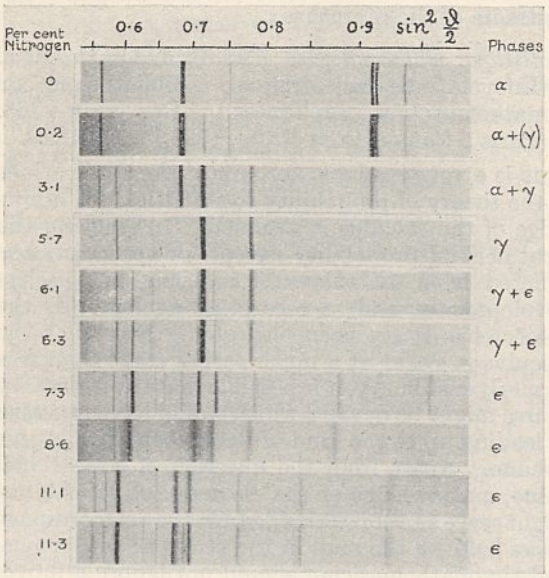

FIG. 1.

solid solutions of nitrogen in iron. Studying the iron–nitrogen system by means of X-rays, I have found the latter opinion to be the correct one.

Pure iron, obtained by reducing carefully prepared iron oxide with hydrogen, was treated with pure ammonia in a porcelain tube heated in an electric furnace. The temperature was measured with a nickel–nichrome thermo-couple. The chemical analyses of the products were done according to different methods. The maximum amount of nitrogen was found in a preparation containing 11·3 per cent nitrogen. It may be pointed out that no trace of hydrogen could be shown.

The X-ray analyses were carried out by the powder method in three focusing cameras using the *K*-radiation of iron.

The structure of the 'nitrides' was found to be dependent only on the nitrogen content and not on the conditions (temperature, duration of treating with ammonia, etc.) under which the 'nitride' was prepared.

Photograms of the most deviated lines from preparations with different contents of nitrogen are compared in Fig. 1. Already at 0·2 per cent nitrogen very faint lines belonging to a face-centred cubic (=close-packed cubic) phase (γ) appear, and at 5·7 per cent nitrogen all lines of α-Fe have disappeared. The lines of the α-Fe do not change their positions, which shows that its lattice dimensions remain constant. The lines of the new phase also remain fixed with increasing nitrogen content. The edge of the elementary cube is 3·789 A., which is somewhat larger than the parameter of pure γ-Fe (=3·6 A.), but as the existence range of this new phase at high pressure certainly will join the existence range of γ-Fe, it seems justifiable to give this phase also the denomination γ.

The γ phase is therefore to be considered as a solid solution of nitrogen in γ-Fe. The iron atoms are arranged in a cubical close-packed lattice, and the nitrogen atoms are located in the interstices between them. The distance between the centres of the iron atoms is $a/\sqrt{2}=2{\cdot}679$ A. Nothing in the photograms indicates regular distribution of the nitrogen atoms.

Between 5·7 and 6·1 per cent nitrogen, new lines belonging to a hexagonal close-packed phase (ϵ) appear. The new lines are at first fixed, showing the existence of a two-phase range. Between 7·3 and 8·6 per cent nitrogen, however, the lines begin moving inwards, showing an increase in the lattice dimensions. The percentage at which the homogeneous range begins is estimated to lie between 7·5 and 8 per cent nitrogen. The parameters of the ϵ phase are here, $a=2{\cdot}695$ A. and $c=4{\cdot}362$ A. (axial ratio $c/a=1{\cdot}619$). In this case, when the atoms are not absolutely spherical, one has to distinguish two values of distances between the centres of adjacent atoms. One is $=a=2{\cdot}695$ A. and the other (the shorter of the two) is $=\sqrt{\frac{a^2}{3}+\frac{c^2}{4}}=2{\cdot}679$ A. The latter accurately coincides with the shortest distance between the atom centres in the γ phase.

As more nitrogen enters the ϵ phase, the parameters increase, c, however, relatively less than a, so that c/a decreases.

In the photogram of the preparation with the maximum nitrogen percentage of 11·3, some of the lines are split, owing to the fact that the preparation consists of two parts with different nitrogen content. As c is not very sensitive to changes in the nitrogen content, the lines will be the more split the greater the angle the reflecting net plane forms with the basal plane. In this photogram the part richest in nitrogen has the parameters $a=2{\cdot}782$ A. and $c=4{\cdot}419$ A. ($c/a=1{\cdot}588$).

The ϵ phase may evidently be considered to be a solid solution of nitrogen in a hexagonal close-packed form of iron, where the nitrogen atoms are situated in the interstices between the iron atoms. No photograms of this phase show any lines indicating a regular distribution of the nitrogen atoms.

There seem to exist several analogies to this type of solid solutions in other systems; for example, the tungsten and molybdenum carbides described by Westgren and Phragmén, the nickel hydride described by Bredig and Allolio, and probably the copper hydride described by Müller and Bradley. The hexagonal close-packed form of chromium which Bradley and Ollard showed in some preparations of electrolytic chromium might also be an analogous hydride.

It is of interest to note that some of the concentration limits of the homogeneous phases lie very close to stoichiometric proportions of iron and nitrogen. Thus, the upper limit of the γ phase, which, as already mentioned, seems to lie between 5·7 and 6·1 per cent nitrogen, might coincide with the formula Fe_4N with 5·9 per cent nitrogen. In the same manner, the lower limit of the homogeneous ϵ phase, which was supposed to lie between 7·5 and 8 per cent nitrogen, might coincide with the formula

Fe_3N with 7·72 per cent nitrogen. It is also worth mentioning, that all recent investigators of the iron–nitrogen system put the upper limit of nitrogen concentration attainable at atmospheric pressure to slightly above 11 per cent nitrogen, which is close to the formula Fe_2N with 11·14 per cent nitrogen. These coincidences may of course be only accidental, but it is also possible that they are related to certain concentrations of valency electrons.

In recent years the method of treating iron with ammonia has sometimes been used in industry to obtain very hard surfaces (cf. the articles by A. Fry in the *Kruppsche Monatshefte*, 1923 and 1924). With the purpose of showing to what extent an iron surface will be 'nitrated,' a thin iron sheet was heated in ammonia for four hours at 450° C. The thin grey film on the surface caused rather strong γ lines and weak ϵ lines to appear in the photogram.

The fact that the iron 'nitrides' are solid solutions of nitrogen in iron will also furnish a possible explanation of the action of iron as a catalyst in the Haber ammonia process. The catalysing substance is there prepared by reducing iron oxide with ammonia and will therefore consist mainly of iron 'nitride.' The nitrogen dissolved in the iron is probably monatomic, and as such must be expected (cf. 'active' nitrogen) to react easily with hydrogen, forming ammonia.

A more detailed report on this investigation will be published later.

The experiments are being continued with 'nitrides' of other metals.

GUNNAR HÄGG.

Institute of Metallography,
Institute of General and
Inorganic Chemistry of the University,
Stockholm, April 5.

The Colour of the Peacock's 'Eye.'

I HAVE for some time past been experimenting at intervals on this subject. There has been much debate as to whether the animal colour in this and other difficult cases is due to pigments, or to a structure on a scale comparable with the wave-length of light, which gives colour by interference. It is not proposed here to embark on this controversy, but to mention some observed facts, reserving discussion for the present.

If the feather is exposed to strong ultra-violet radiation from a quartz mercury lamp placed a few inches away, the colours soon begin to alter, for the most part becoming less brilliant. The effect is noticeable after an hour, and conspicuous after several hours. It is convenient to screen half the feather, thus reserving it as a standard of comparison. The various zones of colour are affected in different ways, entirely new tints being produced in certain cases. This shows the complexity of the phenomenon. I am not ready to give a full description at present. The effects are naturally different for the different zones as we go out from the centre of the 'eye,' and depend also on the obliquity or otherwise of the reflection.

The conditions are simpler if we examine the feather through a monochromatic filter. Two striking cases may be mentioned. For the sake of description, I consider the feather as showing four chief zones, disregarding minor and transitional zones of colour. The four are numbered from the innermost.

Examining the feather in sunlight at normal incidence through a red filter, it is found that the second zone is made notably brighter, and the third notably darker than it was before exposure. If we use oblique incidence and a blue filter, it is found that exposure has made the second zone much darker, and the fourth zone, including the straggling outer portions of the feather, much brighter than originally. This observation is most striking if we use a glass mercury vapour lamp as illuminant, because it is rich in blue rays.

Prolonged exposure (hundreds of hours) to the quartz mercury lamp destroys the colour of all the zones entirely, leaving only a black background, on which, however, the position of the zones formerly seen in colour can be distinguished.

Experiments of the same kind have been made on some other cases of brilliant animal colours. It may be mentioned that the colour of the brilliant blue butterflies from Brazil, used in making 'butterfly jewelry,' is almost immediately affected, and after a few hours entirely discharged. On the other hand, the golden beetles, in which I was able to detect interference spectra (*Proc. Roy. Soc.*, A, vol. 103, p. 233; 1923), are entirely unaffected by very prolonged exposure, running to hundreds of hours.

RAYLEIGH.

Terling Place,
Chelmsford, May 10.

Hardness of Alloys.

IN a letter to NATURE, published in the issue of May 7, 1927, I gave curves showing the hardness of some alloys of copper in terms of the percentage of the alloying metal. I here add similar curves for alloys of lead with antimony, tin, and bismuth (Fig. 1).

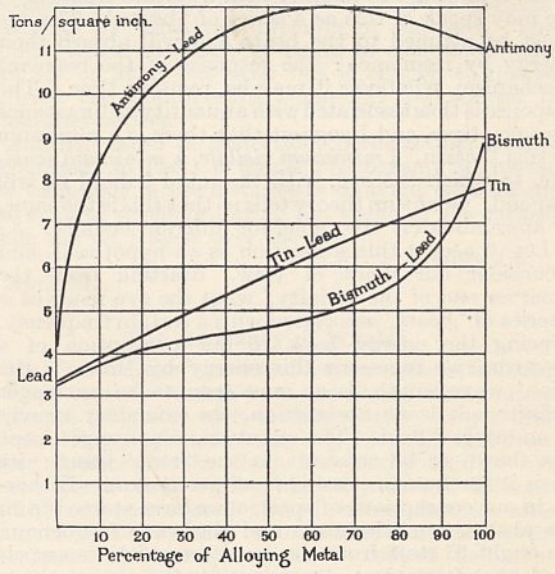

FIG. 1.—Curves showing the hardness of alloys of lead with antimony, tin, and bismuth. The percentages are percentages of volume.

The hardness was measured, as in the former experiment, by pressing with a known force a cone of the metal to be tested against a hard flat surface and taking the area of the flat thus formed at the point of the cone.

There are no special features in the hardness curves of the tin and bismuth alloys, but the antimony alloy shows a not very marked maximum when between 50 and 70 per cent of the volume is antimony.

A. MALLOCK.

9 Baring Crescent,
Exeter.

The Quantum Postulate and Atomic Theory.

EVERY physicist is greatly indebted both to Prof. Bohr for committing to paper, and to NATURE for printing, the admirable account of the new wave mechanics entitled "The Quantum Postulate and the Recent Development of Atomic Theory," which appeared as a Supplement to the issue of April 14. It sets out in an extraordinarily luminous manner the essentials of the new ideas.

Bohr speaks of a 'complementarity,' which is a duality of observed phenomenon and observing mechanism. He points out that in the delicate observations involved in the study of interactions between atoms, or between atoms and radiation, the two are no longer separable but become two aspects of one whole. I wish to suggest that Bohr's complementarity is rather a trinity, of which the third member is the 'conscious' observing mind. It will be seen in the sequel that this leads directly to an explanation of the origin of the quantum.[1] The extension is, indeed, clearly involved in Bohr's statement: the demarcation between subjective and objective disappears, as he says in his conclusion, and the subjective involves at least the living factor, which is a part of consciousness.

The three are one. Consider, for a moment, the observation of a spectrum band (not line) of the hydrogen spectrum, seen by the eye. The energy of the band is contained within a small but finite width: we are accustomed to associate with it a definite wave-length, but such a narrow band, covering a range of wave-lengths, is more properly represented by a succession of wave-groups with indefinite boundaries, following one another with a certain frequency: we may speak of this as a series of 'beats.' The eye must be attuned to the beats and will absorb their energy by resonance: the response of the resonant mechanism, whatever it may be, requires time. The response is thus associated with a quantity of dimensions energy × time, and I suggest that there is a minimum of this 'action,' a *minimum visibile*, a *minimum sensibile*, to which the eye, with the mind behind it, will respond. Quantum theory tells us that this is the same, or approximately the same, for different colours.

Let us accept this suggestion as an hypothesis, and reconsider our point of view. Starting from the observer end of the 'trinity,' what the eye receives is a series of 'beats,' associated with a certain frequency. Tracing the energy back to our conception of a spectrum, we represent this energy by $\int I d\lambda$. λ, the 'line' wave-length, is at once seen to be no longer definite: it is an abstraction, the boundary merely of an integral field. The quantum, which experiment has shown to be constant, is the 'real' thing: its basis is the human possibility of perception. Hitherto, in our conceptions of spectra, we have started from the abstraction, the wave and the wave frequency: we ought to start from the quantum, with its associated beat frequency, dependent on the eye mechanism, and we can, of course, at once reproduce the conception, the wave. The same idea follows through all encounters of atoms and atoms, atoms and radiation, using the method of resolution of the Hamiltonian 'action' into wave-groups, as suggested by wave mechanics.

Every observation is a trinity in unity. Every physical quantity, the result of such observation, is expressed in terms of three units, of length, time, mass, but preferably for our present purpose of length, time, action. Every event perceived involves all three: we can leave out one in our conceptions for convenience, but in any full description of the event, that is, of our perception, all three are involved as part of one whole. We can change the measure of any one with consequent changes in the measures of the other two; but there is a *minimum sensibile* which fixes a limit to the whole, a subjective unit; to talk of its absolute size is meaningless; the measurements in Lilliput would be indistinguishable, save by external omniscience, from those in London.

It will be seen from the preceding paragraph that the limiting velocity of Einstein, the velocity of light, at once follows from the general conception. We never need to use a greater velocity in describing our perceptions. Quantum theory completes and rounds off the theory of relativity into one consistent whole.

The *minimum sensibile* in the above, it will be noted, is a *minimum visibile*. The *minimum sensibile* is not necessarily the same for other sense perceptions.

In "Space, Time, and Gravitation," Eddington wrote: "We have found a strange foot-print on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last we have succeeded in reconstructing the creature that made the foot-print. And lo! it is our own." No words more apt could be written in relation to quantum theory.

I wish to say one final word. All the ideas contained in the above are to be found in Bohr's paper. He speaks even of the 'individuality' associated with an event. I have but rearranged the setting of the picture.

F. J. SELBY.

Teddington, May 1.

[1] I use throughout the quantum of 'action,' Planck's constant h.

The Application of the Irregular Doublet Law to Complex Spectra.

PROF. M. N. SAHA and Mr. P. K. Kichlu have recently (NATURE, Feb. 18, p. 244) shown that the irregular doublet law, which has been applied by Millikan and Bowen to locate approximately the spectra of elements which are reduced by electric discharge to the same electronic configuration, can also be applied to complex spectra. We have tested this hypothesis by taking the two groups (1) Ne, Na^+, Mg^{++} . . . and (2) A, K^+, and Ca^{++}. In group (1), one of us has already demonstrated the applicability of the law. It now remains to add that the spectrum of Mg^{++} can be predicted with the aid of this law, since the spectra of both Ne and Na^+ are known. A number of strong lines, some of which were previously obtained by Handke and by McLennan, have been located between the wave-lengths λ2400 and λ1800. This is quite in accordance with the prediction of Messrs. Saha and Kichlu.

In the group A, K^+, Ca^{++}, the spectrum of A is now completely known, thanks to the work of Meissner (*Zs. für Phys.*, vol. 40). The lines of K^+ have been grouped into energy levels by T. de Bruin (*Proc. Amst.*, vol. 29), though he has not yet attempted the comparison with the predictions of Hund's theory. This can be easily done from his work, and the $5M_2(N_1 \leftarrow\!\!- N_2)$ lines written down. The fundamental difference $^3P_1 - {}^1P_1$ comes out to be 2425. As regards Ca^{++}, the spectrum was obtained by Anderson (*Astro. Jour.*, vol. 59, p. 76) by using the condensed discharge in vacuum, and a large number of lines entirely new (about 800) were obtained between the wave-lengths λ2100 and λ4800. One of us has undertaken the analysis of this spectrum and has been able to identify the group $5M_2(N_1 \leftarrow\!\!- N_2)$. The fundamental difference is $^3P_1 - {}^1P_1 = 3766$. The correctness of this difference is shown not only by the fact that it connects a number of the strongest lines given by Anderson, but also by the fact that it is approximately the difference (actual difference is 3804) between the two strongest

lines, λ403·8 and λ410·1, obtained by Millikan and Bowen in the hot spark spectrum of Ca in the extreme ultra-violet. These must be the $^1S_0 - {}^1P_1$, $^3P_1$ lines of transition $5M_2(M_2 \leftarrow\!\!- N_1)$. The applicability of the irregular doublet law is illustrated in the following table:

Group I.		Group II.	
$5M_2(N_1 \leftarrow\!\!- N_2)$.	$^3P_2 - {}^3\overline{P}_2$.	$6M_2(N_1 \leftarrow\!\!- N_2)$.	$^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}}$.
A	13987	K	12985
K^+	25647	Ca^+	25192
Ca^{++}	37194	Sc^{++}	36566
Sc^{+++}	(48600)	Ti^{+++}	47534

A further comparison has been made between the spectra of A and K, K^+ and Ca^+, Ca^{++} and Sc^{++} (*vide* table above). The lines compared belong to the groups $5M_2(N_1 \leftarrow\!\!- N_2)$ and $6M_2(N_1 \leftarrow\!\!- N_2)$ in each case. The difference is that the second group has only one more electron in the inner M_2-level. The value of $^3P_2 - {}^3\overline{P}_2$ line in group I is almost identical with the value of the $^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}}$ line in group II (lines arising out of the transition $6L_2(M_1 \leftarrow\!\!- M_2)$). The same analogy has been obtained in the spectrum of the groups Ne, Na, Na^+; Mg^+; Mg^{++}, Al^{++}.

The analysis of the Ca^{++} spectrum lends no support to Pannoecock's view that the spectrum of the solar corona is made up of the lines of Ca^{++}. The ionisation potential of Ca^{++} comes out to be approximately 52 volts, and the excitation required for stimulating the line $\nu = 37194$ would amount to about 53 volts if we start from the neutral state.

K. MAJUMDAR.
G. R. TOSHNIWAL.

Department of Physics,
University of Allahabad.
Mar. 22.

Apparent Distortion in Sports Photographs.

IN conversation with various people of some scientific attainments (even with some who have considerably greater technical skill in practical photography than I have myself), I have found usually that not enough allowance is made for the distortions produced by so-called *instantaneous* photographs. In my own Goerz-Anschutz focal-plane camera (some twenty-five years old), the nominal exposure of $\frac{1}{1000}$ sec. is obtained by allowing a slit of about $\frac{1}{25}$ the width of the plate to travel in front of the plate, at such a speed as to cover the whole plate in $\frac{1}{40}$ sec. In later patterns some increase in speed may exist, but the essential idea is the same.

The distortion is illustrated in the simplest possible way by considering a man of, say, 6 ft. to be running at such a speed as to cover 100 yd. in 12 sec., that is, at 25 ft./sec. The photographer will endeavour to place himself so as to get the runner to cover about $\frac{3}{4}$ of the height of the plate; or the slit corresponds to $\frac{1}{25}$ ($\frac{4}{3}$) 6 ft. $= \frac{8}{25}$ ft. at the distance of the runner. Compared with the speed of the runner, this distance would correspond to $\frac{1}{25}$ ($\frac{8}{25}$) sec. $= \frac{8}{625}$ sec. $= \frac{1}{80}$ sec. roughly. But this is very nearly half the time during which the slit falls.

Probably a graphical investigation will help to make the matter clearer: we can simplify our ideas by taking in the first place the effect of, say, 25 strips on the plate, each having (theoretically) *instantaneous* exposures, at intervals of $\frac{1}{40}$ sec.

In the first strip affected by the runner (some strips will not receive his image at all) there will be a straight line[1]: in the next strip, an equal vertical line displaced a distance to the side. This displacement will correspond to $\frac{25}{40}$ ft. $= \frac{5}{8}$ ft. at the distance of the runner: and 8 ft. at that distance is represented by the height of the plate. Thus the sideways displacement is $\frac{5}{64}$ of the height of the plate: while each strip is $\frac{1}{25}$ of the height. Accordingly, the general effect is to produce an appearance of the form sketched (Fig. 1):

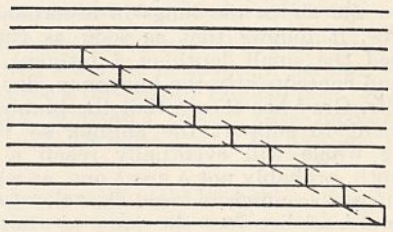

FIG. 1.

where the slanting lines make with the horizontal an angle the tangent of which is $\frac{64}{125} = 0{\cdot}512$. This angle is roughly 27°.

In the actual case of continuous exposure, a vertical line (moving at right angles to the line of sight) is therefore swung (by the camera alone) through about 63° (= 90° − 27°).

No doubt, in few *actual* photographs can such enormous distortion appear: for usually the photographer (from experience of previous bad results) is likely to stand near the finish of a race and to point the camera so that its axis makes an angle of (perhaps) less than 20° with the direction of the race. This would reduce the angle of swing to something more like 25° or 30°; but even this is enough to distort entirely the photographs commonly reproduced in illustrated papers.

Another cause of distortion, perhaps less readily recognised, in (say) a tennis photograph is due to the variations in the distance of different parts of the player (and specially during the swing of the racket) while the slit travels over the plate.

T. J. I'A. BROMWICH.

April 21.

The Buoyancy of Whales.

MR. R. W. GRAY'S series of letters make interesting reading to one who has been associated with various attempts to enable men to dive a little deeper than usual. From what has been published, and from other documents Mr. Gray has kindly lent to me, the evidence that whales can dive to 500 fathoms and beyond seems good, while it is certain that, after being harpooned, they can remain submerged for 40 minutes, and much longer in the case of the bottle-nosed whale. Since they can exist so long without taking breath at a time when they are exerting their utmost energies to escape, there need be little difficulty in accepting the view that when resting or sleeping (and consequently using oxygen at a slower rate) they can remain under the ice or on the sea bottom for some hours.

I find it difficult to accept the hypothesis that they can regulate their buoyancy by actively compressing the air in their lungs. Raising the intra-thoracic pressure to any useful extent would surely interfere with the circulation, as in Valsalva's classic experiment, which, with Muller's experiment and everyday experience of human divers with various forms of

[1] For simplicity consider the runner as merely a vertical line.

apparatus, impresses on one the fact that the mammalian circulation cannot carry on unless the air in the lungs is kept at practically the same pressure as the fluid environment of the body, whether that be air at atmospheric pressure or water at a hydrostatic pressure many times as great.

When a whale starts to dive, part of its buoyancy is derived from blubber and part from the volume of air in its lungs, and assuming, as I think one must, that the increasing hydrostatic pressure of the sea water acting through the body walls automatically compresses the air in the lungs in accordance with Boyle's law, it follows that as soon as the whale has reached the small depth of 5 fathoms, the air volume, and consequently the buoyancy, due to it is halved. Mr. Gray has shown that the blubber alone is insufficient to support the animal, so that the descending whale will eventually reach a certain critical depth, probably not a great one, at which the air buoyancy is so much reduced that the density of the whole animal becomes the same as that of the sea water; and if the whale dives below this and dies, it will tend to sink still farther, as in the instances Mr. Gray has described.

In diving to 500 fathoms, the air in the lungs would be compressed to about $\frac{1}{100}$ part of its original volume, and the lungs must shrink to a corresponding degree: it is not surprising, therefore, that anatomists have commented on their remarkable elasticity. Hunter's words (for which I am indebted to Mr. Gray) are that they are so elastic "as to squeeze out any air that may be thrown into them and to become almost at once a solid mass having a good deal the appearance, consistence, and feel of an ox's liver." The human lungs and chest are so formed that (without distortion) they cannot hold less than about $\frac{1}{5}$ of the volume of air contained after a deep inspiration, so that naked pearl divers cannot descend much beyond twenty fathoms.

The appearance of drops of condensed water in the spout of whales in the tropics may be attributed to the rapid expansion and consequent cooling of the air in the lungs as the animal ascends from a great depth.

G. C. C. DAMANT.

Photography of the Infra-red Solar Spectrum.

NEARLY fifty years ago, Sir William Abney (*Phil. Trans.*, Part II., p. 653, 1880, and Part II., p. 457, 1886) photographed and measured fine detail in the solar spectrum out to λ9867. He also recorded, with low resolving power, a few broad absorption bands of greater wave-length, but he evidently observed no individual absorption lines having wave-lengths exceeding that of the line mentioned. It is remarkable that, in spite of some subsequent improvements in equipment, no one has measured lines in the solar spectrum out to the limit reached by Abney. The nearest approach of which I am aware is that of Brackett (*Astrophysical Journal*, **53**, 121; 1921), who measured λ9849 and could see a few more faint lines beyond.

With the aid of plates sensitised by neocyanin, the solar spectrum is now being examined once more, using both prisms and gratings. A filter of iodine in carbon disulphide, described long ago by Prof. Tyndall, is found to be the most efficient means of preventing fog. On the prismatic plates about a dozen lines are observed between λ10,000 and λ10,750, one of which is fully as conspicuous as Hα. It stands clear of the great water-vapour band ρ, and several photographs made at various solar altitudes and on days of very different humidity fail to show any change in its appearance. On spectrograms made with the grating, dispersion 4·7 A. per mm., it appears as a single wide line of wave-length 10049·8 A. The line is clearly of solar origin. Its wave-length, width, and general appearance leave little doubt that it is really the fourth member of the Paschen series of hydrogen, the calculated wave-length of which in air is λ10049·4. Later members of this series fall in the water-vapour band between λ9000 and λ9600, so that they are very difficult to observe. In addition to the lines already mentioned, fifteen others, faint and sharp, have been measured with the grating out to λ10,220.

In spite of this extension of Abney's limit by nearly 900 A., my experience leads to the belief that his emulsion was far more sensitive in this spectral region than any of those now available. He mentions Tyndall's filter, but seems actually to have used copper-flashed ruby glass, transmitting the red as well as the infra-red. Fog due to false spectra and the diffusion of shorter wave-lengths must have caused his failure to observe the lines recorded here.

HAROLD D. BABCOCK.

Mount Wilson Observatory,
Pasadena, California,
Mar. 24.

Observed Relative Intensities of Stark Components of Hα.

BY means of wave mechanics, Schrödinger (*Ann. d. Phys.*, **4**, 80, 437; 1926) has made quantitative calculations of the intensities of Stark components in hydrogen which are commonly considered to be an improvement on the earlier estimates based on the correspondence principle (H. A. Kramers, *D.K.D. Vidensk. Selsk.*, **8**, 3, 287; 1919). That this is so in the case of Hβ was shown recently by the writers in a quantitative experimental investigation (NATURE, Oct. 23, 1926).

The greatest variation of the new theory from Prof. Stark's results, however, occurs in the parallel components of Hα. There are three pairs of such components which have been photographed, and in the original experiments, as well as in the older quantum theory, the outside components were found to be the strongest. This is further supported by the recent calculations of Epstein on wave mechanics (*Phys. Rev.*, **28**, 695; 1926). In contrast to these results, Schrödinger finds the greatest intensity for the pair with intermediate displacements (Fig. 1). The

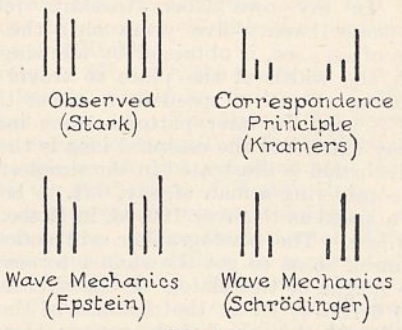

FIG. 1.

difference between Schrödinger's calculations and the observations of Stark is obviously rather large to be considered as an experimental error. Yet this is what it appears to be according to numerous plates obtained by the junior author in an extension to the earlier experiments, the new results being in general agreement with the calculations of Schrödinger.

The new photographs are taken by the Lo Surdo

method, with a tube designed to give components which run parallel for a short distance on the plate. It is not thought probable that this source should produce components with intensities essentially different from those which might be obtained from a canal-ray tube. Its design permits the use of a micro-photometer in the ordinary way. On the plate from which the accompanying curve (Fig. 2) was

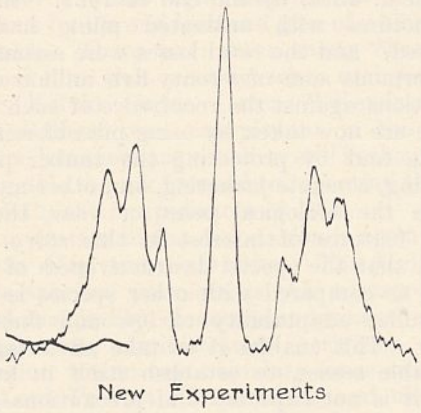

FIG. 2.

taken there appears to be a strong undisplaced parallel component, but, in reality, this is due to the overlapping of the images on the slit.

Quantitative measurements of the intensities by a wedge method are in progress. The present note is just to state that on this most outstanding point Schrödinger is correct.

J. STUART FOSTER.
M. LAURA CHALK
(National Research Student).
Macdonald Physics Laboratory,
McGill University, Montreal,
Mar. 21.

Genes and Chromomeres in Flowering Plants.

THE objection to identifying chromomeres with genes was that there were not supposed to be enough chromomeres. In my opinion this supposition was based on post mortem changes, or on too low a working aperture in the microscope. I have studied the pachyphase (pachytene stage) in *Aloe*, *Lilium*, *Kniphofia*, and *Agapanthus* especially. The less the opportunity for change before fixation, the greater the number of cells showing the ultimate chromomeres.

These ultimate chromomeres appear about twice as broad as long, in all positions of the fibre. They differ in size; and sometimes only the scattered largest ones take the stain, and the others are nearly or quite invisible. They show equally well in iron-acetocarmine squeezes, or in smear preparations fixed in chromic-acetic-formol and stained with iron-brazilin. Their lateral extension is due to their composition out of the laterally joined homologous chromomeres of four strands, and the longitudinal divisions can sometimes be made out.

In many pachyphase cells these chromomeres are seen merged into long blocks, or into a continuous thread; but the writer considers this phenomenon to be a post mortem change. In *Aloe purpurascens* an enumeration of the ultimate chromomeres in pachyphase, by an apparently trustworthy method, gave approximately 1250 for the total in the cell. These chromomeres averaged less than a third of a micron apart, and so approached the limits of microscopical separation. At diaphase, and still more at metaphase, the number of separable chromomeres has greatly decreased; but these are obviously compound bodies. Hence a useful working hypothesis seems to be that the ultimate chromomeres are genes.

JOHN BELLING.
Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor, N.Y.,
April 14.

Milton and Modern Science.

IF Lucretius can be quoted in NATURE as anticipating modern scientific discoveries, perhaps space may be found for a far greater English poet, John Milton.

Are not Millikan's cosmic rays foreshadowed in Bk. IV. of "Paradise Lost"? Eve has just asked (657-8):

> But wherefore all night long shine these? for whom
> This glorious sight, when sleep hath shut all eyes?

Adam replies:

> Those have their course to finish round the Earth
> By morrow evening, and from land to land
> In order, though to nations yet unborn,
> Ministering light prepared, they set and rise;
> Lest total darkness should by night regain
> Her old possession,
> . . . these soft fires
> Not only enlighten, but with kindly heat
> Of various influence foment and warm,
> Temper or nourish, or in part shed down
> Their stellar virtue on all kinds that grow
> On earth, made hereby after to receive
> Perfection from the sun's more potent ray.

Again, Bk. XI., from v. 429 onwards, contains an excellent description of a cinema show, and the chariot of Paternal Deity (vi. 750) is a motor-car. Truly,

> What the sage poets, taught by th' heavenly Muse,
> Storied of old in high immortal verse

("Comus," 517), is well worth rescuing occasionally from the oblivion into which such things fall.

C. L. BARNES.
Manchester, May 13.

Ultra-Violet Transmission of New Glasses.

DR. L. C. MARTIN, in his interesting article in NATURE of April 21, on "The Ultra-Violet Transmission of Transparent Materials," makes a reference to the new glass of the Corning Glass Co., and states that it is not yet available in large pieces.

The chemical composition of this glass undoubtedly involves manufacturing difficulties at present greater than are met with in the preparation of Vita-glass and the newer ultra-violet transmitting window glasses now being marketed in Great Britain, Germany, and America. It may interest readers of NATURE, however, to know that early this year I received from the Corning Co. a sheet of the new glass, known under the name of Corex, of dimensions $8\frac{3}{4}$ in. × $6\frac{3}{4}$ in. and 4 mm. thick, a size sufficient for many screening purposes. The sheet appeared to be quite homogeneous and clear. In thickness of 2 mm. it was found to transmit down to 0·212μ and to have the following percentage transmissions: 86·5 at 0·295μ; 66 at 0·250μ; 35 at 0·230μ; and 13 at 0·220μ.

W. E. S. TURNER.
Department of Glass Technology,
The University, Sheffield, April 21.

Shipworms in San Francisco Bay.

THE San Francisco Bay Marine Piling Committee was established in 1920 by the American Wood-Preservers' Association, following a serious outbreak of damage by shipworms to timber structures in the northern part of San Francisco Bay. The Committee's work was, almost from the first, associated with the national scheme of research on the same subject begun by the U.S. Forest Service and later co-ordinated by a special committee of the National Research Council. The final report now issued [1] brings together the results of all the researches undertaken. While a good deal of the ground has already been covered by the report of the National Committee published in 1924 (see NATURE, Nov. 22, 1924, p. 744), the fuller account of the local conditions and of the admirable series of biological, hydrographical, and engineering researches carried out at San Francisco is very welcome.

It is now possible to get a clear picture of the succession of events in this region. It is pointed out in the historical section of the report that shipworms have been active at San Francisco at any rate since the days of the gold rush in 1849. By 1857 many wharves were derelict and tottering from their attacks. This was at the water-front of San Francisco itself, just within the Golden Gate, and no doubt the species of shipworm causing most of the damage was *Xylotrya* (now *Bankia*) *setacea*, described by Tryon in 1863. This species is probably indigenous to the Pacific coast, and in San Francisco Bay it is confined to the region of high and constant salinity (not much less than 25 per mille), not penetrating to the northern districts (San Pablo and Suisun Bays) where the salinity is low and fluctuating. An isolated record of the species from San Pablo Bay is considered to be due to the shipworms having been present in the piles before they were driven.

Before the seventies of last century, the Crustacean borer *Limnoria* was unknown at San Francisco, but in 1873 it is mentioned as having "only recently made its appearance in our waters," and it speedily became very destructive. The distribution of *Limnoria* within the bay coincides with that of *Bankia*, and nearly all the damage done in the middle and southern parts of the bay is caused by these two species. In these districts their destructive activities have been long guarded against by the use of piling protected by impregnation with creosote or by other methods.

In the northern districts, where the salinity is greatly diminished by the influx of fresh water from the Sacramento River, no dangerous borers had ever been known to occur, and extensive wharves and other structures were built of unprotected timber. In 1914, however, a species of shipworm, later identified as the European *Teredo navalis*, was found to be causing damage at the Mare Island Navy Yard in San Pablo Bay. No further damage was reported until 1917, when the pest broke out again, and in the following years assumed disastrous proportions. Wharves collapsed on all sides, sometimes carrying buildings with them, until, by the end of 1921, "the bulk of structures with untreated piling had been destroyed," and the total losses were estimated at the enormous sum of twenty-five million dollars. Precautions against the recurrence of such a catastrophe are now taken by using piles of reinforced concrete and by protecting the timber piles by creosoting, concrete jacketing, and other methods.

From the biological point of view, there are several features of interest in this story. It is evident that the special destructiveness of *Teredo navalis* as compared with other species is due to its peculiar adaptability to low and fluctuating salinity. This enables it to take advantage of a favourable season to establish itself in localities where it is not expected and precautions against it have not been thought necessary. At San Francisco, as was shown long ago in Holland, the outbreaks could be definitely correlated with years of reduced rainfall and consequent increased salinity in harbour waters. Once established in the timber, the animals can survive many weeks in water of reduced salinity by closing the mouths of their burrows with the pallets and resume their activity when the salinity rises again. Since the individuals rarely survive for more than one year, a succession of favourable years is probably necessary to cause a severe and prolonged outbreak.

Doubt has been cast on the popular opinion which attributes sudden outbreaks of shipworm to importation from abroad, but in the case of the San Francisco outbreak, at any rate, there is good reason to regard it as justified. Investigations on the shipworms of the bay were made in 1910–11, and again in 1912–13, and no specimen of *Teredo navalis* was recorded. It is just possible that it may have existed in small numbers in some part of the region, but favourable conditions must have occurred many times before 1914 which would have led to its invasion of the northern districts had it been there to take advantage of them. It is much more likely that the species was introduced in some unknown manner in 1913 or 1914. When first discovered, it was described as a new indigenous species, and it was only after prolonged and careful study that its identity with the European species was established.

It is sometimes assumed by practical men that the only help to be expected from scientific research in dealing with marine timber pests is the discovery of new kinds of poison for protecting the wood. Fortunately, the American investigators have taken a wider view. They have shown that detailed studies of the systematics, distribution, physiology, and bionomics of the shipworms and other marine boring animals can yield results that are of immediate practical importance to the engineer.

W. T. C.

[1] Marine Borers and their Relation to Marine Construction on the Pacific Coast: being the Final Report of the San Francisco Bay Marine Piling Committee. C. L. Hill and C. A. Kofoid, editors-in-chief. Pp. ix+357. (Berkeley, Cal.: University of California Press, 1927.) 4 dollars.

The Glasgow Meeting of the British Association.

MANY of the senior members of the British Association still carry in their memory pleasant recollections of the last meeting in Glasgow twenty-seven years ago, and of the wonderful excursions by sea and loch and glen of which it was the centre. There have been many changes of personnel since that meeting, when such names as Rücker, Kelvin, Geikie, Lister, M'Kendrick, and Bayley Balfour were conspicuous in the list of members, but there are not a few still in the position of being able to look forward to repeating this year (Sept. 5-12) their experiences of 1901.

The invitation to the Association is again a joint one from City and University. The University, with its spacious premises, is able to exercise the unusual hospitality of accommodating the entire sectional and administrative activities of the Association within one boundary-fence, while the City—Lord Provost, Corporation, and citizens—is leaving no stone unturned to make the meeting a success.

The main activities of the meeting will be concentrated in the University, that impressive pile of buildings—situated on the high right bank of the Clyde valley just where it is cut through by the tributary Kelvin—which looks out from its dominating position across the broad river valley with its alluvial flats now covered in great part by busy streets and docks and shipyards. The great hall of the University—the Bute Hall—will function as Reception Room, with general offices, post-office, bookstall, etc.: the adjoining Randolph Hall will be used as a writing-room; while in close proximity accommodation will be provided for the president and general officers, the secretaries and local secretaries, and the representatives of the Press.

The individual sections will be housed as a rule in the University department devoted to their particular subjects, thus ensuring the availability of suitable furnishings and equipment. In a few cases, to secure greater convenience, this general rule is departed from; thus Section C (Geology) will meet in the old Natural History Lecture Room, E (Geography) in the Department of History, F (Economics) in that of English, J (Psychology) in the newly completed west wing of the main University building, M (Agriculture), and also the forestry sub-section of K, in the new medical block.

Long experience has demonstrated the great practical advantages to be derived from the secretarial staffs of the different sections being housed together in one residence during the meeting. In organising the Glasgow meeting it was found impossible to obtain adequate accommodation for this purpose in immediate proximity to the University, and the secretariat is consequently to be housed in the Training College Hostel at Jordanhill, about two miles to the north-westward. The local committee is, however, providing transport arrangements which will, it is hoped, reduce the practical inconvenience of this arrangement to negligible dimensions.

For the presidential address, the Corporation has placed at the disposal of the Association the finest of its halls, St. Andrew's Hall, with seating for 4000 and admirable acoustic properties. For the evening discourses the governors of the Royal Technical College are giving the use of their great hall.

As regards lodging accommodation, the chief Glasgow hotels are much in demand, so prospective visitors will do well to secure their accommodation as soon as possible. As, however, the meeting of the Association takes place out of term, many of the lodgings normally occupied by students will be available, and the same applies to the various students' hostels. Further information regarding lodging accommodation may be obtained from the Local Secretaries, 30 George Square, Glasgow, C.2.

The attractions of the Glasgow meeting will not be confined to those of a purely intellectual kind. On Thursday, Sept. 6, the Lord Provost and Corporation will welcome the members at an evening reception and dance in the magnificent City Chambers, while on the following Monday evening the hospitality of the Corporation will again find expression when the Kelvingrove Art Galleries will be placed at the disposal of the local committee for a second evening party. At this party, members who slip away for a while from the extensive galleries devoted to the sciences, in which as members of the British Association they are primarily concerned, will have the opportunity of revelling amongst the artistic treasures which form one of the chief glories of Glasgow.

Nor again will the meeting be devoid of tempting distractions outside the city. Even those who are unaware of the charms of Glasgow itself are dimly conscious that it guards the gateway to the wonderful scenic beauties of the western Highlands. Many undoubtedly will see in the Glasgow meeting an excuse for a prolonged Highland holiday either before or afterwards. But even those who do not will have the opportunity of devoting the Saturday to one of many excursions which have been organised for that day. Biologists will be drawn towards Millport, with its admirably situated and well-equipped biological station, where the Scottish Fishery Board's research vessel *Explorer* is expected to be an object of special attraction. Archæologists will tend to Bute with its ancient remains and modern developments: engineers to the Falls of Clyde and its electric power station. Others will devote the day to recuperation by a long day's sail round Bute and Arran and Ailsa Craig or round the various sea-lochs, or by an expedition by land to the Trossachs and Loch Katrine and Loch Lomond, or farther afield to Aberfeldy and Loch Tay. Other interesting excursions will be to the

Burns Country, and to Peebles and its neighbourhood.

Saturday is, as usual, devoted entirely to excursions, but in addition there will be numerous half-day and afternoon excursions during the week. Many of these will be of special sectional interest, or will be devoted to visits to particular works and industrial centres. That great achievement in applied science, the Port of Glasgow, with its quays and docks and shipyards, will, of course, be of special interest to many visitors, and to facilitate its inspection the Clyde Trustees are generously proposing to place their steamer *Comet* at the service of members of the Association.

The Harvey Tercentenary.

THE place that William Harvey occupies in the development of modern physiology and medicine can only be properly appreciated when his work is viewed in the light of the current scientific knowledge of the seventeenth century. Like many other great discoveries, that of the circulation of the blood owed something to the work of previous observers, but all the more honour is due to Harvey for proving experimentally beyond the shadow of a doubt that the blood circulates, when others had approached the truth but had failed to draw the correct inference from the facts available, and had not devised experiments to test the correctness or otherwise of this deduction.

Ever since the time of Galen, it had been held that some of the blood must pass from one side of the heart to the other through the wall or septum separating the two ventricles : in the earlier part of the sixteenth century, the anatomist Vesalius proved that there was no direct communication between these two chambers of the heart, but such was the force of tradition that he did not directly deny Galen's teaching, the difficulty being surmounted by assuming that the blood passed through invisible channels in the muscle. At about the same period, Servetus described the circulation through the lungs, but failed to correlate this observation with the circulation of the blood through the rest of the body.

Harvey studied at Cambridge and at Padua : at the latter University he came under the influence of Fabricius ab Aquapendente, who published at about this time—in the first few years of the seventeenth century—a treatise on the valves in the veins, which was probably the starting-point of Harvey's discovery. It is easy to demonstrate in the human arm that the blood in the veins can only flow towards the heart owing to the existence of these valves. During the next ten years Harvey was working at the problem arising from these facts: and in 1616 he was lecturing before the College of Physicians in London on the circulation of the blood. Accepting the truth of the facts previously demonstrated, he saw that the only explanation possible must be that the blood reaching the right side of the heart from the veins, was pumped by the right ventricle through the lungs, returning to the left side of the heart, whence it was pumped to all other parts of the body. By animal experiment he was enabled to demonstrate the truth of the conclusion drawn from the anatomical data at his disposal. The work was not published in book form until 1628, when the first edition of " De Motu Cordis (Exercitatio anatomica de motu cordis et sanguinis in animalibus) " was printed by Wilhelm Fitzer of Frankfurt-on-Main.

Harvey may be truly described as the founder of modern physiology and scientific medicine : he refused to be bound by tradition, yet, whilst discarding traditional teaching for which he could find no basis in fact, he paid honour to the earlier workers : above all, he always insisted on testing the truth of inferences and on seeking the explanation of observed facts by means of animal experiments, not excluding observations on man himself.

The celebration of the tercentenary of the publication of the " De Motu Cordis " was arranged by the Royal College of Physicians of London : delegates attended from nearly thirty different countries. The celebration took the form of orations to Harvey's memory, a reception of the delegates by the King, and scientific demonstrations and visits to places and institutions especially associated with Harvey.

The proceedings commenced on May 14, when the delegates were received by the King at Buckingham Palace, being introduced by Sir John Rose Bradford, president of the Royal College of Physicians. Harvey, as a physician, was closely associated with both James I. and Charles I., and accompanied the latter to Oxford : King Charles always supported Harvey's experimental work so far as he was able. In the afternoon, the delegates were welcomed at the Royal College of Physicians and presented their addresses from universities and learned institutions throughout the world. The rare honour of honorary fellowship was conferred upon Lord Balfour, Sir Ernest Rutherford, Prof. I. P. Pavlov, of Leningrad, and Prof. K. F. Wenckebach, of Vienna. Eulogies of Harvey were delivered by Sir Charles Sherrington, Prof. Chauffard, of Paris, and Dr. Keibel, of Berlin.

Sir Charles Sherrington said that the Renaissance occurred first in letters and scholarship, then in the physical sciences, but last in the study of living animals. Harvey was really the first to investigate their function, as distinct from study of their outward form. It is experiment, together with observation, which is at the basis of medicine as we know it to-day. Prof. Chauffard compared the

period of twelve years during which Harvey continued his investigations before the "De Motu Cordis" was published with the same period Francis Bacon required for the maturing of his work, and with the twenty years which elapsed between the time Newton and Darwin began their work and their dates of publication. Perhaps the most striking characteristic of Harvey's work is its modernity: the outlook and the methods are those of to-day.

On May 15 the delegates visited St. Bartholomew's Hospital, where Harvey was physician for twenty-one years: after lunch, Sir Wilmot Herringham gave an account of Harvey's connexion with the hospital and paid a tribute to his memory. On May 16 the delegates were entertained at dinner at Guildhall by the president and fellows of the Royal College of Physicians. In connexion with the celebrations, demonstrations and exhibitions of objects of interest at University College and at the Royal College of Physicians were also arranged. The celebrations were concluded by visits to Merton College, Oxford, of which Harvey was warden, on May 17, and on May 18 to Caius College, Cambridge, from which Harvey graduated.

In connexion with the tercentenary, Dr. Geoffrey Keynes has published an attractive little bibliography of Harvey's writings.[1] The text is illustrated with reproductions of the title pages of certain of the editions, two portraits of Harvey, and several prints illustrating the valves in the veins. Although the "De Motu Cordis" is the best known of Harvey's writings, he published also two short essays on the circulation of the blood in 1649, addressed to John Riolan the younger, professor of anatomy at Paris, in answer to certain criticisms of his work, and two years later his "Exercitationes de Generatione Animalium" appeared. Although the latter has been somewhat neglected, it is almost as great a contribution to science as the "De Motu Cordis," and reveals the master mind of the Father of modern physiology.

[1] A Bibliography of the Writings of William Harvey, M.D. Discoverer of the Circulation of the Blood. By Dr. Geoffrey Keynes. Pp. xii+68+8 plates. Edition limited to 300 copies. (Cambridge: At the University Press, 1928.) 21*s.* net.

Chemical Industry in Modern Life.

WHEN public attention is from time to time directed towards the great scientific achievements of the age, the seeker after the mysteries of Nature is assured of the respectful praise and admiration of modern British men and women as he displays the results of his labours, whether his audience understand their significance or not. It is probably true to-day to say that there is in all civilised countries a keen appreciation of such successes, and a general desire that they shall be acknowledged by public honour, equally, for example, with the no less worthy achievements in the realms of art and literature.

Chemistry, however, and its sister sciences, have now reached a stage of development in which they operate so profoundly on the course of human affairs, and especially on national health and safety, that it becomes necessary to put clearly and frequently before the public such facts as will lead to a proper recognition of the magnitude of the issues which exercise the minds of scientific men. It becomes necessary, for example, to present what may be described as interim non-technical reports exemplifying the progress that is being made in preserving the general well-being of the community and in meeting the demands of modern conditions of existence, and indicating the broad lines along which—perhaps not without public support—development can from time to time be foreseen. The Chemical Industry Conference, organised by the Society of Chemical Industry in co-operation with its London section and Chemical Engineering Group, and with the Institution of Chemical Engineers, which was in session in London on May 11-15, was not intended to introduce new technical data to a technical circle; its function was rather to present such general reports primarily to its members and guests, and also to the Press, and hence to a far wider audience. Such a conference, apart from the offer of opportunities of personal contact and discussion, performs the valuable service also of bringing the labours of one group of workers more vividly before the minds of other groups than is possible through the medium of technical publications.

The conference opened, on its professional side, with an address by Mr. F. H. Carr, president of the Society of Chemical Industry, who dealt with some chemical engineering aspects of the fine chemical industries. Sir Arthur Duckham, the first president of the Institution of Chemical Engineers, contributed an important paper on the fuel industries and the work of the chemical engineer, emphasising the necessity for practical training, and for closer contact between the university and the factory. He confessed that, with ever-widening experience, he became more and more convinced of the great scope which exists for improvement even in our latest methods, and of the splendid prizes still to be won by application of technical knowledge, imagination, and driving force to the daily problems of industry; he put the matter in a nutshell when he stated that the basic need in industry is to get exact knowledge of what we are doing.

Lieut.-Col. G. P. Pollitt described developments in the heavy chemical industry, pointing out that we are at the beginning of a period of replacement of natural products by products made by synthetic and partly synthetic processes, and that what is a 'fine' chemical now may well become 'heavy' in a few years' time. In this paper the general effect of the War on chemical manufacturers was summarised, and the principal differences between pre-War and post-War practice were indicated; recent achievements, such as the synthesis of ammonia, the hydrogenation of coal, and the artificial silk industry, were also passed under review. Prof. G. T. Morgan's contribution was an account of a

chemical study of low-temperature tar, a material the investigation of which has been carried out chiefly since the War. All these papers thus dealt with matters of the highest technical importance, and gave some idea of the responsibility that rests on the chemical engineer in transferring successful laboratory processes to the domain in which mechanics and economics occupy so dominating a position.

Other papers were more general in their appeal. Sir Alfred Mond, as was to be anticipated from the title of his paper, "Scientific Research as applied to Industry," delivered a most inspiring and convincing address on the broad questions at issue. He was rightly insistent, in the first place, that science is not national, but human, and that little is therefore to be gained by attempts to nationalise it. He was also anxious to remove the widespread impression that chemical industry and the manufacture of dyes are synonymous terms, and incidentally showed that the obstacles which in the past have stood in the way of rapid development of that branch of the industry within the shores of Great Britain are to be sought in the patent laws rather than in any deficiency in British technical capacity. Indeed, it was most encouraging to hear him—a man of great experience and responsibility—declare that in Great Britain we have now, and probably always have had, the right kind of men who can be entrusted with the care of our important chemical industries, and that we can claim a superiority in this respect over other countries. Further, although the ability for original inquiry is inborn, and hence not to be acquired to order, the spirit of research and the intelligent, courageous application of new knowledge should permeate the factory; conversely, of course, practical considerations must always occupy a prominent place in the field of vision of the researcher. One might, indeed, go further, and say that the diffusion through civilised communities of such a spirit, call it what one may, is one of the prime factors in our progressive attempts to make the world a better place to live in.

Sir Alfred has had unique opportunities of estimating the cash value of research, and he sees in large industrial combinations the opportunity of making the best use of specialised talent and new possibilities. His statement that the leaders of chemical industry nowadays are the guardians of the nation's defence and prosperity could have encountered no lurking doubts in an audience of men and women acquainted with some of the relevant facts; the dependence of a cheap and plentiful food supply on cheap synthetic or artificial fertilisers, and the possibility of the economic conversion of coal into fuel oil, are but two examples of the vital considerations which were evidently in his mind.

Sir Ernest Rutherford, under whose chairmanship Sir Alfred Mond was speaking, amplified the discussion by pointing out that at the foundations of the applied research which means so much for industry are the labours of those devoting themselves to 'pure' science, and he exemplified the manner in which apparently academic or unpractical investigations may in a surprising way lead to applications of the greatest significance.

Water supplies formed, under Lord Desborough's chairmanship, the subject of another session of the conference. An abundant supply of pure water, especially in urban areas, is now so universal and commonplace a service that few other than those directly concerned give a thought to the extent to which its provision draws on our resources of scientific knowledge and invention, and—in average seasons, at any rate—how it depends on considerations of fluctuating supply and demand. As Lord Desborough showed, the question is not altogether devoid of anxiety, and the matter requires constant skilled and highly organised supervision. Sir Alexander Houston gave a most interesting account of the various ways in which London's water supply is purified before it reaches the consumer, and expressed some apprehension concerning the possible pollution of water supplies by gulls. Mr. J. H. Coste discussed more fully the pollution of tidal and non-tidal waters by house rubbish and sewage, and by the waste products of trades, whereby a pleasant river may be rendered unsavoury or unsafe, and normal life in it, of fish in particular, may be degraded or destroyed. Mr. Coste referred to the nature and movement of the pollution, discussed the causes of the unfitness of water for fish life, the standards applicable to, and treatment of, works' effluents, and the legal and administrative steps that have been taken to protect streams from unnecessary pollution.

The scientific assistance which can be afforded to agriculture was represented by Sir John Russell's paper on the part played by British workers in the application of fixed nitrogen to the soil. In the unavoidable absence of the author, the paper was read by Dr. B. A. Keen, who said that in agricultural chemistry two main considerations are in the foreground, namely: "What is 'quality'?" and "What is the detailed effect of fertilisers on yields?" The paper presented a concise, yet informative, account of experiments which have been carried on for many years at Rothamsted Experimental Station, Harpenden. Such a mass of data has accumulated from these continuous field experiments that the application of modern and newly devised statistical methods has been necessary in its interpretation. These new methods have paved the way to a study of the effect of soil and climatic conditions on the effectiveness of fertilisers. The investigations indicate the possibility that, if the general character of a season could be predicted, appropriate manurial schemes could be drawn up for mitigating its bad features and utilising to the fullest extent all its good ones. Alternatively, it would be possible to construct tables of expectancy of crop yield, on the basis of which large fertiliser combines could insure farmers using recognised fertiliser mixtures against getting less than an agreed yield per acre. If it is true that 1400 million people till the soil in order to feed and clothe 1800 million inhabitants of this planet, could science be applied in any more vital interest?

News and Views.

PROF. J. W. GREGORY has received a cable from Sir Edgworth David announcing the discovery of a rich fossil fauna of ancient annelids and arthropods throughout the whole of the Adelaide Series which lies at the base of the Cambrian System in South Australia. The appendages are excellently preserved. Sir Edgworth David considers the age probably Lipalian, but possibly Lower Cambrian. The newly discovered fossils extend from 2000 ft. to 12,000 ft. below the fossiliferous Cambrian beds. The Lipalian is the name given by Walcott to a division of time a little lower than the Cambrian. This discovery, amongst its many other bearings, may be expected to throw important light on the age of the ancient glacial deposits of South Australia which have been assigned either to the Cambrian or to the pre-Cambrian.

AFTER an interval of more than six years, the non-magnetic sailing ship *Carnegie*, of the Carnegie Institution of Washington, set out on May 1 on another scientific world cruise. The scientific and navigating staff of the yacht numbers eight men. The cruise is intended to cover three and a half years; the places to be visited, in order, are England, Germany, Iceland, the West Indies, Panama, the South Pacific (the Society Islands, Easter Island, Peru), Japan, California, Honolulu, Samoa, New Zealand, Cape Horn, South Georgia, South Africa, Ceylon, India, Western Australia; across the South Pacific again and around the Horn to Buenos Ayres, Argentina, St. Helena, Azores, Madeira, and back to Washington. The first object of the cruise is to take magnetic observations, in order to determine the secular variation without which the magnetic charts, used nowadays for aerial as well as ocean navigation, cannot be kept up-to-date; atmospheric electric observations will also be made, as on the preceding cruise. In addition the staff are taking up new work of three kinds: the investigation of radio-propagation, in accordance with a programme of transmission and reception arranged with the Washington Naval Research Laboratory; the investigation of the sedimentary deposits on the ocean bed; and the mapping of the sea bed by sonic depth-finders. The *Carnegie* is due to arrive at Plymouth on May 26, and will be there until June 8. During her stay at Plymouth, Capt. J. P. Ault and his staff will welcome visits from scientific workers anxious to see the vessel and examine her equipment.

THE expedition organised by the British Association Great Barrier Reef Committee will leave England for Brisbane by the R.M.S. *Ormonde*, which sails from Tilbury on May 26. The party, which is now fully constituted, will consist of the following: Leader, Dr. C. M. Yonge, Balfour Student in the University of Cambridge; second in charge and leader of the boat party, Mr. F. S. Russell, assistant naturalist at the Plymouth Laboratory; leader of the reef party, Dr. T. A. Stephenson, lecturer in zoology, University College, London; chemist and hydrographer, Mr. A. P. Orr, chemist, Marine Station, Millport; phytoplankton worker, Miss S. M. Marshall, assistant naturalist, Marine Station, Millport; botanist, Mr. G. Tandy, Department of Botany, British Museum (Natural History); zoologist and leader's assistant, Mr. G. W. Otter, University of Cambridge; medical officer, Mrs. C. M. Yonge. Mrs. Russell and Mrs. Stephenson will accompany the party. There will follow later, Mr. J. A. Steers, fellow of St. Catherine's College, Cambridge, and Mr. M. Spender, of Balliol College, Oxford, who will carry out geographical work under the auspices of the Royal Geographical Society, and also Mr. J. S. Colman, of New College, Oxford, who will assist Mr. Russell in his work on the distribution of zooplankton. Valuable assistance is expected from Australian sources. With the exception of Mr. Russell, Mr. Tandy, and Mr. Steers, who will be in Australia for six months only, the members of the expedition will carry out continuous observations for a period of about thirteen months.

A GREAT quantity of apparatus is being taken by the Great Barrier Reef Expedition, for the object aimed at is a repetition under tropical conditions of the standard observations, chemical and planktonic, made in temperate seas, so that not only will the results obtained give new and much-needed information about the conditions prevailing in tropical waters, but also they may throw considerable light on conditions in temperate seas when the results of parallel observations in the different localities are compared. The conditions underlying the formation of coral reefs will, naturally, receive the greatest attention, the nutrition and calcium metabolism of corals and associated organisms being one of the chief objects of the expedition, while the many economic possibilities of the Great Barrier Reef will be fully explored. The total cost of the expedition will be some £10,000, of which about £8000 has been received to date, the money having been provided by the Empire Marketing Board, the Commonwealth Government, the British and Australian Associations for the Advancement of Science, the Australian Great Barrier Reef Committee, the Royal Society, the Royal Geographical Society, the Zoological Society, and a number of private individuals. The committee hopes to raise the remaining £2000 during the coming year, and any subscriptions towards this would be welcomed by the committee, the chairman of which is the Right Hon. Sir Matthew Nathan; the treasurer, the Hon. J. Huxham, Agent General for Queensland; and the secretaries, Prof. J. Stanley Gardiner and Mr. F. A. Potts, Zoological Laboratory, Cambridge.

VERY hearty congratulations are extended to Sir Daniel Morris, K.C.M.G., botanist, and Col. R. E. Crompton, C.B., electrical engineer—two octogenarian men of science—who celebrate, respectively, their eighty-fourth and eighty-third birthdays on May 26 and May 31. Sir Daniel Morris was born at Loughor, Glamorgan, and was educated at Cheltenham and

Trinity College, Dublin. Early in his career Sir Daniel's particular studies and efforts were directed towards promoting the economic resources of tropical parts of the British Empire by means of scientific exploration and research. Appointed Director of the Royal Botanic Gardens, Ceylon, in 1877, he afterwards became Director of the Botanic Department, Jamaica, vacating this post on his appointment as Assistant Director of the Royal Botanic Gardens, Kew. Here he remained for twelve years (1886–98), becoming then Imperial Commissioner, West Indian Agricultural Department. From 1908 until 1913 he was scientific adviser in tropical agriculture to the Colonial Office. Sir Daniel was president of Section K (Botany) at the Bournemouth meeting of the British Association in 1919.

COL. CROMPTON, the distinguished engineer, who forms one in a still living group of veterans in that branch of science, is a Harrovian. After leaving school he began training as a mechanical engineer, but for family reasons entered the army and for some years served with his regiment in India. Whilst on the Commander-in-Chief's staff at Simla, he persuaded the Governor-General, Lord Mayo, to promote the first large-scale road transport experiment. Returning to England in 1876, Col. Crompton engaged in electrical engineering, founded the firm of Crompton and Co., and remained its managing director for nearly thirty years, a period of unceasing application to electrical undertakings at home and abroad. For long Col. Crompton rendered unstinting service to the National Physical Laboratory in a consultative capacity. He has been twice president of the Institution of Electrical Engineers, and he was, in 1926, awarded the Faraday medal of the Institution. Still actively engaged, he is a member of council of the Institution of Civil Engineers, and representative of that body on the official Advisory Panel (Ministry of Transport).

A CONVERSAZIONE was held at the East London College on May 15 to commemorate the twenty-first birthday of the College as a 'school' of the University of London. The College has, however, provided education of university type for more than forty years, and for eighteen years has participated in the Government grant to university colleges. His Majesty the King is Patron of the College, and the King and Queen visited it five years ago. On the present occasion the Duke and Duchess of York were distinguished guests, and, with the Masters and Wardens of the Drapers' Company, the Vice-Chancellor and the Principal of the University of London and more than 2000 others, were received in the Queen's Hall by the Deputy Chairman of the College Council, Sir Lynden Macassey and Principal Hatton. After the presentation of the members of the College Council, of the Academic Board and of the officials of the Students' Union to the Duke and Duchess, their Royal Highnesses made a tour of the laboratories, in which about 150 experiments had been arranged and were demonstrated by the staff or the students. Short lectures on broadcasting, television, and noctovision, and on other subjects were given by Capt. P. P. Eckersley, Mr. J. L. Baird, and members of the staff.

A FEATURE of the laboratory exhibits, somewhat unusual at a conversazione, was the amount of apparatus and the number of experiments representing research either completed or in progress in East London College. As examples may be mentioned: in the physics laboratories, the elasticity of metals and experiments on sound; in the geology laboratory, the photomicrography of rocks; in the botany laboratory, the exhibit by Dr. W. A. Goddyn of Leyden, illustrating natural hybrids between plants and between humans, and that of mosquito larvæ and their food; in the electrical engineering laboratory, the investigation of the electrical field about high-voltage apparatus and of the three-carbon arc; in the mechanical engineering laboratory, the researches on the temperature distribution in a dual cycle oil engine and that on the application of the principle of similitude to earth pressures; in the chemical laboratories, the furnace for specific heats of gases at 1500° C. and the apparatus for measuring heats of solution; and in the zoology department, the specimens illustrating species. The fine library on the lines of the British Museum reading room, with its large collection of books relating to Shakespeare from the library of the late Sir Sydney Lee, provided interest for the literary guests, while the dancing to which the Queen's Hall was devoted after 9.30, kept many of the students and guests until nearly midnight.

THE annual general meeting of the Institute of Physics was held on May 15, when the following officers were elected for the year 1928–29: *President*, Sir Frank Dyson; *Vice-Presidents*, Dr. Alexander Russell and Mr. C. C. Paterson; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. A. O. Rankine. Sir Ernest Rutherford and Sir Richard Glazebrook were elected honorary fellows of the Institute. The president, in moving the adoption of the Report of the Board for the year 1927, referred to the substantial additions to the membership of the Institute during the year, and to the increased activities which coincided with the transfer of the offices to South Kensington. The Royal Meteorological has been added to the list of participating societies. The report affords evidence of the progress made by the *Journal of Scientific Instruments*, which now, at the close of its fourth annual volume, may claim to be firmly established. The journal has become a recognised medium for the publication of papers dealing with the instrumental aspects of scientific work. An important announcement in relation to the journal, of interest to present and future members of the Institute, was made at the meeting, namely, the decision of the Board that, commencing in January 1929, the journal is to be distributed without charge to fellows, and at a small charge to associates. Dr. C. V. Drysdale's resignation from the editorship, largely on account of ill-health, has been accepted by the Board with great regret; the secretary of the Institute, Mr. Thomas Martin, has been appointed his successor.

AT the close of the annual meeting of the Institute of Physics, Sir Frank Dyson gave his presidential address, taking as his subject "Physics in Astronomy." Among the developments of astronomy and astrophysics in which physics has played an important part are the successive improvements in the construction of clocks which have led to accurate timekeeping. The independence of the 'judiciary' and the 'executive,' that is, of the pendulum and the clock train, is largely secured by Riefler's work. The latest solution of the difficulties, resulting in a nearly perfect timekeeper, has been made by Mr. Shortt in conjunction with Mr. Hope Jones of the Synchronome Company, in the clock they have produced. Sir Frank Dyson also referred to the work of astronomers in ensuring uniformity of timekeeping by the distribution of time signals, from the dropping of the time-ball by hand, which was instituted by Pond at Greenwich at the commencement of the last century, to the final stage in which wireless is used in the co-operation of Greenwich with the British Broadcasting Corporation. Increase in the size of telescopes has called for the assistance of the engineer and physicist in the provision in the observatory of driving clocks and electric motors for moving the instrument and turning the domes and shutters; while the manufacture of optical glass has provided one of the principal and most important fields for the practice of physical science in the service of the astronomer.

PROF. S. LANGDON'S summary of the sixth season's work of the Oxford-Field Museum Expedition's work at Kish, which appeared in the *Times* of May 17, serves to emphasise once more the remarkable additions to our knowledge of the early age of metal which have been made by the excavations in Mesopotamia of the last few years. In the past season this expedition has been engaged under its field director, Mr. M. F. Watelin, in the excavation of a mound to the north-west of the great stage tower of Hursagkalamma. After laying bare to a depth of 25 feet, the ruins of a temple of Sargonic times, dating from about 2700 B.C., over an area of 300 yards square, beneath a sterile stratum 7 ft. thick was reached a continuous red earth stratum of five feet in thickness which extended over the whole area and represented the temenos platform on which the stage tower and three great temples of Kish were erected. This represents plain level. At this point there is a definite break between the objects of the red stratum and those of the earlier civilisation beneath, which yields, as Prof. Langdon points out, "a most valuable chronological and archæological criterion in the evolution of ancient civilisation." In this earlier stratum excavations were carried down 25 ft. below plain level. Here were found a long series of brick-vaulted tombs with true arches, in which the bodies were laid upon boards resting on layers of potsherds. Inscribed cylinder seals and tablets cease at this level, and the funerary equipment is entirely different from that of the later strata. Stone bowls and spouted painted pots characterise the cemetery. Two of the tombs contained two- and four-wheel chariots mounted in bronze and with the bodies of the oxen. It would appear, therefore, that the custom of sacrificing oxen and attendants to accompany their master was practised. The overlying red layer is definitely dated as preceding 2900 B.C. Prof. Langdon dates this pre-Sumerian culture at about 1000 years before the oldest Sumerian inscriptions which can be translated. Prof. Langdon concludes by announcing that Dr. Rushton Parker has generously offered to give to the funds of the expedition 10 per cent of the total amount of any contributions received before Oct. 1 next.

THE Huxley-Wilberforce debate at the Oxford meeting of the British Association in 1860 has come to be regarded as a classic encounter in the progress of modern scientific thought, typifying the overthrow of rhetorical distractions, prejudice, and intolerance in face of cool reason. On all hands the effectiveness of Huxley's closing words were admitted, and it is strange that in spite of this unanimity, no member of that memorable audience could recollect the exact terms of his overwhelming retort to the Bishop of Oxford. Prof. E. B. Poulton's contribution to the *Jesus College Magazine* Lent Term number, therefore, makes some welcome additions. He shows that Huxley was present at the meeting against his own inclination, and quotes several versions of the encounter, revealing that the article in *Macmillan's Magazine* for October 1898 was written by Mrs. William Sidgwick. But the most accurate account is that contained in the letter from J. R. Green, who had just graduated B.A., to his college friend, now Sir William Boyd Dawkins. (It is amusing to picture this doyen of British prehistoric archæologists 'chucking' a snowball through the glass of Green's window, as he confessed to the author he had done.)

GREEN'S letter was written three days after the meeting, and Prof. Poulton prints a communication from Huxley himself, written less than a year before his death, stating that in his opinion its account, with one emendation, was accurate. "I asserted, and I repeat, that a man has no reason to be ashamed of having an ape for his grandfather. If there were an ancestor whom I should feel shame in recalling, it would rather be a *man*, a man of restless and versatile intellect, who, not content with [an equivocal] success in his own sphere of activity, plunges into scientific questions with which he has no real acquaintance, only to obscure them by an aimless rhetoric, and distract the attention of his hearers from the real point at issue by eloquent digressions, and skilled appeals to religious prejudice." We have placed in parentheses the words which Huxley considered he did not use. Sir William Boyd Dawkins has expressed his intention of presenting the letter from which the above is a short extract, together with others of the deepest interest, to the archives of Jesus College, Oxford.

A CUNEIFORM tablet of Rusa I. of Chaldæa (733–714 B.C.), found by the Armenian scholar Avdalbegian in July last at Nor-Bayazet in Armenia, proves to be of considerable historical importance. It definitely identifies the Velitkukhi region with the district of

Nor-Bayazet, confirming the indication of another tablet of King Rusa in which Velitkukhi is mentioned among twenty-three countries conquered by that king. Some scholars identify Velitkukhi with Colchis, thus extending the Chaldæan conquests far into the north. The inscription is cut on a massive basalt slab, apparently the corner stone of some edifice, and consists of eight lines. An illustration, with translation, appears in the *Weekly News Bulletin* of Feb. 4 of the Russian Society for Cultural Relations with Foreign Countries.

THE *Eugenics Review* begins its twentieth volume in a new dress, in accordance with its increasing importance as a periodical dealing with everything that concerns eugenics or racial welfare. It is edited for the Eugenics Society by Mr. Eldon Moore. The current number contains the annual Galton Lecture by Dr. C. J. Bond, on the causes of racial decay. Mr. W. T. J. Gun replies to Prof. Raymond Pearl's rather hasty conclusion that great men have usually sprung from mediocre families, and Miss M. C. Buer discusses present and past birth- and death-rates in a review of Griffith's "Population Problems of the Age of Malthus." Other short articles are on "The Cost of a Child" and "Temperament and Social Class." The remainder of a number containing 74 pages is devoted to notes, book reviews and notices, and current periodicals. The net is spread widely, and everything bearing on the current problems of eugenics finds a place. The journal is valuable to all those interested in the problems of sociology, medicine, anthropology, and heredity applied to man.

THE popular interest taken in evolution in America is shown by a new monthly journal called *Evolution*, published in New York. A recent number has on its front page the "Family tree of Man," in which the relationships of the various types of human, prehuman, and anthropoid ape skulls are diagrammatically shown from an exhibit in the American Museum of Natural History. The nature of the contents of the number can be judged from some of the titles, which include "Thomas H. Huxley and Peter Kropotkin," "How Man differs from the Ape," "X-rays stimulate Variation," "Evolution and the New Perspective of Life Purposes," "How old is the World?" The editor does not deal gently with the Fundamentalists. The result should be to spread a more rational and unprejudiced attitude to the whole subject of man's origin and development.

IN September next, the Folk-Lore Society, which was founded in 1878, will celebrate its fiftieth anniversary. The occasion is to be marked by an International Jubilee Congress of Folk-Lore which will be held in London on Sept. 19–25. An influential advisory council is in process of formation. Among those who have already intimated their willingness to serve are: Sir James and Lady Frazer; Prof. R. M. Dawkins, president of the Folk-Lore Society; Prof. J. L. Myres, president of the Royal Anthropological Institute; Dr. M. Gaster; Dr. Haddon; Lady Gomme; Prof. Halliday; Sir Everard im Thurn; Prof. Westermarck; Sir Richard Temple; Prof. Sayce; Prof. Seligman; Sir D'Arcy Power; Mr. Henry Balfour; as well as a number of distinguished continental and American folklorists and anthropologists.

IN the issue of *Chemistry and Industry* for April 20 is an account of an address delivered by Prof. H. E. Armstrong before the Lancaster Astronomical and Scientific Association. The subject of the address, which was reported in full in the *Lancaster Observer and Morecambe Chronicle* for Mar. 23, was Edward Frankland. Prof. Armstrong was at one time an assistant to Frankland, and he gave an interesting account of Frankland's life as a man, rather than of his work as a chemist, which has been told before. One of Frankland's greatest scientific contributions was his investigation of public water supply and drainage, which led to a great reduction of cholera and typhoid fever during the latter half of the nineteenth century.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 2. The Observatory will be open for inspection by invited guests at 3.30 P.M.

THE British Empire Cancer Campaign has received an intimation that His Majesty The King (Patron of the Campaign) will receive the overseas delegates to the forthcoming International Conference on Cancer at Buckingham Palace on Monday, July 16.

A PUBLIC meeting will be held at King's College, London, at 5.30 P.M. on Thursday, May 31, under the auspices of the University of London Animal Welfare Society, to discuss "Man's Duty to Animals." The chair will be taken by Prof. Hobday, Principal of the Royal Veterinary College, who is president of the Society.

A LARGE earthquake was recorded at Kew Observatory on May 14 at 22 hr. 27 min. 26 sec., G.M.T. The epicentre is estimated to be 5850 miles away in an easterly direction and is probably one of the islands off the Asiatic coast. The main shock was followed by a smaller one at the same distance away on May 15 at 2 hr. 49 min. 00 sec.

BY the will of Lieut.-Col. A. J. C. Cunningham, R.E., who died on Feb. 8, aged eighty-five years, the London Mathematical Society will receive £1000 for the improvement of the method of factorisation of large numbers, and £2000 for the publication of Col. Cunningham's unpublished printed mathematical works and the completion and publication of his mathematical MSS., and also his library of mathematical books. The residue of his estate is to be divided as to one-twelfth to the London Mathematical Society, and one-twelfth to the British Association, mathematical subsection, for preparing new mathematical tables in the theory of numbers.

AT a general meeting of members of the Institute of Metals, held in London on May 8, an invitation was received from the American Institute of Mining and Metallurgical Engineers to hold a meeting in the United States in 1932. The invitation was accepted,

and it is hoped the ample notice given of the proposed meeting will make possible a good attendance. The council of the Institute is endeavouring to arrange for an inclusive fare of about £100 to cover the entire cost of the trip, which will be of about five weeks' duration, and will take place in the autumn, both Canada and the United States being visited.

THE centenary of the incorporation by Royal Charter of the Institution of Civil Engineers will be celebrated on June 3–7. On Sunday, June 3, the president and council of the Institution, with members and delegates, will attend a service at 3 P.M. at Westminster Abbey. On the following day an address will be given by the president, Mr. E. F. C. Trench, at a reception in the Hall of the Institution, and in the afternoon the thirty-fourth James Forrest Lecture will be delivered by Sir Alfred Ewing on "A Century of Inventions." The remaining days of the celebration will be occupied by a conference dealing with railway, marine, hydro-electric, and other aspects of engineering, and with visits to engineering works. Cards of admission to the meetings of the conference can be obtained from the secretary of the Institution by members of other engineering societies.

THE council of the Institution of Electrical Engineers has made the following awards of premiums for papers read during the session 1927–28 or accepted for publication: The Institution Premium to Mr. F. H. Rosencrants; Ayrton Premium to Mr. F. Lydall; Fahie Premium to Mr. B. S. Cohen; John Hopkinson Premium to Mr. D. B. Hoseason; Kelvin Premium to Messrs. T. N. Riley and T. R. Scott; Paris Premium to Messrs. A. H. Law and J. P. Chittenden; Extra Premiums to Mr. E. C. McKinnon, Mr. H. B. Poynder, Dr. T. H. Turney, Mr. P. D. Morgan; Wireless Premiums to Prof. E. V. Appleton, Lieut.-Col. A. G. Lee, Messrs. G. W. N. Cobbold and A. E. Underdown; and Willians Premium to Lieut.-Col. H. E. O'Brien.

THE annual congress of the South-Eastern Union of Scientific Societies opens at Rochester on June 6, and Sir Martin Conway will take as the subject of his presidential address "Mountain Exploration." As a veteran explorer and traveller, his reminiscences on this subject will undoubtedly prove of much interest and importance. The congress will last over four days, and addresses will be given by Prof. E. W. MacBride, Dr. Mortimer Wheeler, director of the London Museum, Dr. William Martin, the well-known London archæologist, Mr. H. B. Milner, of the Royal School of Mines, who will lecture on "Geology from the Air," and others. Visits will be paid to Rochester Cathedral and Castle, Gads Hill and Dickens Land, Blue Bell Hill, where is the famous Kits Coty dolmen and other stone age relics, and other places of interest. Further information can be obtained from the honorary secretary, Mr. Edward A. Martin, St. Lawrence, Isle of Wight.

THE annual free booklet published by Messrs. Burroughs Wellcome and Co. is this year entitled "Pictorial Perfection in Photography," and besides some interesting pictorial illustrations and elementary details of manipulation, includes time and temperature tables for development with the various 'tabloid' developers prepared by the firm, some details regarding enlarging, and colour effects obtained by staining, by toning, and by double toning.

THE February issue of *X-Ray News and Clinical Photography*, published by Kodak Limited, is devoted to the use of X-rays in dentistry. The factors treated of are illustrated by diagrams, photographs, and examples, and include the position of the patient's head, the fixation of the head, the use of a film holder to prevent the film from slipping, the correct angle of the tube, and the exposures necessary for the various teeth under conditions that are given. Extra-oral work is also described showing how to avoid the super-imposition of the image of the anterior jaw on the area under examination.

ON the occasion of the Linguistic Congress at The Hague last month, an International Society of Experimental Phonetics was founded. The following elections took place: *President*, Prof. E. W. Scripture, of Vienna; *Vice-President*, Dr. E. A. Meyer, of Stockholm; *Honorary Members*, Prof. A. Meillet, of Paris, and Prof. L. Zwaardemaker, of Utrecht. The object of the Society is the promotion of scientific research in experimental phonetics. A *Bulletin* will be issued from time to time. The membership fee for 1928 is 5 shillings, or a dollar and a quarter. Applications with fee are to be sent to Prof. E. W. Scripture, Strudelhofgasse 4, Vienna, Austria.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Acton Technical Institute—The Secretary, Middlesex Education Committee, 40 Eccleston Square, S.W.1 (May 30). An instrument maker to assist in making and repairing scientific instruments, at the Bradford Technical College—The Principal, Technical College, Bradford (May 31). A part-time lecturer in sociology at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 4). An assistant in the mining department of the North Staffordshire Technical College—The Clerk to the Governors, Town Hall, Hanley, Stoke-on-Trent (June 4). A lecturer in architecture in the University of Sheffield—The Registrar, University, Sheffield (June 4). A full-time teacher in the department of mechanical engineering of the Rugby College of Technology and Arts—The Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (June 6). A senior technical officer in the Wireless Department of the Royal Aircraft Establishment, primarily for work on design and development of wireless receivers for use in aircraft—The Chief Superintendent, R.A.E., South Farnborough, Hants (June 9, on form A.258). An assistant lecturer in geography in the University of Birmingham—The Secretary, University, Birmingham (June 11). A lecturer in mechanical engineering and a lecturer in mathematics and physics at the Chesterfield Technical College—The Principal,

Technical College, Chesterfield (June 11). A part-time demonstrator in biology at King's College for Women (Household and Social Science Department)—The Secretary, King's College for Women, Campden Hill Road, W.8 (June 16). A reader in chemistry at the East London College—The Academic Registrar, University of London, South Kensington, S.W.7 (June 21). The John Lucas Walker studentship of the University of Cambridge—Prof. H. R. Dean, Pathological Laboratory, Medical School, Cambridge (June 29). A leather research chemist for the New Zealand Tanners' Research Association—The High Commissioner for New Zealand, 415 Strand, W.C.2 (June 30). A dairy bacteriologist, a dairy chemist, two senior plant pathologists, a senior plant geneticist, and a senior plant physiologist, each under the Australian Commonwealth Council for Scientific and Industrial Research—The Acting Secretary, Commonwealth Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, Victoria, Australia (Aug. 15). A test assistant at the Royal Aircraft Establishment for calculation work in connexion with engine investigations—The Chief Superintendent, R.A.E., South Farnborough, Hants (quoting A.275). A senior research assistant, experienced in the science and practice of poultry husbandry, at the National Institute of Poultry Husbandry—The Director, National Institute of Poultry Husbandry, Newport, Shropshire. Teachers of engineering and of mathematics and a full-time instructor in engineering workshops, with special qualifications in metal plate work, at the Wandsworth Technical Institute—The Principal, Wandsworth Technical Institute, S.W. An assistant in the physics department, Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18.

Our Astronomical Column.

THE PLANET MERCURY.—Mr. W. F. Denning writes: "A favourable easterly elongation of the planet Mercury will occur on June 3, and this rather difficult object ought to be well seen as an evening star between about May 26 and June 7. At spring elongations, Mercury is usually seen under the brightest aspect a few evenings before the date of elongation. This year the planet sets about two hours after the sun for about a fortnight, and should be distinctly visible to the unaided eye after sunset whenever the west-north-west sky is clear of clouds up to about June 7. The twilight is very strong at this period of the year, but Mercury will be brighter than a first magnitude star, and should be easily distinguishable by persons of ordinary vision. It exhibits a reddish lustre and presents a starlike aspect from the fact that its small disc shows scintillation similarly to that of the fixed stars. The low altitude at which it is usually observed encourages this appearance as the atmospheric effects are more pronounced when objects are near the horizon than when they are at considerable elevations. Were the English climate more favourable for astronomical observations, Mercury would be often seen either before sunrise or following sunset and considered an easy object, but clouded sky at low altitudes frequently prevents the attempts of observers being successful."

MAGNETIC STORMS AND SUNSPOTS.—Among the astronomical exhibits from the Royal Observatory, Greenwich, which were on view during the conversazione held at the Royal Society on May 17, there was a series of solar photographs and reproductions of magnetic traces illustrating the frequent coincidence between very large terrestrial magnetic storms and large sunspots. The period represented by the exhibits was 1874–1927. During these 54 years there were recorded at Greenwich 17 large magnetic storms with ranges as follows: Declination 90′, or, Horizontal Force (or Vertical Force) 500 γ. In 15 of those cases there was, at the time of the commencement of the storm, a large sunspot (mean area 500 millionths of the hemisphere or greater) within 4 days of the sun's central meridian. At the time of one of the two remaining storms there was a smaller spot near the central meridian, but this spot had been a large one in the previous rotation, when it was associated with one of the 15 large magnetic storms. In the case of the remaining storm, there was also no large spot near the central meridian at the time, but possibly it is of significance that one solar rotation (about 27 days) afterwards a large spot originated near the central meridian. The coincidence shown between these very large magnetic storms and large sunspots is strongly suggestive of a relationship between individual spots and individual magnetic storms of a certain magnitude.

A SUGGESTED CAUSE OF NEW STARS.—M. C. Johnson offers in *M.N.R.A.S.* for March a suggested explanation of new stars. He points out that any acceptable explanation must be adequate to account for the large amount of energy liberated, and must be likely to occur sufficiently often to give two or three novæ annually; this includes the faint novæ that do not attain naked-eye visibility.

Collision of star with star would not occur often enough to be acceptable as a general explanation. The theory that the outburst is due to some sudden change in the star's interior has found favour of late, but we have no data for estimating whether such changes would occur sufficiently often to explain all cases.

We know that gaseous nebulæ extend through vast regions of space, so that the impact of a star with a nebula is not too improbable as an explanation; but the boundaries of nebulæ are so diffused that it has not been considered likely that a collision would give rise to such a sudden outburst as we observe in novæ. Mr. Johnson suggests that the first effect of the entry of a star into a nebula may be to form a blanket round the star which obstructs the output of its heat and so causes a gradual accumulation of heat which culminates in a violent outburst. The suggestion is similar to the explanation of long-period variables by supposing a smoke-cloud to form round them, bottling up the heat, until the latter accumulates and dissipates the cloud.

The author gives reasons for thinking that the entry of a faint dwarf into a nebula would be the most likely to produce the required conditions. It might be in the nebula for two centuries before the outbreak occurred, its light being dimmed by 40 per cent. Its surface temperature, taken as 3000° previously, might then rise to 11,000° for three months or so. Col. F. J. M. Stratton and Prof. E. A. Milne have helped and encouraged Mr. Johnson in this study.

Research Items.

GHOSTS IN EAST AFRICA.—A further contribution to the study of ghosts and devils in East Africa, by Mr. G. W. B. Huntingford, appears in *Man* for May. Among the Bantu, ghosts visit the huts of sick people only. When they appeared it was usual to go to a medicine man for medicine to exorcise them. A goat was killed, some of its blood put in a pot with the medicine, and it was left at some distance for the ghost to eat. The spirits of the dead live in holes in the ground and people in good health do not see them. A kind of evil spirit which is abroad at night takes the form of a black bird. Among the Syan of Bugishu in Uganda it is customary to make yearly offerings of eleusine corn to the spirits of the dead. If anyone neglects this custom the angry spirit comes at night and seizes him by the neck with its hands. In the morning he is ill and cannot eat. He must go at once to a medicine man, who will tell him to make an offering of a goat or fowl and beer. The goat or fowl is put in a tree at some distance, while the beer is put in a hole dug just outside the door of the hut. Certain of the witch doctors are said to turn into hyenas at night and to prowl around the huts of people they do not like, howling like hyenas (the Kitosh of northern Kavirondo). Among the Nilo-Hamitic peoples, the Nandi believe in a devil with one leg, nine buttocks, and a mouth which shines like a lamp, which they call Chemosit. It wanders about at night looking for children to eat, whom it entices by singing. Tobolwa Hill, in north-west Nandi, is said to be haunted. The spirits of people, cattle, and goats may be heard there. While others deny this, it is evident that the hill is not liked, and there are no huts or people anywhere near it.

PAGANISM IN THE CHURCHES.—Some interesting examples of survivals of pagan beliefs and practices in early and modern Christianity were cited in an article by Mr. C. E. Lart in the *Hibbert Journal* for April. The Edict of Theodosius of A.D. 380, later ratified by Gregory the Great in his letter to Mellitus, the missionary to Britain, allowed heathen temples to be reconsecrated to Christian use, and sanctioned the continuation of such rites and usages as could be turned to the purpose of the church. This recognised a practice which had already begun in the Church of the Catacombs. As a result, while the Church forbad the worship of sticks and stones, the local god became a saint, the pagan holy stone was sprinkled with holy water and a Latin cross was cut on it. The worship of fire, lighted torches, trees, fountains, wells, and menhirs were forbidden by numerous Church Councils from that at Arles in A.D. 453 down to that at Toledo in 692, and similar practices were forbidden by Charlemagne in 789, including that of beating the bounds. St. Patrick took holy stones into the church after sprinkling them with holy water, one such, covered with gold plates, being preserved in the Cathedral of Clogher until 1498. Traces of sun worship are numerous, for example, in the use of the south side of the churchyard, the north being allotted to suicides. The wedding ring is a symbol of the sun. Monasticism was taken over from Buddhism, and the nun was the vestal, the 'bride of the god.'

THE RODENTS OF CEYLON.—In continuation of his guide to the mammals of Ceylon, W. W. A. Phillips now describes the rodents (*Spolia Zeylandica*, vol. 14, 1928). Greater in numbers than any other mammalian order in the island, with the exception of the bats, they also show more differentiation in structure, as is indicated by the large variety of families, genera, and species. Of the twenty-seven indigenous forms, the majority are squirrels and rats, apart from which there occur only a porcupine and a hare. The specific descriptions contain many interesting notes on habits. It is remarkable to read of the ferocious disposition of the Ceylon gerbil, which has been observed to kill and devour a young rat and a small bat, and to have attacked a small monkey. Seasonal movements, and the control of the balance of Nature, are well illustrated in the succession of events which follow the maturing of the 'nillu' (*Strobilanthes*), a jungle plant common on the hill-sides. As soon as the abundant seed commences to ripen, a local migration takes place, and jungle fowl, bronze-winged doves, and many rats of different species make for the area, and gorge upon the seed. Some of the gourmands eat to death, and others reach the same end by becoming so lethargic that they fall easy victims to the carnivores which have followed hard upon the heels of the first migrants.

THE CLASSIFICATION OF SPIDERS.—Twenty-five years have passed since the last volume of Simon's "Histoire Naturelle des Araignées" was published, and in that time the study of spiders has so increased the number of known species and genera, that a revision is welcome. Prof. A. Petrunkevitch, whose preliminary paper on the subject was noticed in these columns four years ago, has now produced a striking and invaluable work—"Systema Aranearum"—in *Trans. Connect. Acad. Sci.*, **29**, 1-270. This lists the whole of the 2144 genera established to date, arranged in 55 families. Tables for dividing the families into sub-families are given wherever they are required, followed by the genera of each sub-family, printed alphabetically, with their authors, dates, and types. Finally, there is an alphabetical list of 623 generic synonyma, with their authors, dates, types, and the genera to which they should be referred. It is at present useless to expect complete agreement of all authorities upon every title, and there are a certain number of details which do not conform to the present British custom; but these are small blemishes in a work the importance of which it would be hard to overestimate. After long uncertainty, the order of spiders is reaching a welcome condition of stability.

STOMIATOID FISHES.—The species of the deep-sea Stomiatoid fishes have recently been reviewed by Mr. A. E. Parr as a result of a very rich collection of these fishes made by the *Pawnee* under the direction of Mr. Harry Payne Bingham (Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927. *Bulletin of the Bingham Oceanographic Collection*, vol. 3, art. 2, 1927). More than thirty species were captured, of which twenty-one were new to science, from the waters in the region of the Bahamas. Mr. Parr has grouped the families Astronesthidæ, Idiacanthidæ, and Melanostomiatidæ in a new suborder, the Gymnophotodermi. They are characterised by the presence of highly differentiated luminous organs combined with a primitive (though secondary) nakedness of the skin. The author has not included in this suborder the genus *Stomias* on the grounds that fishes of this genus possess scales that cannot be considered as having been redeveloped from a naked ancestor. At the same time, the genus cannot be regarded as a direct representative of a scale-bearing ancestor of the first Gymnophotoderm owing to the positions of its fins. Regarding *Astronesthes* as the most primitive of the recent Gymnophotodermi, the author traces the probable phylogenetic relationships of the genera of

the Melanostomiatidæ. Keys are given to the genera and species, and the new species are described, with illustrations by the author and by Mr. W. S. Bronson.

CHROMOSOMES IN MEIOSIS.—*Thespesia populnea* belongs to a genus of Malvaceæ related to the cottons (*Gossypium*). Youngman (*Annals of Botany*, v. 41, p. 755) finds that it has 13 haploid chromosomes, the same number as the Asiatic cottons, while the American cottons are known from the work of Denham to have twice as many chromosomes. Youngman describes a peculiar behaviour of the chromosomes of *Thespesia* during meiosis. He states that the 13 bodies of the heterotypic prophase become massed together and emerge in the metaphase as an equatorial belt of 8 bodies. This is interpreted to mean that 10 bodies fuse in pairs, leaving 3 unpaired. The latter pass undivided into one daughter nucleus, while the 5 pairs separate. A tetrad results, in which one nucleus has more chromosomes than the other three. The explanation suggested is that transverse fragmentation of certain chromosomes takes place at some stage in the life history. Some of the figures suggest imperfect fixation, but the problem involved is a very interesting one and will no doubt be cleared up by further investigation.

LONG-LIVED PLANT CELLS.—D. T. MacDougall and his collaborators have made some interesting observations regarding certain types of plant cells which seem to show remarkable longevity (*Amer. Nat.*, **60**, 393, and **61**, 385). Living medullary cells of the tree cactus (*Carnegiea*), well over a century old, have been recorded, and examination of elements of all ages indicates active enlargement during the second half of the century. The melon cactus (*Ferocactus*) has also been found to contain similar medullary cells of great age, the active growth in this case, however, ceasing after the first decade. In all of these cells, the carbohydrate constituents, pentosans and hexoses, progressively decrease with age, while the fatty constituents and nitrogenous materials change much less. Transformation of sugars to wall material with consequent thickening is apparent in *Carnegiea* and in the medulla of *Ferocactus*. It is interesting to note, however, that the disappearance of carbohydrates in the cortical cells of *Ferocactus* extends even to the cell walls, which are thinner after a hundred years than after the first ten years of their life, suggesting the removal and liquefaction of pentosans. Still more recently MacDougall and Smith have recorded living ray cells in the heartwood of *Sequoia sempervirens* (*Science*, vol. 66, No. 1715). The changes in the Redwood are accompanied by the disappearance of starch and protoplasts from all wood parenchyma cells, and the formation of an orange-coloured resin that completely or partially fills the lumina. Similar disappearance of starch from the ray parenchyma cells is not always followed by the death and disintegration of the protoplasts, and a thin layer of cytoplasm and a conspicuous nucleus are sometimes retained. Cells of this kind have been recorded by the authors from places seventy layers deep in the heartwood, and, as the sapwood was about twenty-three layers in thickness, the approximate age of the cells was reckoned at nearly a century.

ON *PALUDINA DILUVIANA*. — With the view of ascertaining which living form is nearest akin to the *Paludina diluviana*, Kunth, V. Franz (*Biblioth. Genetica*, Bd. 11) discusses the whole of the European species of *Paludina* (now better known as *Viviparus*). Following the earlier continental textbooks, the author reverses the names of the two common species, *V. viviparus* and *V. fasciatus*, a fact which has to be borne in mind when studying his paper. Careful descriptions of the shells of the several species with excellent figures and elaborate tables of measurements are given, but no anatomical details. The conclusion reached is that *P. diluviana*, Kunth, stands nearest to *P. pyramidalis*, Crist. and Jan, and belongs to the relatively thermophil group, so that its presence in deposits north of the Alps is thus indicative of warmer interglacial periods.

GEODETIC TABLES. — New geodetic tables for Clarke's figure of the earth of 1880 are published by the Royal Geographical Society (R.G.S. Technical Series, No. 4, 5*s*.). In a preface to the tables, Mr. A. R. Hinks explains that the International Congress of Geodesy and Geophysics at Madrid in 1924 decided to accept not Clarke's, but Hayford's figure of 1910 as the standard figure of the earth. The publication therefore contains also the transformation to the Madrid figure, that is to say, the 1910 figure of Hayford.

SURVEY OF NEPAL.—The General Report for 1926–27 of the Survey of India records that after three years' field work, the first survey of Nepal has been completed. The task was undertaken by the Maharaja of Nepal, who asked for the co-operation of Indian surveyors. The result is that it is now possible to publish a skeleton map of Nepal, a country of about 55,000 square miles, pending the preparation of maps on larger scales. The skeleton map showing the main features of the structure and drainage is attached to the report. Field work was carried out on a scale of 4 miles to 1 inch, and an 8-mile contoured map in three sheets is now being prepared. The new information will afterwards be incorporated in revised editions of the standard 'degree sheets.' The survey presented considerable difficulties by reason of rugged relief and diversity of climate. It is believed, however, that any inaccuracies will be practically inappreciable on the scales to be used. None of the triangulation stations is likely to be so much as 100 ft. wrong in position or 20 feet in height.

THE EAST AFRICAN EARTHQUAKE OF JAN. 6, 1928. —Mr. W. C. Simmons, of the Geological Survey of Uganda, has sent us an interesting account of an earthquake of intensity 10 (Rossi-Forel scale) which occurred on Jan. 6 in the Subukia Valley, thirty miles north of Nakuru, in the Great Rift Valley, Kenya. We regret to be unable to find space to print the communication in full, but the following digest gives some of the points of particular value included in it. The epicentre of the earthquake may be taken as about 0° 12′ N. lat., 36° 15′ E. long. On the eastern side of the Subukia Valley, near the foot of the Laikipia escarpment, a fault-line, indicated on the surface by a small scarp and series of cracks, was traced by Mr. Simmons for about 15 miles, running north-northwest and south-southeast. Where the slope of the escarpment approaches 40°, the fault appears to have a downthrow to the west of as much as 8 feet. The fault was nowhere seen in solid rock, but was always best developed in scree slopes and soil deposits on the hill-sides, so that the apparent downthrow is exaggerated by the slip. Where the fault crosses horizontal ground, it either becomes a crack with little downthrow or a series of anastomosing cracks, or is represented by a mound of soil running in the same direction. There is apparently very little horizontal displacement with the fault. It seems clear that this earthquake was due to the opening up of an old fault, and, as the Rift Valley shows very numerous lines of fault and is itself due to faulting, it is to be expected that earthquakes should occur.

A NEW INCINERATING FURNACE.—A furnace which has recently been designed to replace the old-fashioned muffle-furnace for the incineration of samples for chemical analysis is described by Dr. Fortnet of Berlin in the *Chemiker-Zeitung* of April 21. In this furnace the bulky fireclay parts have been very greatly reduced in extent and replaced by tall thin cylindrical shells, in which the air can circulate freely under its own draught round the specimen. Four of such shells are mounted on one base and the simultaneous combustion of four samples can be completed in less than an hour without the addition of oxygen or of solid oxidising reagents; nor does the sample require attention during the combustion. The furnace is supplied by Messrs. Armin Kühn of Charlottenburg.

A PATHOLOGICAL MICROSCOPE.—Reference was made in NATURE, April 14, to several distinctive features of the Beck Pathological Microscope which has been adopted for use in the laboratories of the London School of Hygiene and Tropical Medicine. A complete description of the instrument has now been included in Messrs. R. & J. Beck's catalogue (Section F). The microscope is of large size, and suitable for advanced students' use and for research investigations in bacteriological, medical, and general work. An important feature is the built-in mechanical stage, which is provided with a special holder to take ordinary slides. This can be easily removed, and the top plate will then accommodate a large petrie dish or culture plate which can still be moved by the mechanical motions. The usual cylindrical fittings of the substage have been replaced by dovetailed slides by means of which the change from one form of illumination to another can be made rapidly, accurately, and with the minimum disturbance of the adjustments of the instruments. The milled heads for the adjustment of the mechanical stage and of the substage have been placed on the left-hand side so as to leave the right-hand side clear for drawing. The fine focussing adjustment is operated by two milled drums, one on each side of the limb. Rotation of one of these moves the body at twice the speed obtained by rotation of the other. An intermediate as well as a fine adjustment is thus provided.

RUTHS' STEAM ACCUMULATOR.—In any industrial undertaking, shortage of steam in any one department has a serious effect on the output. In many cases the steam consumption of the various departments fluctuates widely, and the sudden demands have often no relation to one another. Owing to the limited thermal storage capacity of a steam boiler, it is not suitable to meet wide fluctuations in the load. To get over this difficulty, Dr Ruths invented some years ago a steam storage system which enables the steam to be generated at a constant rate although the load fluctuates between wide limits. His steam accumulators are now in use in several hundred factories, mills, and power stations throughout the world. The system is described in a booklet by A. J. T. Taylor, of Africa House, Kingsway, London, W.C.2. By using a steam accumulator, the requisite number of boilers can be considerably reduced, and yet the plant is able to carry on easily over the peak load. The accumulator is shaped like a very large cylindrical boiler, and special methods are used to ensure its thermal insulation. If the initial pressure of the steam in it is 60 lb. per square inch and the final pressure 10 lb., then the amount of steam produced would be 4·24 lb. per cubic foot of water initially in the boiler. A pressure variation of 50 lb. per square inch would be inadmissible in almost any boiler, but the Ruths' accumulator is specially designed for a large pressure drop. In a typical case investigated, the equalising effect of a steam accumulator due to its thermal capacity was found to be eight times that of a Lancashire boiler and forty times that of a standard water-tube boiler. The thermal loss by radiation from the steam accumulator is about 0·2 of a British thermal unit per square foot of exposed surface per hour per degree Fahrenheit. It is so small that the accumulator can be located outside the building, even when it is exposed to the rigours of a Swedish winter.

APPARATUS FOR USE WITH METALIX X-RAY TUBES.—We have received from Messrs. Watson and Son (Electro-Medical), Ltd., a catalogue of their 'Sunic' apparatus specially designed for use with the Philips 'Metalix' X-ray tube. The weight and cost of X-ray apparatus had been gradually increasing as the need for adequate protection was appreciated, until the introduction of the Metalix tube with its self-contained protection enabled apparatus to be made lighter and less costly, but at the same time providing adequate protection. On examining the apparatus described in Messrs. Watson's catalogue, one immediately notices the absence of the large and unwieldy protective box which had become such a familiar feature of most apparatus. As Messrs. Watson remark, though the protection at the tube is all that can be desired, it cannot protect against the scattered radiations from the patient: hence the provision of the usual lead rubber aprons and screens. All types of apparatus for diagnostic work are described and the combined couch and screening stand is of interest. In this apparatus, one tube and its carriage are used for upright screen, over and under couch work, and in addition, the apparatus can be used for tele-radiography, up to more than six feet tube to patient distance. All the tube movements can be made quickly without disturbing the patient. All the apparatus is of excellent quality and construction. A wide range of Metalix tubes is described, and a tube can be found suitable for any apparatus for diagnosis or therapy.

THE DETECTION OF FLAWS IN CASTINGS.—By the use of γ-rays so penetrating that they will pass through pieces of metal fifteen inches thick, the Russian State Radium Institute of Leningrad has effected, according to a *Daily Science News Bulletin* issued by Science Service of Washington, D.C., a marked improvement in the examination of thick metal castings, etc. Examination in this way, when compared with the normal X-ray investigation, possesses several distinct advantages. It is cheaper, since the radium lasts indefinitely: large and expensive photographic plates are unnecessary, since the rays which pass through the metal are detected by a special sensitive electroscope, and an automatic record can be taken which may be filed for reference. Another very distinct advantage is that the time required may be cut down to a couple of minutes for a large casting, whereas with X-rays an exposure of the order of several hours might be required, even when the metal is not much more than two or three inches thick. The apparatus is very simple: a glass capsule with the radium preparation is inserted into a deep hole bored in a large ingot of lead; all rays except the strong, narrow beam passing along the bore are stopped. The beam, after passing through the casting, encounters two filaments electrically charged and enclosed within a copper cage. So long as no ray penetrates the metal the air space between the filaments and the cage acts as an insulator. As soon, however, as the γ-rays get into the cage, the air is ionised and a current flows from the filaments to the cage, then through the galvanometer and back to the battery.

The Royal Society Conversazione.

THE first of the two annual soirées of the Royal Society was held at Burlington House on May 17. Sir Ernest Rutherford, president of the Society, received the guests, who were, on this occasion, supplemented by a number of the delegates attending the Harvey tercentenary celebrations. Fortunately for their peace of mind, visitors to this old-established gathering are under no stress to find the "principal scientific exhibit of the year"; an unwritten law of equality reigns, embracing all the departments of science.

A highly interesting illustration of the changes in crystalline form of ammonium nitrate with change of temperature came from the Explosives Branch, Research Department, Woolwich. The substance may occur in five different crystalline forms, according to temperature. Successive changes during cooling from the molten condition were demonstrated by illumination with polarised light and screen projection. Certain difficulties met during the filling and storage of shell with ammonium nitrate explosives are due to these changes.

Sir William Bragg demonstrated the crispations formed on liquids lying on vibrating surfaces, in the study of which Faraday had originally occupied himself, and described, in 1831. These effects underwent re-examination in 1883 by Lord Rayleigh, who confirmed Faraday's interpretations. The exhibit was a model of careful preparation and successful exemplification outside laboratory confines.

The British Museum (Natural History) provided five exhibits; in mineralogy (Dr. L. J. Spencer), the fluorescence of minerals in ultra-violet rays; in geology (Mr. W. E. Swinton), a model of an armoured dinosaur, but with a conjectural head; in zoology (Dr. Baylis), parasitic infection in a whale; the giant shipworm mollusc, allied to *Teredo*, with its shelly tube (Mr. G. C. Robson); and anatomical preparations of Ratite birds (Mr. P. R. Lowe). Dr. Imms, Rothamsted Experimental Station, suitably illustrated biological control in relation to insect pests and noxious plants. In conjunction with the Cawthron Institute, New Zealand, aided by grants from the Empire Marketing Board, and the Government of New Zealand, experiments are in progress with the view of checking the spread of gorse and the notorious ragwort, by the utilisation of insects. The biology of certain species concerned are being studied at Rothamsted prior to shipment. Mention should be made of an exhibit of marine animals and bottom deposits, obtained by the staff of the recent *Discovery* expedition.

The National Physical Laboratory had two exhibits, a high-temperature electric resistance furnace (Dr. Rosenhain and Mr. Prytherch), and an optical interference method of observing modes of vibration of piezo-electric quartz resonators.

The Royal Observatory, Greenwich, showed a transparency of the total solar eclipse, June 29, 1927, and also solar photographs and magnetic traces illustrating the frequent coincidence of large magnetic storms and big sunspots (*v.* p. 842).

Imperial Chemical Industries sent specimens of new ketone dyes; the British Silk Research Association specimens of fibre and yarn-testing instruments; the Cambridge Scientific Instrument Company an apparatus developed in conjunction with the British Research Association for the Woollen and Worsted Industries, and designed for maintaining constant the humidity of the air in rooms where hygroscopic substances, such as textile materials, tobacco, paper, etc., are being tested or stored.

Sir Robert Hadfield, among other interesting items, showed a machineable non-magnetic steel possessing a high yield point, and also samples of recently developed corrosion-resisting steel, indicating in particular greatly improved resistance to dilute sulphuric and phosphoric acids.

Lord Rayleigh demonstrated and offered interpretations of the fading of peacock's feathers in ultra-violet light, described by him in a communication in our correspondence columns (p. 827), and Prof. C. V. Boys exhibited solid dipleidoscope prisms, by means of which an object seen by external reflection from one face may also be seen in the same direction by light which has made two internal reflections.

The International Standard Electric Corporation sent an ingenious machine, though of strange and complicated make-up (of the kind that would have delighted Lord Kelvin) designed for the production, distribution, and analysis of artificial telephone traffic. Where automatic switches are arranged in simple groups, the quantities required to ensure a given grade of service can be determined from curves based on the theory of probability, but to test the efficiency of more complicated switch arrangements it has been necessary to resort to artificial traffic experiments, impracticable by mathematical means.

The Royal Botanic Gardens, Kew, sent examples of grasses used as cereals by African natives; and plants yielding an oil coming into repute in the treatment of leprosy. The species are tall trees occurring in the dense forests of India, Burma, and Siam. The Marine Biological Association showed Dr. Poole's submarine photo-electric photometer apparatus, as used on the Association's trawler. The photo-electric current is measured by a potentiometer, using an interrupter, condenser, and amplifier, with a telephone to indicate the null point.

Mr. J. Reid Moir exhibited limestone implements found at Coney Island, Rosse's Point, and Ballyconnell, Sligo, Ireland, which have been the subject of much discussion. The specimens, which are of limestone and exhibit early Mousterian forms and technique, were found by Mr. J. P. T. Burchell; and they are regarded as important evidence in support of the view that Lower Palæolithic man inhabited Ireland.

From the Pharmaceutical Society's School of Pharmacy came specimens of the animal materia medica of the seventeenth century. At this period entire animals, as well as parts and excretions of animals, were largely used medicinally.

An exhibit from the British Mosquito Control Institute, Hayling Island, shown in the principal library, occasioned much interest. With the projection on a screen of living larvæ and pupal stages, it proved highly instructive. The exhibit was arranged by the director of the Institute, Mr. J. F. Marshall, whose work in mosquito control has had important practical issues.

Among the general exhibits was a theodolite made in 1574 and signed by Humphrey Cole, the Elizabethan craftsman, described by Mr. George H. Gabb as the oldest known instrument of the kind; and there was shown, by Capt. R. Berkeley, a portrait of Sir Isaac Newton, which, although itself of considerable artistic merit, was somewhat unconvincing as regards recorded lineaments.

In the meeting room Dr. Stanley Kemp gave a short lantern lecture on the whaling industry in the Antarctic, which proved attractive and informative.

Oilwells in Great Britain.

IT will be recalled that during the late years of the War, a determined effort was made by the Government to locate oilfields in Great Britain, unfortunately without any commercial success. Of the eleven wells put down at the time, only two can be said to have given technically favourable results, one at Hardstoft, in Derbyshire, the other, the Darcy Well, near Edinburgh. Since that time, in the absence of any striking developments, interest in British oil possibilities has naturally waned, and most people are probably unaware that Hardstoft No. 1, first brought in on May 27, 1919, is still contributing its mite to the world's annual production.

Between that date when it was brought in and the end of last year, this well yielded 2500 tons of oil, about 17,500 barrels, equivalent to an average of just under 6 barrels per day. This oil is of good quality, and in many respects resembles some of the best Pennsylvanian crude. The gravity is 0·823 and, according to Hackford's analysis, the oil yields on refinement 7·5 per cent motor spirit, 39 per cent kerosene, 20 per cent gas oil, 30·5 per cent lubricating oils, 0·26 per cent sulphur, and 3 per cent of paraffin wax. In colour it is dark brown, with green fluorescence, has a setting point of 0° F., and viscosity at 100° F., Redwood 48 seconds. In common with Pennsylvanian crude, the Hardstoft oil possesses in its lubricating fractions a high percentage of oils suited to steam cylinder lubrication, which makes the analogy between the two crudes a still closer one.

The well is situated on a subsidiary anticline of the Pennine system, actually on a local dome developed on this fold, striking north-west–south-east; the folding is accompanied by much faulting. The well is drilled 3070 feet in a sandy limestone near the top of the main carboniferous limestone, though there seems to be some difference of opinion as to the precise horizon responsible for production.

Interest in Hardstoft has been reawakened by Dr. A. Wade's recent paper on this and two subsequent oilwells at Hardstoft, read before the Institution of Petroleum Technologists on April 3. The wells are on the Duke of Devonshire's property, and his agent, Capt. J. D. Penrose, has been instrumental in preserving detailed records and history of operations, without which many of the facts would have been lost to the public.

Hardstoft No. 2 was started on May 16, 1924; its location was chosen about 600 feet west of No. 1, and it was drilled 3125 feet without any other success than a good oil show at 760 feet (a 10-gallon sample after the well had stood for 24 hours), and 20,000 cubic feet of gas at 370 lb. pressure from 1620 feet, afterwards utilised as fuel for the boilers. This well went ultimately to water, and with 2800 feet constant head in the hole, which could not be reduced by bailing, it was abandoned on Mar. 24, 1925.

Hardstoft No. 3 was selected 600 feet north of east of No. 1 well and was started on Aug. 5, 1925. In results it was as disappointing as No. 2, though it was carried much deeper (to 3825 feet), being finally abandoned in a bed of lava on June 8, 1926. In this hole, shows of oil were struck at 1900 and 1978 feet, and a gas show at 1812 feet.

While it is evident that the general geological structure of the district is comparatively determined, the results of these three borings, with their contrasted logs and behaviour, show clearly that the subsurface structures are far from being understood, largely, no doubt, due to the extensive faulting prevalent. We are not aware of what particular methods were employed for subsurface correlation of the well-samples, whether, in point of fact, anything more than casual logging by the drillers was carried out. In any case, the very remote possibility of finding a commercial oil-pool in this area, or in any other in the British Isles for that matter, warrants further drilling neither in Derbyshire nor elsewhere, and although these three wells furnish a pretty problem for the oil geologist, they and their predecessors serve as a warning of what awaits further search for petroleum in Britain.

The Iron–Chromium–Carbon System.

AN important paper on "The Structure of the Iron–Chromium–Carbon System" was presented by Messrs. Westgren, Phragmén, and Negresco at the May meeting of the Iron and Steel Institute (May 3). As a result of the X-ray determination of the lattice dimensions of various iron–chromium alloys, it is shown that there is a progressive change from end to end of the system, confirming the general view that these metals form with each other an unbroken series of solid solutions. Three carbides of chromium have been detected in the chromium–carbon series, one, cubic, with a probable formula Cr_4C, a trigonal one Cr_7C_3, and an orthorhombic carbide Cr_3C_2. In the ternary system containing iron, cementite, which may contain chromium to the extent of rather more than 15 per cent, is also present.

For each of the chromium carbides substitution of iron for chromium may to some extent take place. In the cubic form the chromium may be replaced by iron up to about 25 per cent: in the trigonal carbide the iron content may rise to 55 per cent, but in the orthorhombic carbide only a few per cent of chromium can be replaced by iron. No definite double carbide, the presence of which would necessitate the presence of both iron and chromium atoms, is found.

In annealed chromium steels containing only one or two per cent of chromium, the only carbide found is cementite, the iron of which is partially replaced by chromium. The difference of distribution of the carbide in such steels appears to be due not to any definite difference of composition, but to something of the nature of segregation. The carbide in stainless steel is the cubic one saturated with iron. In a steel containing about 1 per cent of nickel, 11 per cent of chromium, and 2 per cent of carbon (used for dies), the trigonal carbide occurs, rather more than half of the chromium of which is replaced by iron. Sections through the ternary solid model show that as the chromium content is raised the area of the γ-iron phase is gradually reduced and finally disappears: the eutectic occurs at a lower carbon content than in iron–carbon alloys, for example, at about 3·7 per cent with 15 per cent of chromium.

The solubility of the carbide in austenite is reduced as the chromium is increased, and the cementite line consists of two distinct portions corresponding to the solubility of different types of carbide. With 3 per cent chromium, for example, the lower portion of the curve represents the solubility of the trigonal carbide, and the higher temperature region the solubility of cementite. With 15 per cent of chromium the lower temperature portion gives the solubility in the γ-phase of the cubic carbide, and at higher temperatures of the trigonal one.

University and Educational Intelligence.

CAMBRIDGE.—Sir Richard Threlfall, Gonville and Caius College, has been appointed to represent the University on the Grand Council of the World Power Conference's Fuel Conference. The Committee of the Privy Council for scientific and industrial research has appointed Mr. H. T. Tizard as a member of the University Committee for Magnetic Research.

EDINBURGH.—At the meeting of the University Court on Monday, May 14, Dr. F. A. E. Crew was appointed to be professor of animal genetics and director of the University Department of Research in Animal Breeding. The chair, which is to be known as the Buchanan chair of animal genetics, was founded by a donation from Lord Woolavington, supplemented by a grant from the International Education Board, New York.

LONDON.—Dr. Geoffrey Hadfield has been appointed as from May 1 to the University chair of pathology tenable at the London School of Medicine for Women.

Dr. Percival Hartley has been appointed as from Aug. 1 to the University chair of biochemistry tenable at the London School of Hygiene and Tropical Medicine. Dr. Hartley was educated at the Technical College, Bradford, and the Yorkshire College, Leeds. From 1909 until 1913 he was physiological chemist to the Imperial Bacteriological Laboratory at Muktesar, United Provinces, India, and in March 1913 he was appointed first assistant to the head of the Biochemical Department at the Lister Institute; from 1919 until 1921 he was head of the Biochemical Department of the Wellcome Physiological Research Laboratories, and since 1922 he has been on the staff of the National Institute for Medical Research, Hampstead.

Dr. C. B. Fawcett has been appointed as from Aug. 1 to the University chair of economic geography tenable at University College. From 1906 until 1911 Dr. Fawcett was geography master in the Derbyshire County Secondary School at Long Eaton, near Nottingham, and from 1911 until 1913 he worked in the School of Geography at Oxford, obtaining the Diploma in Geography with distinction and the B.Litt. degree as a research student. Later he was lecturer in geography at University College, Southampton, and worked part-time in the Ordnance Survey Office during the War, while since 1919 he has been lecturer, and later reader, in geography in the University of Leeds. Dr. Fawcett was editor of the "General Handbook" for the Leeds meeting of the British Association, for which he wrote two sections.

The title of professor of experimental pathology in the University has been conferred on Dr. Archibald Leitch, in respect of the post held by him since 1921 as Director of the Research Institute at the Cancer Hospital.

The title of reader in pathological chemistry in the University has been conferred on Dr. C. R. Harington, in respect of the post held by him since 1922 as lecturer in pathological chemistry at University College Hospital Medical School. Dr. Harington is known for his work on the chemistry of thyroxine and related subjects, published chiefly in the *Biochemical Journal*.

APPLICATIONS for grants from the Chemical Society Research Fund, made upon forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, W.1, must be received by, at latest, June 1.

THE Committee of Leplay House E. T. A. has organised the following tours for those interested in historical, geographical, and social studies: (1) To south Sweden, visiting Gothenburg, Stockholm, afterwards going to Lappland; (2) to Aldrans, above Innsbruck, in the Austrian Tirol; (3) to St Peter in the Black Forest, 'students' camp.' Particulars of these visits can be obtained from Miss Margaret Tatton, Leplay House, 65 Belgrave Road, S.W.1.

DR. DU BOIS, a Swiss biologist of the University of Geneva, recently working with Prof. Caullery in Paris, has been awarded a Junior Fellowship in Science (£250) by the International Federation of University Women, to enable her to continue her research in Berlin. This is the first of a series of fellowships for graduates wishing to carry on research in a country other than that in which they have previously worked, for which an endowment fund is being raised.

APPOINTMENTS to the twenty fellowships awarded by the Commonwealth Fund and tenable by British graduates in American universities for the two years beginning in September 1928, include the following: Mr. R. H. Angus, of Sydney Sussex College, Cambridge, to Stanford University, in electrical engineering; Dr. G. A. Cumming, of St. Andrews, to the California Institute of Technology, in geology; Mr. Cyril D. Forde, of University College, London, to the University of California, in anthropology; Dr. Norman P. Inglis, of the University of Liverpool, to the University of Illinois, in engineering (metallurgical); Dr. J. M. Robertson, of the University of Glasgow and the Royal Institution, London, to the University of Michigan, in chemistry; Mr. Robert Spence, of Armstrong College, University of Durham, to Princeton University, in physical and engineering chemistry; Miss C. S. Steele, of St. Andrews, to the University of Illinois, in organic chemistry.

THE Association of Teachers in Technical Institutions is holding its annual conference this year at Bradford Technical College, May 26–29. Among the resolutions to be discussed at the conference is one relating to the social applications of biological science. It expresses agreement with the spirit and intention of certain resolutions of a conference of the British Social Hygiene Council and representatives of education aiming at the adoption by health, education, and labour authorities of practical measures for dispelling the prevalent ignorance of elementary biology. "In order to provide a foundation on which an adequate sense of racial responsibility may be developed," biology teaching ought, it is urged, to be extended to all schools, the type of teaching being in each case such as to fit the ages and circumstances of the pupils. Attention is directed likewise to the urgent need of such further education for adolescents between fourteen and eighteen years of age as "would encourage a sense of individual responsibility in the science and art of healthy living." Another resolution signifies approval of the action taken by the President of the Board of Education as a result of the recommendations of the Emmott Committee. The first-mentioned resolution stands in the names of Mr. J. Wickham Murray, secretary of the Association, and Mr. A. E. Evans, of the Battersea Polytechnic, honorary secretary, on behalf of the Association's executive committee. The address of the new president, Mr. W. W. Sirman, of the Technical College, Handsworth, will be delivered on May 28, and there is to be an address on the following day by Mr. Arthur Greenwood, M.P., followed by a visit to the research station of the British Research Association for the Woollen and Worsted Industries.

Calendar of Customs and Festivals.

May 27.

WHITSUNTIDE.—Whitsuntide observances bear a close resemblance to those of Mayday. This is clearly seen in the custom of decorating an individual with green boughs, who, it may be inferred, represents the spirit of vegetation, and occasionally of subjecting him or her to some form of indignity or horseplay which it is not far-fetched to regard as a survival of a sacrifice. The leaf-clad man may be drenched with water, or thrown in a brook, when he scatters water on the bystanders, thus distributing his own 'virtue'; his head may be cut off, or he may be stabbed. Frazer, in "The Golden Bough" (vol. 2, pp. 89 *sqq.*, etc.), quotes a number of instances of this observance at Whitsuntide, among them a Russian example in which a young birch tree is dressed up in female clothes and brought to the village, where 'she' remains as a guest for three days in one of the houses and is then thrown into the water.

In England various Whitsuntide observances have been recorded. None is perhaps in itself so clearly indicative of the nature of the Whitsuntide ceremonial as the central European customs quoted by Frazer, but taken as a whole they point to its origin in a seasonal festival.

One trace at least of its character as the opening of the year survives in the custom of hiring farm servants at this season, the engagement being for the whole of the succeeding year. A similar practice obtains in November, which survives from the Celtic custom of beginning the year at this date. At Whitsuntide it was customary for the hired servants to return to their homes for a week's holiday. It is probably to this interval that we owe the survival of a considerable number of Whitsuntide customs, especially the itinerant performance of Morris dances and the practice of holding sports and contests of the familiar winter versus summer type. Races were one of the features recorded in connexion with Maypole and other Mayday observances.

WHITSUN ALE.—In many parishes throughout the country it was customary for a collection to be made just before or at Whitsuntide. This was expended on the provision of cakes and ale for a feast which was held at the church house. Wardens were elected for the purpose of making the arrangements, and any surplus funds were afterwards reserved for extraordinary parish expenditure. The well-known Eton Montem, which was sometimes attended by the reigning monarch and his consort, was of an analogous character. A procession of Eton scholars in military or fancy dress marched in procession to a mound on the Bath Road, where they took up their position, and then exacted a toll of money 'for salt' from all present and from all travellers passing. Sometimes as much as £1000 or more was collected.

After the Whitsun Ale feast, the afternoon was usually devoted to sports. That this feast was originally of a sacrificial character is indicated by the record of a curious custom at Kidlington, Oxford, on the Monday after Whitsun, when the maids in the town, with their thumbs tied behind them, ran after a lamb, which they tried to catch with their teeth. When it was caught, the successful maid became the 'lady of the lamb,' the animal was dressed and carried in procession on a long pole before the lady and her companions, accompanied by Morris dancers. On the following day the lamb was eaten at the 'lady's feast,' when the lady sat at the head of the table.

In several localities, for example, Heybridge, Essex, Monk Sherborne, Hants, and Herefordshire, rushes were strewn in the church or sprigs of birch were attached to the pews as decorations. Sometimes, as in Northampton, there was a maypole at the Whitsun Ale, as well as a Lord and Lady. At a fair held on Whitsun Monday at Hinkley, Leicestershire, an elaborate procession of the trades took place, which included several grotesque characters, such as Baron Hugo and his lady, the Baroness Adeliza. In Shropshire a 'boy bailiff' was elected for Whitsun week. He was accompanied by a retinue of men and boys mounted on horseback, who carried wooden swords at their right sides. They first rode round the whole franchise and then were met at the Guildhall by the civic authorities. An elaborate Court of Array was held at Litchfield, in which Morris dancers, the bailiffs and city officers, and the members of the trades and guilds with standards or posies took part. The posies afterwards become implements of trade or mere puppets or garlands borne upon halberds, which nevertheless were received as they visited each ward with a volley from the men-at-arms. These last also fired over each house at which they received money and liquor from the inhabitants.

Immediately after the annual hirings were completed, it was customary for the men and women to hold a dance, in which the men chose their partners in a more or less recognised manner which suggests a forgotten ritual of pairing. In some parts of Wales it was indeed the custom for boys and girls to retire, each sex apart, to a wood, when individuals in each party elected or declared the choice of a partner from the opposite sex. On their return to the dancing place, each had to take his declared partner, under a penalty in case of default.

THE MORRIS DANCES.—A regular feature of the Whitsuntide observances was the Morris dance. The name Morris was generally derived from the word *Morisco* = Moor, and it was said that the dances came from Spain. More probably, however, the name itself is derived from the fact that the dancers once used to black their faces, and although dances of a similar character are even now regularly performed in elaborate form, including a bear dance, in the Pyrenean area, similar dances are too widely distributed to warrant a Spanish or Hispano-Moorish origin. The dance, it is scarcely open to question, is a survival of a ritual dance, representing the primitive vegetation spirit ceremonies. This was the view suggested by the late Mr. Cecil Sharp. It is a survival of the sacrifice of the vegetation spirit and the subsequent meal in which the worshippers took part. In the related sword dance the knotting of the swords clearly represents the killing of one of the dancers, and although the Morris dancers carry handkerchiefs and not staves, Mr. Sharp's suggestion that the handkerchief is a survival of the sword is probably correct. It is to be noted that in more than one of the Whitsuntide ceremonies, not the dances, it is recorded that those who took part wore wooden swords. In some of the Morris dances a cake is carried on a sword decorated with ribbons and flowers before the six dancers. This may be all that survives to indicate the sacrificial meal, or victim. At Kidlington, however, the lamb, as mentioned above, was actually carried on a pole at the head of the procession before it was eaten. Finally, the religious character of the Morris is indicated by the fact that in some villages the dance took place in the church tower, whither it must have been relegated from the chancel, where in the early Christian church the dances absorbed from paganism used to take place until they were forbidden.

Societies and Academies.

LONDON.

Linnean Society, May 3.—**G. S. Carter**: The swamps of the Paraguayan Chaco. The Paraguayan Chaco is a plain stretching westwards from the Rio Paraguay towards the Andes. A belt within 100 miles of the river consists partly of grassland, in the more open parts of which are large areas of shallow swamps. During the summer months the climate is tropical, and the nature of the water most largely influenced by the amount of the rainfall. The most striking result of the analyses was the evidence that they gave of the small amount of oxygen present in the water at all times. The co-operation of several conditions, such as the absence of disturbance and the large amount of decay in the water, produces this result. The oxygen-content plays a determining part in the control of the fauna, which includes many forms adapted to life in a medium poor in oxygen. This was especially clear of the fishes and the oligochætes.

Royal Meteorological Society, May 16.—**Sir Gilbert T. Walker**: On periodicity and its existence in European weather (*Memoir*, vol. 1, No. 9). When examining the amplitudes of a number p of the periods that can be derived by analysing a series of numbers, it is important to know how many of these are independent. Further, we must compare the biggest amplitude found with the probable biggest that would be produced by purely random figures, and in order to estimate this we want to know how many of our p amplitudes are independent. This is determined as the number of Fourier frequencies, corresponding to submultiple periods, each of which has one or more of the calculated frequencies nearer to it than to any other Fourier frequency. Applying this to European weather, it is concluded that the periods in temperature of $12\frac{1}{3}$ and 13 months, apart from the annual period, may be regarded as real. Under ordinary conditions it is sufficient if, instead of the accurate figures to be analysed, we use group figures of which the interval is as large as a third of the standard deviation.—**D. Brunt**: Harmonic analysis and the interpretation of the results of periodogram investigations (*Memoir*, vol. 11, No. 15). The paper collects together for convenience of reference the formulæ used in harmonic analysis. In a general discussion of periodogram results, it is shown that Walker's method of deriving the 'probable greatest amplitude' is faulty. Discussing the periodogram of London temperatures, it is shown that only a very small part of the variations of temperature from month to month can be accounted for by the periods the amplitudes of which are equal to, or greater than, 0·39° F.—**C. E. P. Brooks**: Periodicities in the Nile floods (*Memoir*, vol. 11, No. 12). The paper analyses a series of records of Nile floods extending from A.D. 641 to 1451, by means of the 'difference-periodogram.' Nineteen periodicities are determined, ranging from 1·91 to 76·8 years in length, with mean amplitudes up to 16·9 cm. (the standard deviation of the Nile flood is 56 cm.). The majority are submultiples or multiples of 22·12 years. The lengths undergo a fairly regular variation with a cycle of about 500 years, the cause of which is not known.

CAMBRIDGE.

Philosophical Society, May 7.—**J. Taylor**: On the action of the Geiger α-particle counter. The action of the counter, its partial reversibility, and its self-restoring properties are considered as a general problem of intermittency in discharge tubes and explained on three bases: the threshold current hypothesis, the shape and significance of the volt–ampere characteristics, and the photo-electric theory of sparking potentials.—**J. Taylor** and **W. Taylor**: The high-frequency electric discharge at low pressures. Some new forms of the well-known high-frequency electric discharge at 4×10^7 cycles per sec. are studied at very low pressures (10^{-3} mm. and less) and the presence of more than one type of discharge is demonstrated.—**E. J. Williams**: Some applications and implications of Duane's quantum theory of diffraction. The quantum theory of diffraction is applied to the reflection of electrons by crystals and to the spatial distribution of photo-electrons and fluorescent radiation from a crystal. The extent of coherent scattering of X-radiation by a crystal is also considered.

PARIS.

Academy of Sciences, April 16.—**H. Deslandres**: A new comet discovered at the Paris Observatory. This comet was observed by M. Giacobini on Mar. 17, and was again seen on Mar. 23. Positions are given for Mar. 17 and 28, the latter from photographs by M. Mineur.—**Charles Moureu, Charles Dufraisse**, and **Louis Girard**: Researches on rubrene. New experiments with rubrene peroxide. Crystallised from various solvents, the crystals always contain solvent of crystallisation. The dissociation of the peroxide by heating gives as the only gaseous products carbon dioxide and oxygen; the latter corresponding to from 74 to 80 per cent of the total oxygen present in the compound.—**H. Douvillé**: Concerning ophite.—**André Blondel**: The adaptation of bifilar oscillographs to the study of triode valves. The bifilar oscillograph in its usual form is not sufficiently sensitive for recording the variable currents in triode valves. Various modifications are suggested, that involving the use of a specially designed transformer proving to be the best.—**Alexandre Pantazi**: The extension of a theorem of Čech on projective applicability.—**Mandelbrojt**: The singularities of Dirichlet's series.—**Michel Broszko**: The yielding of prismatic bars compressed axially.—**Charles Volet**: A new method for the absolute determination of gravity by the pendulum. In the method proposed, all the measurements are made with the same knife-edge submitted to a constant load: the time of oscillation is varied by displacing a mass on the rod. Some advantages over the usual method are claimed.—**R. de Mallemann**: Calculation of the rotatory power of quartz.—**Mlle. M. Hanot** and **H. Guillemet**: The laws of photographic blackening: the case where the source of light is a series of electric sparks. From the results of the experiments described, it is concluded that in researches in photographic photometry with sparks, such as the study of a spark spectrum, the factor of contrast of the plate may be determined either with a continuous or intermittent source.—**Victor Henri** and **Svend Aage Schou**: The absorption spectra of formaldehyde and carbon monoxide. Close relationship between the two molecules. Analyses of the absorption spectra show close analogy between carbon monoxide and formaldehyde. The latter is a bivalent molecule having a system of triplets with the same separations as carbon monoxide. Moreover, in the absorption spectrum of carbon monoxide, the intercombination bands $^1S - {}^3P$ are found as in the case of bivalent atoms.—**G. Denigès**: The rapid estimation of the phosphate ion in soils and manures by means of molybdenum blue.—**Bodard**: The volcanic activity of Rakata.—**Ch. Jacquet** and **H. Bellocq**: Magnetic measurements in Corsica and Charente. Results of work done in 1926 at 56 stations, 24 of which are new.—**P. Idrac**: The registration of submarine currents of the Straits of Gibraltar. A change in the direction of the current was proved at a depth of 200 metres.—**Antonin Němec**: Determination of the requirements of the soil in

phosphoric acid according to the soluble silica.—**H. Bierry** and **Max Kollmann**: The mode of action of vitamin B. From the experimental results described, it is concluded that the stimulating action of the water-soluble vitamin B acts both on the glands with internal secretion and those with external secretion.—**Auguste Lumière** and **Mme. R. H. Grange**: The comparative toxicity of the serum of arterial blood and that of venous blood. Venous blood serum is always much more toxic than the serum from arterial blood. This is in agreement with the authors' hypotheses on the mechanism of the toxicity of the sera from mammals for animals of another species.—**A. Policard**: The study, by micro-incineration, of the amounts of mineral matter fixed by various parts of the cell. The methods described in an earlier communication have now been applied to animal cells.—**E. Nicolas** and **K. Katrandjieff**: The antigen character of albumens modified by heating and their specific differentiation by precipitating sera. The authors regard their work as solving the problem of the specific differentiation of cooked meats.—**Costantino Gorini**: Climbing culture and microbial dissociation.—**S. Nicolau** and **Mlle. E. Mateiesco**: Septineuritis of the rabic virus. Proof of the centrifugal course of the virus in the peripheral nerves of rabbits.

April 23.—**Pierre Termier** and **Eugène Maury**: New geological observations in eastern Corsica. The radiolarites. The radiolarite abounds in eastern Corsica. It appears, with the same petrographical characteristics, in two kinds of layers, those of the Apennine type, with non-metamorphosed limestones and clays, and in deposits of the Pennine type, with limestone schists much metamorphosed. In the layers of both types it is connected with the green rocks, and there is no essential difference between the two ophiolithic series.—**Louis Roy**: The equations of elastic surfaces with three parameters.—**E. Mathias**: Magnetic measurements in the Allier and the Puy-de-Dôme. These measurements form part of the new magnetic network of France and were carried out in 1925, with the assistance of grants from the Loutreuil Foundation. Elements are given for 37 stations, 28 of which are new.—**L. Féraud**: Surfaces admitting a finite group of projective deformations.—**V. Hlavatý**: The second fundamental form relative to the geodesic curves of a V^*_2 in V^*_3.—**Serge Bernstein**: The polynomials of Jacobi.—**de Possel**: The prolongation of the surfaces of Riemann.—**J. Delsarte**: Certain groups of non-Euclidian functional rotations.—**André Roussel**: A generalisation of the notion of primitive.—**Al. Proca**: Further reflections on dynamics. Interferences.—**F. Margond**: The general equations of a synchronous machine, not saturated, outside the normal regime.—**C. Chéneveau**: The magnetic susceptibility of aluminium. Measurements were made on a specimen of aluminium purified by Hoppes' method (iron 0·06 per cent) and on the commercial metal (iron 0·5 per cent). There appears to be no simple relation between the proportion of iron present in the metal and the magnetic susceptibility of aluminium.—**Mme. Ch. Lapp**: The measurement of the true specific heats of nickel by a direct electrical method. The changes in the specific heat of nickel with the temperature were measured over the temperature range −175° C. to +460° C. The point of discontinuity found at 357·6° C. agrees with the point of magnetic discontinuity (Curie point).—**Y. Rocard**: New diffused radiations. A theoretical explanation of the experimental results of C. V. Raman.—**J. Gilles**: The structure of the second order spectrum of sulphur (S II).—**Maurice Lambrey**: The absorption spectrum of nitric oxide.—**J. Cabannes**: The theoretical calculation of the diffusion of light in a fluid.—**J. F. Saffy**: Profound alteration of a copper–nickel alloy by the action of steam superheated to 350°-400° C. The alloy containing nickel (68·6 per cent), copper (28·9 per cent), manganese (1·6 per cent); it showed great resistance towards a series of corrosive reagents and kept its mechanical properties after seventeen months in steam at 150° C. But this alloy suffered marked change, losing its mechanical properties after a month in superheated steam at 375° ± 25° C.—**Pierre Jolibois**, **Henri Lefebvre**, and **Pierre Montagne**: The decomposition of carbon dioxide at low pressure under the action of the electric current. The tube containing the gas had its electrodes connected with a source of continuous current with several megohms resistance in series. For currents varying between 0 and 2 milliamperes the final dissociation equilibrium was independent of the current intensity, but this equilibrium was reached more rapidly with the larger current. The amount of gas dissociated increases as the pressure of the gas is lowered.—**M. Guichard**, **Clausmann**, and **Billon**: The expansion in hydrogen of metals and alloys containing a little oxide.—**F. Bourion** and **Ch. Tuttle**: The cryoscopic determination of the molecular equilibria of resorcinol and pyrocatechol in aqueous solution.—**R. Cornubert** and **H. Le Bihan**: Attempts at the benzylation and phenylation of α-methylcyclohexanone.—**P. Brenans** and **Ch. Girod**: Bromoiodo-phenols obtained with the 5-bromo- and 3, 5-dibromosalicylic acids.—**Ch. Mauguin** and **L. Graber**: The study of micas containing fluorine by means of the X-rays. A lepidolite containing 6·82 per cent of fluorine has exactly the same parameters as a lepidolite containing only 1 per cent of fluorine. The number of atoms of fluorine and of oxygen is variable in different minerals, but their sum is constant, and it appears that one or more atoms of oxygen can be replaced by the same number of atoms of fluorine in the crystalline network.—**Duboin**: The reproduction of tenorite, oligist iron, and cobalt oxide as crystals. The crystals are formed by the prolonged action of fused potassium fluoride (two or three days at a red heat).—**H. Parent**: A Pyrenees irregularity on the edge of the Maurettes.—**Pierre Viennot**: The extrusions which mark the edge of the French Pyrenees.—**J. Repelin**: The tectonic of the hills forming the southern edge of the Marseilles basin (Carpiagne).—**J. Thoulet**: The Humboldt current and the sea of Easter Island.—**Lucien Daniel**: The variations in calcium oxalate in certain grafted plants.—**Michel-Durand**: The physiological rôle of the tannins.—**Jules Amar**: The water united with colloids.—**Philippe Fabre**: The comparison of the parameters of muscular excitability by the microscopic examination of the reactions.—**J. Risler**, **A. Philibert**, and **J. Courtier**: The photobiological action of radiations. The light emitted by the instantaneous volatilisation of an aluminium wire by a continuous current has high penetrative power and its bactericidal power is greater than that of any other source of light hitherto studied.—**W. Arciszewski** and **W. Kopaczewski**: Microbial antagonism and the problem of cancer. The antagonism between *B. tumefaciens* and *Streptococcus erysipelatus* appears to be a biological fact capable of physico-chemical explanation. A real and strong physico-chemical antagonism appears to exist between *B. prodigiosus* and the bacterial agent of erysipelas. Biologically, the introduction of this organism in the treatment of tumours of plants by the Streptococcus is without effect.—**Et. Hubault**: A bacillus parasite of the caterpillars of *Dasychira pudibunda*. A detailed morphological and biological description of this parasite is given: its virulence and toxigenic power are under examination.—**E. Brumpt**: A new trypanosome pathogenic to cold-blooded vertebrates, *Trypanosoma parroti* from *Discoglossus pictus*.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society of Victoria. Vol. 40 (New Series), Part 1. Pp. v+57+7 plates. (Melbourne.)

Memoirs of the Indian Museum. Vol. 8, No. 4: Recent and Fossil Viviparidae; a Study in Distribution, Evolution and Palaeogeography, by Dr. B. Prashad; The Mantle and the Shell of the Viviparidae, by Dr. B. Prashad. Pp. 153-328+plates 19-24. (Calcutta: Zoological Survey of India.) 6 rupees; 9s 9d.

British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index 1927. Pp. ii+514. (London and Edinburgh: Gurney and Jackson.)

The Physical Society. Proceedings, Vol. 40, Part 3, April 15. Pp. 71-157. (London: Fleetway Press, Ltd.) 7s. net.

Quarterly Journal of Pharmacy and Allied Sciences, incorporating the Year-Book of Pharmacy. Vol. 1, No. 1, Jan.-Mar. Pp. vii+162. (London: The Pharmaceutical Press.) 10s.

Union of South Africa: Department of Agriculture. Science Bulletin No. 63: South African Tanning Materials (The Black Wattle). By C. O. Williams. (Division of Chemistry Series No. 84.) Pp. 68. (Pretoria: Department of Agriculture.) 6d

Transactions and Proceedings of the New Zealand Institute. Vol. 58, Part 4, December 1927. Pp. iv+359-638+xii. (Wellington, N.Z.)

Association of Teachers in Technical Institutions. Programme, Bradford Conference, 1928. Pp. 20. (London.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 3, No. 27: The Inheritance of Long and Short Wings in the Weevil (*Sitona hispidula*), with a Discussion of Wing Reduction among Beetles. By Dorothy J. Jackson. Pp. 665-735+7 plates. 11s. 6d. Vol. 55, Part 3, No. 29: The Highland Schists of Middle Deeside and East Glen Muick. By Dr. H. H. Read. Pp. 755-772+2 plates. 3s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Institution of Gas Engineers. Seventeenth Report of the Gas Investigation Committee: Examination of Products of Combustion from Typical Gas Appliances. Part 2: Gas Fires. (Presented June 14, 1927.) Pp. 85-154. Eighteenth Report of the Gas Investigation Committee: Studies in Carbonization, Part 2. (Presented June 14, 1927.) Pp. 207-270. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 1: Award of the Boyle Medal for Pure Science to William Ringrose Gelston Atkins, O.B.E., Sc.D., F.I.C., F.R.S., 1928; Report of the Committee of Science and its Industrial Applications. Pp. 9. 6d. Vol. 19 (N.S.), No. 2: Award of the Boyle Medal for Applied Science to Walter Ernest Adeney, D.Sc., F.R.C.Sc.I., F.I.C., 1928; Report of the Committee of Science and its Industrial Applications. Pp. 11-15. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate Ltd.)

British Non-Ferrous Metals Research Association. Eighth Annual Report for the Year ending December 31st, 1927. Pp. 44. (Birmingham.)

Proceedings of the Royal Society of Edinburgh, Session 1927-1928. Vol. 48, Part 1, No. 7: Note on the Sympathetic Nervous System of *Lepidosiren paradoxa*. By Penelope M. Jenkin. Pp. 55-69. 1s. Vol. 48, Part 1, No. 8: The Invariant Theory of the Quaternary Quadratic Complex. 1. The Prepared System. By H. W. Turnbull. Pp. 70-91. 2s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 377, May. Pp. 453-568+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Journal of the Royal Agricultural Society of England. Vol. 88. Pp. 8+326+clxxiv. (London: John Murray.) 15s.

Proceedings of the Society for Psychical Research. Part 106, Vol. 38, May. Pp. 17-48. (London: Francis Edwards, Ltd.) 2s.

Empire Cotton Growing Corporation. Review of the Present Position in the Principal Cotton-growing Territories of the Empire, and a Summary of the Main Activities of the Corporation since their Formation. Pp. 23. Report of the Administrative Council of the Corporation to be submitted at the Seventh Annual General Meeting on May 16th, 1928. Pp. 44. (London.)

Harper Adams Agricultural College, Newport, Salop. Sugar Beet Problems: Report of Conference held at the College on Wednesday, February 8th, 1928. Pp. 24. (Newport, Salop.) 1s.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 3: A Simple Form of Photo-electric Photometer, using a Neon Lamp to measure the Current. By Dr. J. H. J. Poole. Pp. 17-25. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.). 6d.

Commonwealth of Australia. Journal of the Council for Scientific and Industrial Research. Vol. 1, No. 3, February. Pp. ii+133-192. (Melbourne: H. J Green). 1s. 6d.

The West of Scotland Agricultural College: Department of Plant Pathology. Research Bulletin No. 1: The Endotrophic Mycorrhiza of Strawberries and its Significance. By D. G. O'Brien and E. J. M'Naughton. Pp. 52+6 plates. (Glasgow.)

FOREIGN.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 9, 1927. i. Månadsöversikt över väderlek och vattentillgång jämte anstaltens årsberättelse. Pp. 97. (Stockholm.) 2.50 kr.

The Rockefeller Foundation: a Review for 1927. By George E. Vincent. Pp. 54. (New York City.)

Cornell University Agricultural Experiment Station. Memoir 111: A Population Study of Three Townships in Cortland County, New York. By Dwight Sanderson. Pp. 19. Memoir 114: Building up Resistance to Diseases in Beans. By Donald Reddick. Pp. 15. Bulletin 463: Relative Adaptability of Red-Clover Seed of Different Origins. By R. G. Wiggans. Pp. 38. Bulletin 465: Twenty Years Growth of a Sprout Hardwood Forest in New York; a Study of the Effects of Intermediate and Reproduction Cuttings. By J. Nelson Spaeth. Pp. 49+6 plates. (Ithaca, N.Y.)

Department of Commerce: Bureau of Mines. Technical Paper 427: Propagation of Flame in Mixtures of Natural Gas and Air. By H. T. Coward and H. P. Greenwald. Pp. iv+28. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 31: Statistics of Private High Schools and Academies, 1925-26. Pp. 39. (Washington, D.C.: Government Printing Office.) 10 cents.

Transactions of the San Diego Society of Natural History. Vol. 5, No. 11: The Trimorphodon (Lyre Snake) of California, with Notes on the Species of the Adjacent Areas. By Laurence M. Klauber. Pp. 183-194. Vol. 5, No. 12: A new Echinoid from the California Eocene. By Hubert G. Schenck. Pp. 195-202. (San Diego, Cal.)

Proceedings of the United States National Museum. Vol. 73, Art. 6: Two new Crabs from the Eocene of Texas. By Mary J. Rathbun. (No. 2727.) Pp. 6+3 plates. (Washington, D.C.: Government Printing Office.)

Svenska Linné-Sällskapets Årsskrift. Årgång 11, 1928. Pp. v+201. (Uppsala: Almquist and Wiksells Boktryckeri A.-B.)

CATALOGUES.

Illustrated and Descriptive Price List of "Edney" Thermographs, Hygrographs, Hair Hygrometers, and combined Recording Instruments. Pp. 8. (London: Pastorelli and Rapkin, Ltd.)

Sotheran's Price Current of Literature. Annotated and Classified Catalogue of Standard Works on Exact Science, with an Appendix of Rare and Valuable Works. (No. 811.) Pp. 172. (London: Henry Sotheran and Co.)

Zeiss Field Glasses. (T380£.) Pp. 54. (London and Jena: Carl Zeiss, Ltd.)

Haveg Chemical Plant. Pp. 16. Rotameter. Pp. 4. (London: Trost Bros.)

Diary of Societies.

SATURDAY, MAY 26.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. White: The Use of Carbon Monoxide Masks in Mines.

TUESDAY, MAY 29.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Demonstrations of New Apparatus.

WEDNESDAY, MAY 30.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, MAY 31.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (continued on June 1 and 2).—Laryngological Papers by Dr. Watson-Williams, L. Yates, Sir StClair Thomson, A. J. Wright, Mr. Rake, and W. Mollison.

Friday, June 1.—Otological Papers:—Prof. O. Mayer: The Pathology of Otosclerosis.—H. Kisch: The Use of Temporal Muscle Grafts in the Radical Mastoid Operation.—D. Guthrie: Fat Grafting.

Saturday, June 2.—W. S. Sharpe: The Influenzal Ear.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish District Meeting) (at The Hydro, Peebles) (continued on June 1 and 2).

FRIDAY, JUNE 1.

PHILOLOGICAL SOCIETY (at University College), at 8.—C. T. Onions: Paper.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. L. Woolley: The Results of the Further Excavations at Ur.

PUBLIC LECTURES.

TUESDAY, MAY 29.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. J. Eason: Graves' Disease. (Succeeding Lectures on May 30 and 31.)

UNIVERSITY COLLEGE (in Anatomy Theatre), at 5.30.—Prof. G. Elliot Smith: Elephants and Archæology.

GRESHAM COLLEGE (Basinghall Street, E.C.2), at 6.—A. R. Hinks: Gresham Lectures in Astronomy. (Succeeding Lectures on May 30, 31, and June 1.)

THURSDAY, MAY 31.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. G. V. Anrep: Pathology of Conditioned Reflexes.

KING'S COLLEGE (University of London Animal Welfare Society), at 5.30.—Addresses on Man's Duty to Animals by Rabbi S. Daiches, Rev. B. G. Bourchier, Rev. Father C. C. Martindale, Lt.-Commissioner I. Unsworth, Prof. The Rev. W. R. Matthews. Chairman: Prof. F. T. G. Hobday.

UNIVERSITY COLLEGE, at 5.30.—Prof. Max Bodenstein: Chemical Kinetics. (Succeeding Lectures on June 1 and 4.)

FRIDAY, JUNE 1.

KING'S COLLEGE, at 4.—l'Abbé H. Breuil: Les Industries préhistoriques par rapport à la Géologie.—At 5.30.—Dr. J. Krzyzanowski: Polish Culture in the Middle Ages: Secular Literature and Science.

UNIVERSITY COLLEGE, at 5.30.—Prof. C. Spearman: The Psychologist in the School.