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CONTENTS.

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The Influence of Science on Ethics.[1]

IN his Norman Lockyer lecture, delivered on Nov. 21 under the auspices of the British Science Guild, Dean Inge discussed the effect which the advance of scientific knowledge has exercised upon our modern notions of morality and our ideals of practical conduct. It is difficult in a discussion of this sort to separate religion from ethics, for in practice they are closely intertwined, and the influence of scientific conceptions has perhaps been greater upon religious thought than upon moral tendencies. Science reveals a world incomparably vaster than was dreamed of in the days when the great religions were founded; it has relegated man and his works to a remote and obscure corner of the cosmos, robbing him of the proud position which he arrogated to himself as the centre and crown of creation. Science has, therefore, profoundly modified religious conceptions. Has it had an equal effect upon morality? It seems to us that the effect has been mainly indirect, acting through the changed conceptions of the cosmos which science has imposed, and Dean Inge's remarks appear in general to support this view.

Dean Inge discusses first the problem so clearly stated by Huxley in his famous Romanes Lecture. Huxley considered that the ethical process ran counter to the cosmical process, that the moral life must be a constant fight against the lower instincts and desires which man has inherited from his animal ancestors. Law and morals he considered to be necessary restraints upon the struggle for existence between men in society, and his final conclusion was that "the cosmos works through the lower nature of man, not for righteousness, but against it." Being a man of fine and strong character, and in many ways a typical Victorian, Huxley laid immense stress upon righteousness—upon honesty and courage in thought and action and the paramount claims of duty. He was over impressed by the Victorian conception of Nature as red in tooth and claw, of life as a bitter struggle in which the prizes go to the strong and ruthless. The opposition which he set up between moral Victorian man in societies, and prodigal, careless, and cruel Nature, seems to us now too rigidly drawn. After all, man also, with all his finer desires and aptitudes, his creativeness in art and science and philosophy, is a part of Nature; and, on the other hand, some of the despised lower instincts which he shares with the rest of the animal

[1] Scientific Ethics. By the Very Rev. Dean Inge. (British Science Guild, 6 John Street, Adelphi, London, W.C.2.) 1*s*.

world are the basis of courage and self-sacrifice in man himself as well as in the lower animals. Protection of mate and offspring and sacrifice of self on their behalf are developments of the fundamental instinct of reproduction which is as powerful in man as in the lower animals.

Dean Inge describes Huxley's position as one of radical pessimism, and he is far from sharing it. He does not think that we are forced to consider the universe as radically unfriendly. The main error of the Huxleyan view was that it considered the cosmic process apart from man. To do this is to despiritualise Nature.

"The cosmic process," says Dean Inge, "is responsible for man as he is, with all his unselfish devotion to family, friends, and country, and all his pity and sympathy with the weak, all his idealism and belief in the unseen, as well as for those brute-instincts, which Read thinks are too often forgotten by moralists and reformers. We are not committed to anything so hopeless as a struggle against the cosmic process."

As to the positive contributions which the scientific spirit makes to ethics, Dean Inge finds these mainly in the influence exerted by the increased clarity and honesty of thought which are the result of free and unbiassed inquiry into the nature of things. Thus he thinks that we may expect to see a more exacting standard of accuracy in forming and expressing opinions. Signs of this influence of the scientific spirit are already to be seen even in theological controversy, where "in those churches which are affected by the scientific conscience, there is much less garbling of facts and vilification of opponents than there used to be." Science will help too in driving out superstition and the baser forms of supernaturalism. "Perhaps nothing has corrupted the Christian religion so profoundly as the unethical magic which in many different forms has pervaded it: and it all rests on this assumption that there is a 'supernatural order,' which from time to time 'suspends' the laws of Nature, breaking the natural sequence of cause and effect." True religion, sound ethics, and the spirit of science can make common cause in resisting such beliefs. So, too, though science has nothing directly to do with theology, it may do good service by showing the inadequacy and poverty of the cruder conceptions of God which have done more harm to religion and ethics than the assaults of dogmatic atheism.

An interesting question is raised by Dean Inge's claim that the proof of our blood-relationship with the other animals supplied by the doctrine of evolution has led to a more humane treatment of animals. In countries where the Church has firmly resisted the evolutionary doctrine, animals are as a rule cruelly treated. No doubt there is truth in this view, but it does not seem to us the whole truth, for there have been in all parts of the world lovers of animals and kindly masters long before evolution was dreamt of. We hope, with Dean Inge, that the influence of science, and certainly of scientific men, will be exerted against the wanton destruction of plant and animal life and against the ugliness which seems inseparable from a mechanical civilisation, but we feel that the driving force must come not so much from the spirit of intellectual inquiry as from æsthetic and moral feeling.

Dean Inge devoted an important part of his lecture to a consideration and advocacy of the eugenist position. It is here that the direct influence of scientific thought and of the results of scientific inquiry upon conduct and practice, and even upon political action, is most fully exerted. A very definite ethical problem is raised, which gives rise to much conflict of opinion. Science has shown the importance of taking long views, of providing for the future improvement of the race, and avoiding racial deterioration. Instancing the action taken by America in drastically limiting the immigration of inferior stocks, Dean Inge points out how profoundly this scientific point of view is beginning to affect practical morality and the conduct of human life. We do not propose to enter into a discussion of the eugenist case, on which there is much to be said both for and against, but we confess to some surprise in finding Dean Inge stoutly maintaining that the new eugenic morality is more Christian than the moral traditions of the pre-scientific age. This does not seem to us to be fully reconcilable with his own remarks quoted above about man and the cosmic process, where pity and sympathy for the weak are rightly ranked among the higher instincts of man.

Has the over elaborate civilisation which is the product in the main of the scientific age really led to an increase of happiness or enhanced the dignity and value of the individual life? This is an important question which is dealt with in the concluding sections of the lecture. The mechanisation of human life has proceeded apace. "Civilisation—the accumulation of experience and of tools—seems to have brought intrinsic evolution to an end." Men are becoming the slaves of machinery and a slave is only half a man. Is there any cure for this state of things, any means by which man might recover his lost opportunities for a full and rounded existence? And can science help towards this end?

"It seems to me," says Dean Inge, "that science ought to advocate a return to much simpler conditions. A happy and healthy country would be inhabited—much more sparsely than England is at present—by a population mainly agricultural, with small towns well supplied with schools, colleges, and laboratories. The passion for production at all costs would die a natural death, since the market for standardised products, now artificially stimulated by all the arts of scientific advertising, would be comparatively small. There would not be much of mere drudgery, for we should still have our labour-saving machines; but the arts and crafts would not be strangled and exterminated as they often are now. The instinct of acquisitiveness has become a positive disease; it should be checked by the principle already enunciated, that no needs should be indulged beyond their biological justification. No one should be condemned to the ceaseless repetition of one simple act as his life's work; the human frame and nervous system are not adapted to such unrelieved monotony. It is the dullness and irritation of mechanical labour that drive men to alcohol, gambling, and Bolshevism."

A rational simplification, such as is here suggested, of the present absurdly complicated and cumbrous organisation which we call civilisation is needed to give mankind scope to develop its powers—some portion as men of science and philosophers, others as craftsmen and artists, and others again as good citizens and helpers of their fellow-men.

Sins of the Spirit.

The Clash of Culture and the Contact of Races: an Anthropological and Psychological Study of the Laws of Racial Adaptability, with special reference to the Depopulation of the Pacific and the Government of Subject Races. By George Henry Lane-Fox Pitt-Rivers. Pp. xiv + 312. (London: George Routledge and Sons, Ltd., 1927.) 18*s*. net.

SHORTLY after the War, Capt. Pitt-Rivers took a course at Oxford in psychological and anthropological studies. Thus equipped, and undeterred by the fact that he would be re-traversing the field of research in which had laboured the late W. H. R. Rivers, one of the most brilliant of twentieth-century psychologists and anthropologists, he embarked for the South Pacific islands to undertake a further inquiry into the effect of the impact of alien peoples upon the indigenous tribes. The fruit of his researches is presented in this volume, which bears comparison with those of his famous predecessor for breadth of treatment of subject matter, and exceeds them in its clarity of expression and fearlessness of exposition. Capt. Pitt-Rivers's diagnosis of the complaint from which the primitive communities in Oceania are suffering, and his general conclusions regarding the effects of European exploitation and later well-intentioned British administration, are much the same as those of other objective observers; yet he achieves such novelty of treatment that his book must be read.

There is a growing tendency among humanitarians in Europe and America to assume that 'native problems,' that is to say, native unrest and discontent, exist only in those territories where the native races are being dispossessed of their lands and exploited in the interests of white plantation owners and mining companies. They would reject the idea as preposterous that such exploitation, however cruel, may be less disastrous in its effects upon native morale than an intentionally benign administration or Christian missions. Such implicit faith have they in the perfection of our civil and religious institutions, so conscious are they of the 'uplifting' influence of the conventional codes of their own society when introduced among primitive peoples, that they are apt to ignore the possibility that those of the natives which are being catastrophically destroyed may be intrinsically more valuable to and more consonant with the natural development of native culture. It may shake their complacency to learn that "nowhere in the Pacific is the phenomenon of the disappearance of the aboriginal races more noticeable than in the islands of the Bismarck Archipelago, where European control last made its influence felt. In these Islands the rapid decline, even during the last twenty-five years, is well known and admitted officially." This cannot be attributed to "violence and starvation, and civilised drink and diseases," to which causes Lord Olivier alleges the decrease of native population is due. These, of course, are factors which cannot be disregarded, but there is little doubt, avers Capt. Pitt-Rivers, that the principal cause in certain parts of the world is the destruction of the "old-culture forms and environmental conditions in the endeavour to impose too dissimilar a culture upon a people specialised by a long process of adaptation to particular conditions."

If there is one quality which differentiates the genuine scientific worker from the rest of his fellows, it is his humility of approach to the problems which confront him. When an anthropologist, for example, studies native problems, the existence of differences between tribes and the manifest differences between races do not lead him hastily to assume that one particular culture-form is superior to the rest and that it is in the best

interests of all peoples that they should conform to that one. As Pitt-Rivers says, "He studies native customs to discover their importance in relation to the social organisation of the people, and thereby discover what is essential to that organisation and the communal life of the tribe or race; to study their beliefs and their morality sympathetically in terms of their own thought, and without the desire to substitute for what is native something that is not native or adapted to native life."

There are certain aspects of the social life of most of the communities over which we exercise tutelage which shock the average European. Nakedness and pre-nuptial licence, polygyny, consanguineous marriages, child-marriages, infanticide, are direct contradictions of our code of conventions. Consequently, when confronted with racial degeneracy and depopulation, we attribute them to such 'evil' customs. But, as Pitt-Rivers points out, these customs existed centuries before the advent of the Europeans, and apparently had no lethal effects. If the imposition of our conventions upon native communities, the introduction of our legal system, disciplinary, sanitary, and clinical measures, and our form of religion, are to be regarded as beneficial, there should be an increase of population. The hard fact is that in Oceania there is an obvious decrease.

This decrease supplies the author with his thesis—the lethal effects of culture-clash—and leads him to subject the native customs to searching analyses, more particularly those customs which we deem to be shocking. He defends polygamy and consanguineous marriages and discounts the idea that child-marriages and infanticide are intrinsically bad or lethal in effect among the communities where they are practised. Inbreeding, as he says, and quotes Westermarck in substantiation, has from the earliest historical times been practised most among kingly and chiefly castes, with the aim of maintaining the purity of blood of the ruling castes. Provided there is some motive and ideal of selection in mating, inbreeding is positively beneficial and not the reverse. Dealing with the effect of the Christian missionary, he says, "His first efforts are directed towards inculcating decency and modesty by creating a sense of shame. In other words, by inculcating flesh-consciousness and the virtue of concealment, the two sign-posts of Christian culture."

The later chapters of the book embrace a good deal that is of more general interest than specific application to the Polynesians. Nevertheless, they will repay the most careful study even though we may not be prepared to accept some of his conclusions. The author has brought to the study of 'psychological factors' a fresh mind. He challenges the latest work of Spearman on "The Abilities of Man" with no little skill. On the subject of extrovert and introvert types he is most illuminating. But best of all is his scornful denunciation of Puritan intolerance and its narrowing and retarding effects on European culture.

Capt. Pitt-Rivers is least convincing when dealing with sex-ratio, where he argues from insufficient biological foundation. Some of the statistics he quotes upon which he builds his theory are inadequate to the purpose. Occasionally also he makes sweeping generalisations which are not applicable to every primitive community. With certain parts of West Africa in mind, where the tendency is for the peoples to live in enormous towns, we cannot agree that "it is acknowledged that the tendency of native races of barbaric cultures is towards decentralisation." Again, some of us cannot share his views with regard to a "White Australia." The experiment in white colonisation in Queensland appears to have been most successful so far.

The publication of this volume can do nothing but good. It will shock the susceptibilities of many. That is an advantage. Anything which will arouse our colonial administrators from too smug complacency, anything which will persuade the Home authorities to select men for the Colonial service who have been trained to seek for knowledge, to regard the customs of the native peoples whose interests they should serve as an integral part of their culture and one of the greatest factors in determining their will to live, should be heartily welcomed not only by anthropologists but also by all other scientific workers.

If a suggestion to the author may be made, it is that he should now carry out similar researches in Africa. They are badly needed.

A. G. CHURCH.

Modern Acoustics.

Sound: a Physical Text-Book. By Dr. E. G. Richardson. Pp. vii + 286. (London: Edward Arnold and Co., 1927.) 15*s*. net.

SO long as sound forms the most rapid means of communicating thought from one normal human being to another, the subject of acoustics cannot fail to be important. Nevertheless, after the

time of the publication of the classical treatises of Helmholtz and Rayleigh, it received little attention until in recent years war and broadcasting brought new problems and raised many difficulties in the practical application of the older knowledge. A dreary feature of the pre-War text-books on the subject was the neglect of researches carried out after about 1890. It is therefore a great pleasure to find that Dr. Richardson's book is a well-balanced account of the present state of knowledge in experimental acoustics rather than still another of what may be called the Rayleigh-without-tears type of book. We must not complain that in this volume there is too little of Rayleigh, that is, too little mathematical treatment, for the sub-title is "A Physical Text-Book." The author claims that it covers all that a candidate for the pass and honours degree examinations of British and American universities should need. In actual practice the English degree student can omit the subject of acoustics, and even if the subject is not omitted altogether there is not time for a full treatment such as is here given. The student needs rather a short book dealing with a few of the main topics together with laboratory experiments and problems for solution. Neither of the two latter are given in this volume.

The book is more likely to be of service to the research student, the research worker, and the technician, as it is the only source of information in English of the results so far attained in any branch of the subject, together with copious references to the original papers. Since almost all the important work has been included, it is of interest to note the many problems which are still unsolved, due partly to the neglect of acoustics as a field of research. A fallacy exists in the minds of many physicists that in order to research successfully in this subject one must possess a 'musical ear.' When we see how such a genius as Helmholtz was misled by trusting to his ears, we cannot but wish that much acoustical research would be done by deaf workers, who would be almost compelled to attempt only quantitative measurements. In truth, the ear is not a scientific instrument, although it is a wonderfully sensitive apparatus, the powers of which are well summarised in the chapter on subjective sound. Much remains to be elucidated in the subjects of speech and of hearing.

Another big unsolved problem is that of sound recording. The ease with which one can set up a light membrane, and by coupling it with a suitable optical system, obtain pleasing curves upon photographic films, has misled many workers into thinking that the curves represent the impinging sound waves. Dr. Richardson rightly concludes that the phonodeik is the most accurate sound recorder of the phonograph type, but even this wonderfully delicate instrument was calibrated by a set of organ-pipes, and it was recently stated that at the National Physical Laboratory the organ-pipe as a standard source of sound had to be abandoned. The author shows kindness in omitting to mention one big memoir describing work in which gramophone records were used to study sound waves, and in which the method was fallaciously claimed to be good *because* by playing the record upon a gramophone and listening to it one could tell how nearly the indentations of the record represented the actual sounds originally recorded. It is safe to say that at present we have neither a perfect recording instrument nor a trustworthy standard source with which to test our imperfect instruments. Such as we have are well described in the chapter on analysis of sound in air. One should have liked a fuller treatment of the condenser microphone, including that of H. Riegger, which differs considerably from the Wente type mentioned. An adequate treatment would have required a good deal of space, but the subject is important, for distortionless amplification would have many valuable applications.

Electrical devices in general have already been of great service in acoustical research. The best attempts described in the book at absolute energy measurements, which are so difficult because of the minute absolute value of the energy of a sound wave of normal intensity, all depend upon electrical devices. In almost every chapter occur references to the use of electrical instruments such as the electro-magnet and the valve for maintaining the vibrations of tuning-forks, diaphragms, bars and strings, the oscillograph, the Einthoven string galvanometer, the stroboscope, the piezo-electric oscillator and instruments depending on the change in the electrical resistance of a heated wire over which sound waves pass. As in so many other branches of physics, photography also has given much help, particularly in the recording of vibration and in the instantaneous spark photography of density changes in vibrating gases.

Special chapters are devoted to heat-maintained sounds and to æolian tones, the latter chapter wisely preceded by a discussion of vortex formation and Prandtl's work on viscous fluids. This had not previously found its way into the text-books of physics, despite the test of twenty years' successful application in aeronautics.

Well-written sections dealing with the various

musical instruments are included. It might perhaps be better to omit such chapters from physical text-books, as their interest is more restricted than other branches of acoustics and their inclusion helps to spread the fallacy that acoustics is a subject for the musical physicist only. To such the meagre information available is merely a source of irritation. Because we have a good deal of knowledge of the motions of bowed and struck strings, we must not assume that we understand the acoustics of the violin or the pianoforte. A gut violin string radiates *none* of its energy to the air, and a steel piano string radiates but little. There are many complex changes between the string and the listener's ear. The problem of the special properties of a good Strad violin still defeats us. The strings clearly do not hold the secret, for they are the same as are used upon any violin. Musical acoustics is best treated as an intimate mixture of physics, physiology, and psychology.

The book is very readable, is well produced, and can be heartily recommended to all interested in the subject. Technical readers with little or no mathematical knowledge will have no difficulty in following almost the whole of the treatment. The honours degree student should use also the mathematical treatments of Lamb or Crandall ("Vibrating Systems and Sound," 1927), whilst the research worker will need also Auerbach's "Akustics," 1907, and the eighth volume "Akustics" of the Geiger and Scheele "Handbuch der Physik," 1927.

W. H. GEORGE.

A Canine Encyclopædia.

Dogs: their History and Development. By Edward C. Ash. Vol. 1. Pp. xviii + 384 + 108 plates. Vol. 2. Pp. xvi + 385-778 + plates 109-160. (London: Ernest Benn, Ltd., 1927.) 105*s*. net; edition de luxe, 252*s*. net.

IN these two bulky volumes, Mr. Ash has for the most part succeeded in tracing the histories of practically all the domesticated varieties of dogs which are known at the present day. In an opening chapter on the origin and evolution of dogs as a whole, in which he quotes many well-known authorities, he puts aside Mivart's wolf-jackal ancestry theory in favour of a hypothesis that the ancestors of modern dogs probably existed in Eocene and Miocene times and were closely related to Cynodictus, Amphicyon, Simicyon, and Cynodesmus. It would seem, however, that in view of the rapidity with which change takes place in animals under domestication and artificial selection, there is no necessity to go back very far beyond historic times to find the ancestor of the modern dog, in all its variations, among the wolves and jackals, especially when one considers, as Mr. Ash points out later on in his second volume, that breeds so different as the Yorkshire, the Airedale, and bull terrier have all been 'made' during the past hundred years, and that the so-called Alsatian wolf-hound, more properly known as the German sheepdog, has only been in existence a little more than a quarter of a century.

Again, a comparison of some of the figures of typical dogs of a hundred years ago with those of their modern representatives shows that the type in many cases has changed to such a marked degree that the two might easily represent entirely different breeds. On the contrary, where the type became stabilised many years ago and artificial selection has been carefully carried on by man, as in the case of some of the members of the greyhound group, which are one of the oldest of all breeds, there appears to have been very little change in general appearance between the dogs of to-day and those of 6000 years ago.

In view of the publicity which has been given to Alsatians in the daily press of late, it is interesting to note that Mr. Ash says: "There seems to me to be little doubt that the Alsatian type was obtained or developed at some distant time by wolf and/or dingo crosses," and goes on to quote that the great-granddam of the famous Alsatian "Hector Von Wohlen" was the result of a cross between a dog-wolf and an Alsatian bitch.

The book is not written merely for the technician; it will have an appeal for all dog-lovers, for Mr. Ash's researches have led him to study the dog from many aspects. There are chapters on dogs in relation to religion, medicine, law, and history in general. We learn that in Wales a certain cure for a cough is to put a hair of the patient's head between two slices of bread and give the sandwich to a dog, and also that the hair of a dog when burnt is a sure remedy when applied to a bite. The Chinese seem long ago to have come very near to Pasteur's great discovery: "If a man was hurt by a mad dog, then the man goes mad, the best cure was to use the brain from the same dog and put it on the wound."

As a work of reference the dog breeder will find Mr. Ash's book invaluable, for in addition to the histories of all breeds, there are lengthy appendices in which show points, pedigrees of famous dogs, and championship winners are given. The book is worthy of a bibliography and it is to be regretted

that none is given, the only references being scattered notes in the text and rather inadequate footnotes.

There are more than 150 excellent plates, in which are figured several hundred dogs, from those of ancient Assyria and Egypt down to the living championship winners of to-day. These have been collected from many sources, and they alone testify to the care and perseverance which have gone to the building of what will doubtless be a classical work on dogs and one which should find its way to every good reference library, as well as to the shelves of every dog-lover who can afford it.

Local Floras.

(1) *The Flora of Buckinghamshire: with Biographical Notices of Those who have contributed to its Botany during the Last Three Centuries.* By Dr. George Claridge Druce. Pp. cxxvii + 437. (Arbroath: T. Buncle and Co., 1926.) n.p.

(2) *The Field-Club Flora of the Lothians.* By the Botanical Committee of the Edinburgh Natural History Society. Edited by Isa H. Martin. Pp. viii + 142. (Edinburgh and London: William Blackwood and Sons, Ltd., 1927.) 5*s*. net.

(1) TO be the author of three complete county floras is an achievement which we believe to be unique in the annals of British botany, although C. C. Babington, in addition to his floras of Cambridgeshire and the Channel Islands, compiled the catalogue known as the "Flora Bathoniensis." The present flora is the third from the pen of Dr. Druce, whose flora of Oxfordshire was published in 1886 and the flora of Berkshire in 1897. A flora of Buckinghamshire is the more welcome as no previous flora has ever been published of the county, though a catalogue of 719 species without localities was issued by the late Mr. James Britten in 1867 under the title of a "Flora of Buckinghamshire." The work before us contains records of about 930 species, exclusive of aliens and the microspecies of Rubus and Taraxacum, or slightly more than the number recorded by Pryor for the neighbouring county of Hertford.

To the student of geographical distribution, the most interesting species of the area is *Danaa cornubiense* (*Physospermum aquilegifolium*), which is otherwise confined in Britain to Cornwall and Devon. The flourishing condition of this plant in its one station is, we may note, rendered significant by the fact that several 'western' species occupy their eastern limit at Burnham Beeches also. This is shown by the occurrence there of the liverwort *Microlejeunea ulicina*, or the very rare snail *Vitrina major*, in company with the north-western mollusc *Acanthinula lamellata*. Of the extinct and diminishing species, it is of interest to note that plants of wet habitats predominate, as was shown to obtain in the neighbouring county of Hertford. The introduction contains a brief account of the contributions to the botanical knowledge of the county, in which a short autobiography of Dr. Druce is of especial interest.

This work emphasises once more the debt that British field botany owes to the pharmaceutical profession in general and to the author in particular.

(2) "The Field-Club Flora of the Lothians" is a much smaller work, of a size convenient for the pocket, and embodies the records of the Edinburgh Natural History Society. Localities are given, and a few ecological lists for some selected stations are furnished. Some eight species are noted as having recently become apparently extinct, amongst which we may note especially *Corallorrhiza innata*, *Linnæa borealis*, *Teesdalia nudicaulis*, *Crambe maritima*, *Genista pilosa*, and *Thalictrum flavum*. It is to be regretted that the size, weight, and cost of this little book were increased by the rather unnecessary inclusion of a glossary and seventeen plates illustrative of the botanical terms, as these bear no relation to the main text and are scarcely adequate to the comprehension of a descriptive flora. Nevertheless, despite the diminished convenience, field botanists will welcome this addition to our local floras. E. J. S.

Our Bookshelf.

Dredging and Dredging Appliances. By P. M. Dekker. Pp. xvi + 170. (London: Crosby Lockwood and Son, 1927.) 36*s*. net.

DREDGERS are an extremely varied, albeit highly specialised, type of vessel, interesting alike to the naval architect, the engineer, and the shipbuilder. Literature on the subject of dredger design is, however, far from voluminous and, indeed, is remarkable more for its paucity than for its fullness. There is abundant scope, then, for the volume by Mr. Dekker, and his description of a number of present-day dredging vessels and appliances forms a useful addition to the reference library of the practising engineer. It will be felt, on perusal, that the book is, in fact, mainly descriptive, and that it concentrates largely on individual examples of dredger construction. This does not detract from the utility of the work as a practical directory to the subject, but it still leaves the field open for a dissertation on the principles underlying dredger design. Such a work would, perhaps, be the special province of the naval architect.

Mr. Dekker's book is not divided into chapters,

but is in two parts, with numerous sub-sections. Commencing with a historical résumé and account of early types, the modern bucket dredger is then subjected to analytical description, followed by similar treatment of the sand pump, the suction dredger, and the suction cutter dredger. There is no reference to the dipper dredger, the type so prominently in vogue in North America. No doubt this is due to the author's Dutch nationality and his intention, expressed in the preface, of giving solely an account of the development of dredging appliances in Holland. He points out that "as regards the more recent development, England and Holland may safely claim to have made the greatest progress." A number of interesting photographs and line drawings enhance the attraction of the book. BRYSSON CUNNINGHAM.

The Father in Primitive Psychology. By Prof. B. Malinowski. (Psyche Miniatures, General Series, No. 8.) Pp. 93. (London: Kegan Paul and Co., Ltd., 1927.) 2*s*. 6*d*. net.

SAVAGES, to use a popular term, are no more logical and consistent than civilised peoples. This is a point which is often overlooked and has been usefully emphasised by Prof. Malinowski on more than one occasion. Ever since it has been recorded that some primitive peoples are ignorant of the part of the male in procreation, certain obvious difficulties which it is thought should inevitably arise have caused some doubts as to the completeness of this alleged ignorance. In this book Prof. Malinowski records the results of his inquiries on the subject among the people of the Trobriand Islands, with special reference to its bearing upon the position of the father as a purely sociological and not a biological factor in the family group. The results are extremely interesting, and if Prof. Malinowski has not been successful in disposing of all, he has at any rate solved some of the more serious difficulties. The case of the unmarried mother is still a stumbling-block, and the author has to fall back upon the explanation that a birth is contrary to the custom of society, a force which, when everything is taken into account, does not seem quite adequate, strong as it undoubtedly is. Prof. Malinowski has some illuminating remarks to make on the relation of this lack of physiological knowledge to the attitude of the natives towards Christianity.

Relativity: an Exposition without Mathematics. By Prof. James Rice. (Benn's Sixpenny Library, No. 105.) Pp. 79. (London: Ernest Benn, Ltd., 1927.) 6*d*.

IN this paper-covered pamphlet of eighty pages, which is sold for sixpence, Prof. Rice sets forth the doctrine of relativity: and not only this, but also (as preliminaries to it) the principles of Newtonian physics, the history of optics in the nineteenth century, and the Maxwell-Lorentz theory of electricity. It is a wonderful performance—judicious, scholarly, well written, and sparkling with apt comparisons and illustrations. A little masterpiece in every way.

In the expectation that it will be continually reprinted, and translated into every language under the sun, we venture to point out one or two things which might be amended. On page 13, after correctly describing FitzGerald as "an Irish physicist," the author refers to Larmor as "an English mathematician at Cambridge." Larmor is, however, another Irishman. On pages 51-52 we are told that the mass of the electron has been proved by experiment to be wholly electromagnetic: we do not understand what Prof. Rice means by this: at any rate, the Kaufmann-Bucherer experiments on the mass of β-particles merely show that their mass varies with velocity in the way that any mass, whatever be its origin, must do according to the relativity theory. On page 73, *latitude* is obviously a slip for *longitude*.

Elementary Practical Physical Chemistry. By Dr. James Frederick Spencer. (Bell's Natural Science Series.) Pp. viii+263. (London: G. Bell and Sons, Ltd., 1927.) 5*s*.

DR. J. F. SPENCER has written a very attractive book of practical exercises in physical chemistry. It is an elementary book, describing experiments which can be performed by boys and girls in the upper forms of schools. For this reason, complicated apparatus and tedious experiments have been avoided, and in certain cases new types of simple apparatus have been designed and put on the market, to enable additional experiments to be made. Since the requirements and possibilities of an elementary course in physical chemistry have now been to a large extent standardised, the detailed setting out of the work is more important than its scope, and for this reason Dr. Spencer may be congratulated on the clearness of the 89 diagrams which serve as illustrations to the 100 experiments, for which detailed instructions are given in the narrative of the text. The final test of such a book can only be applied under conditions of 'active service' in the laboratory, but from a preliminary inspection it appears likely that this test will be passed with credit, to the mutual advantage of all those who may be concerned in the enterprise.

Über die Wärme-Leitungsfähigkeit der Metalle. Arbeiten von G. Wiedemann und R. Franz. Herausgegeben von Prof. Dr. Arthur Wehnelt. (Ostwald's Klassiker der exakten Wissenschaften, Nr. 222.) Pp. iii+39. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 2·80 gold marks.

THE first requirement of any theory of the conduction of heat and electricity in metals is that it shall satisfy the law discovered by Wiedemann and Franz in 1853, that metals have the same conductivity for heat and for electricity. Although modern determinations have shown that the law is approximate only, it is most appropriate that the original paper should be republished and made widely available. The editor, Prof. Wehnelt, has added a short life of Prof. Wiedemann and a few notes as to more recent work on the same subject.

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.*]

Discovery of the Function of the Pycnia of the Rust Fungi.

IN a letter to NATURE, published July 23, 1927, I showed, on the basis of experimental evidence, that *Puccinia helianthi* is heterothallic. The results of further experiments now enable me to state definitely that *Puccinia graminis* is also heterothallic. Moreover, since my first letter was written, proof has been obtained that the pycnia (spermogonia) of the Rust Fungi are not, as many botanists have supposed, male conceptacles producing non-functional spermatia, but are active organs having a non-male function which they carry out through the agency of flies. This discovery was made as follows.

In May, 1927, I had a large number of sunflower seedlings, upon the young foliage leaves of which there were many pustules of *Puccinia helianthi*. Each pustule had originated from a single sporidium and had numerous pycnia on its upper surface, and every pycnium had excreted a drop of nectar containing pycnospores. Theoretically, as set forth in my former letter, it seemed reasonable to suppose that the mycelium, pycnia, and pycnospores of some of the pustules were (+) in sex, whereas the mycelium, pycnia, and pycnospores of other pustules were (−) in sex.

On May 17, Prof. A. H. Reginald Buller, of the University of Manitoba, was in the greenhouse of the Dominion Rust Research Laboratory inspecting the experiments in progress. A solitary fly, one of the first to appear after the winter season, had entered the greenhouse. Prof. Buller directed my attention to the fact that the fly was settling on the sunflower leaves, sipping nectar at the pycnia of one pustule and then flying off to another leaf and sipping the nectar of the pycnia of another pustule, and he at once said: "The solution of the problem of the function of the pycnium is an entomological one. Copy the action of the fly. Take (+) pycnospores to (−) pycnia and (−) pycnospores to (+) pycnia, and it may well be that the pycnospores will germinate and bring on the diploid phase of the mycelium, evidence of which will be given by the development of æcia and æciospores on the under side of each pustule." This suggestion has been tested experimentally during the past summer and its excellence has been amply demonstrated. The experiments bearing on the function of the pycnia will now be set forth.

In two sets of experiments with *Puccinia helianthi* on sunflower leaves, pustules of monosporidial origin, each pustule having developed numerous pycnia but no æcia, were treated as follows: in 184 pustules the pycnospore-containing nectar was mixed with the help of a scalpel, the nectar of any one pustule being mixed with nectar of several other pustules; while, as a control, in 174 pustules the nectar of each pustule was stirred up with a scalpel, but not mixed with any other nectar, the scalpel being carefully sterilised before each operation.

Five days after the experiment had begun, the condition of the pustules was as follows: of the 184 mixed pustules 176 had produced æcia, 4 no æcia, and 4 had wilted and died through leaf-injury; of the 174 unmixed pustules only 20 had produced æcia, while 154 were entirely free from æcia. Under normal conditions when the nectar is neither mixed nor stirred, a certain percentage of monosporidial pustules always produces æcia, as already recorded in my first letter. The appearance of æcia in 20 of the unmixed pustules was therefore in agreement with expectation.

From the experiments just recorded it is clear that mixing the pycnospore-containing nectar leads with rapidity and considerable certainty to the development of æcia. While the pycnospores are haploid, the æciospores are diploid. We can therefore also say that mixing the pycnial nectar causes each pustule of monosporidial origin to change from the haploid to the diploid phase.

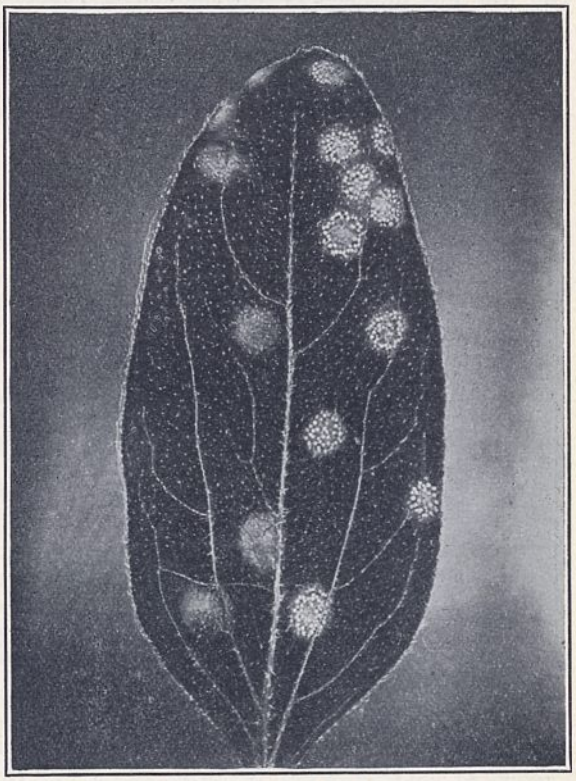

FIG. 1.—Under side of a sunflower leaf. × 1½.

Experiments similar to those just described have been made with *Puccinia graminis* on barberry leaves. In one set of experiments the pycnial nectar of 116 monosporidial pustules was mixed; while, as a control, the pycnial nectar of each of 85 monosporidial pustules was stirred up separately but not mixed with any other nectar.

Six days after the experiment had begun, the condition of the pustules was as follows: of the 116 mixed pustules 102 had produced æcia and 14 no æcia; whereas of the 85 unmixed pustules only 17 had produced æcia, while 68 were free from æcia.

In the experiments with *Puccinia graminis* just described we again have clear evidence of the function of the pycnia; for, when the nectar is mixed, æcia are rapidly formed in most of the pustules, whereas when the nectar is not mixed, most of the pustules do not develop æcia. A certain percentage of unmixed pustules always produces æcia, as in *Puccinia helianthi*.

In Fig. 1 is shown the under side of a sunflower leaf. The leaf was inoculated with sporidia of *Puccinia*

helianthi on July 9. Each pustule originated from a single sporidium and was therefore unisexual. On July 29 the pycnial nectar of the ten pustules on the right side of the leaf was well mixed; while, as a control, the pycnial nectar of each of the six pustules on the left side of the leaf was stirred separately but not mixed. On Aug. 3 the leaf had the appearance shown in Fig. 1, and on Aug. 4 the photograph was taken. This experiment again clearly demonstrates that the pycnia are functional, in that their pycnospore-containing nectar, when transferred from one pustule to another, brings on the diploid phase as shown by the appearance of æcia within five days of the transference.

In Fig. 2 is shown the under side of a barberry leaf. The leaf was inoculated with sporidia of *Puccinia*

FIG. 2.—Under side of a barberry leaf. × 2.

graminis on Aug. 2. Each pustule originated from a single sporidium and was therefore unisexual. Up to Aug. 19 one pustule on the right side of the leaf had produced æcia. On that day, the pycnial nectar of all the pustules on the right side of the leaf was well mixed; while, as a control, the pycnial nectar of each of the eight pustules on the left side of the leaf was stirred separately but not mixed. On Aug. 28 the leaf was photographed and had the appearance shown in Fig. 2. The effect of mixing the pycnial nectar is very evident: æcia appeared on the right side of the leaf where mixing had been effected, but not on the left side where mixing had been avoided.

Proof that flies mix the pycnial nectar of separate unisexual pustules and so cause the pustules to change from the haploid to the diploid phase, as shown by the appearance of æcia, was obtained with *Puccinia helianthi* as follows:

Fifteen to twenty flies were enclosed in a large screen-wire cage with about twelve pots of sunflower seedlings, on the foliage leaves of which there were 98 monosporidial pustules bearing pycnia but no æcia. As a control, flies were kept out of another large screen-wire cage which contained fifteen pots of sunflower seedlings, on the foliage leaves of which there were 159 similar pustules.

Eight days after the beginning of the experiment 96 of the 98 pustules to which flies had had access had produced æcia and only 2 pustules no æcia, whereas only 5 of the 159 pustules to which flies had not had access had produced æcia.

It was found that in *Puccinia helianthi*, and also in *P. graminis*, nectar which had been heated to 70° C. to kill the pycnospores is not effective in inducing the production of æcia when mixed with the nectar of other pycnia on the living leaf. This indicates that it is the pycnospores which are the effective agents in inducing the formation of aecia, and not the nectar.

In a series of experiments with *Puccinia helianthi*, and in another series with *P. graminis*, the pycnial nectar of one monosporidial pustule was removed in a capillary tube and divided into several drops, and then the drops were applied singly to the pycnia of as many pustules as there were drops. In response to this treatment some of the pustules produced æcia and others did not, thus indicating that the pycnospores are of two kinds, (+) and (−). The full details of these experiments will be recorded elsewhere.

It appears that, under natural conditions, there are three ways in which pustules of monosporidial origin may change from the haploid to the diploid condition: (1) by a (+) sporidium and a (−) sporidium settling on a leaf close together, so that they form pustules which coalesce in such a way that the (+) mycelium and the (−) mycelium come into contact directly; (2) by means of flies which carry (+) pycnospores from one isolated pustule to the (−) pycnia of another isolated pustule or, conversely, (−) pycnospores of one isolated pustule to the (+) pycnia of another isolated pustule; and (3) spontaneously. The cause of the spontaneous change of a certain number of the pustules of *Puccinia helianthi* and of *Puccinia graminis* from the haploid to the diploid condition is at present unknown, but the phenomenon finds its parallel among the Hymenomycetes in *Coprinus radians* investigated by Vandendries and in *C. Rostrupianus* investigated by D. E. Newton.

The pycnia attract flies and reward them for their visits in very much the same way as do flowers or the Stinkhorn Fungus. They occur chiefly on the upper side of the leaves, where they are readily accessible to insects; they are usually yellow or red in colour, by which means—and perhaps also by the refraction and reflection of light in the drops of nectar—they are made conspicuous; in some species, *e.g. Puccinia suaveolens*, and possibly in many, they emit an attractive odour; while, finally, the nectar contains sugar, and on this account is sipped by flies with avidity.

It has long been remarked that, in those rust fungi which possess them, the pycnia are the first spore-producing organs to appear. Since they play such an important part in changing the haplophase into the diplophase and in inducing the formation of æcia, their appearance on the mycelium before the æcia can now be readily understood. Pycnia precede æcia, because by pycnial action æcia are formed.

The crossing of two physiological forms of *Puccinia graminis*, etc., might be effected in the following relatively simple manner: obtain monosporidial pustules of both strains and then mix the pycnial nectar of a (+) pustule of one strain with the nectar of a (−) pustule of the other strain, or, conversely, mix the nectar of a (−) pustule of one strain with the nectar of a (+) pustule of the other strain.

In my previous letter to NATURE I stated that, in *Puccinia helianthi*, the æciospores which had appeared in at least some of the æcia of pustules of monosporidial origin are uninucleate. Further cytological experience has convinced me that the apparent

uninucleate condition of these æciospores was due to an artefact. The young æciospores near the spore-bed of every æcium of monosporidial origin that I have investigated more recently have all proved to be binucleate.

In conclusion, I desire to thank Prof. Buller for assisting me with valuable suggestions and helpful criticism.

J. H. CRAIGIE.
The Dominion Rust Research Laboratory,
Winnipeg, Oct. 13.

The Cellulose Space Lattice of Plant Fibres.

Two different types of X-ray diffraction patterns and their interpretations, made from cellulose fibres, have appeared in the literature; one associated with a 'point diagram,' presented by R. O. Herzog,[1] the other, with a 'line diffraction pattern,' by the writer.[2]

Although the two methods used were slightly different, both depend upon 'reflection' of monochromatic X-rays from the uniformly spaced planes of atoms in the fibres, and should therefore be capable of identical interpretation. The data in general are in fair agreement, except in two or three examples where the differences cannot be accounted for by experimental errors. It is the purpose of this communication to direct attention to this lack of agreement, and to point out its effect upon the lattice structure proposed by Herzog.

In the *Journal of Physical Chemistry*, April 1926, pp. 455-467, Herzog discusses a lattice for cellulose which he considers a revision of his earlier work. In the data for this revised lattice there appears a series of interference points which are associated with planes parallel to the c axis of the elementary cell; that is, planes parallel to the long axis of the fibres. In that series particular attention is directed to points A_3 and A_4. The data given below were taken from his Table I., and from them the interplanar spacings d were computed by means of the Bragg formula:

$$n\lambda = 2d \sin \theta,$$

where θ is the glancing angle, and $\lambda = 1{\cdot}54$ A. the K_α wave-length for copper, since the radiation used was from a copper target.

Point.	Sin θ.	d.
A_3	0·17909	4·30 A.
A_4	0·1981	3·89

In the other type of diffraction pattern, as published in the *Journal of General Physiology*, Nov. 1925, pp. 221-233, and May 1926, pp. 677-695, I found no line corresponding to the 4·30 interplanar value for planes which were parallel to the long axis of the fibres. In making these patterns the X-ray beam was passed through a filter to ensure a monochromatic beam of K_α wave-lengths only. When, however, diffraction patterns were made later with the unfiltered radiation, a line which corresponded to the 4·30 value always appeared prominently. Since this interference maximum failed to appear when K_α wave-lengths only were used, and on the other hand always appeared clearly when the beam was a composite of all of its wave-lengths, it was suspected immediately that a single set of planes with strong reflecting powers had produced two interference lines, one from the K_α, the other from the K_β wave-lengths.

[1] Herzog, R. O., "Nature of the Structure of Cellulose and its Significance in Chemical Transformations," *Jour. Phys. Chem.*, **30**-4, 455-467; April 1926.

[2] Sponsler, O. L., "Molecular Structure of Plant Fibres determined by X-ray," *Jour. Gen. Physiol.*, **9**-2, 211-233; 1925: **11**-5, 677-695; 1926.

Calculation shows that the point A_3 might have been produced by the K_β wave-lengths from the very strong 3·89 planes;

Point.	Sin θ.	K_α $\lambda = 1{\cdot}54$ A.	K_β $\lambda = 1{\cdot}39$ A.
A_3	0·17909	4·30	3·89
A_4	0·1981	3·89	

and since no line was found corresponding to the A_3 point when the K_β wave-lengths were filtered out of the beam, one must conclude that Herzog failed to recognise the K_β origin of the A_3 point and gave it the 4·30 value as though it were of K_α origin. That value, therefore, should be discarded from the data.

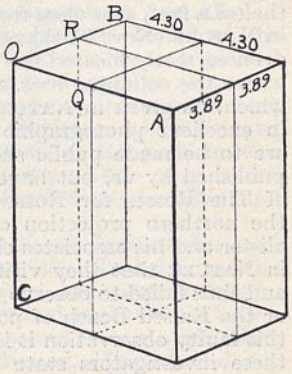

FIG. 1.

Attention was directed to a similar use of a K_β interference point (NATURE, Aug. 15, 1925, p. 243) in the original data of Herzog and Janeke which was published in *Zeitsch. für Physik*, **3**-3, 196-198, 1920, and in which incidentally this 4·30 value does not appear. That value apparently had been discarded at that time as of K_β origin.

When, however, one attempts to discard the 4·30 value now, a new importance is found placed upon it. The dimensions for the axes of the revised elementary cell as proposed by Herzog are given as $a : b : c = 8{\cdot}60 : 7{\cdot}78 : 10{\cdot}22$. This elementary cell may be represented by Fig. 1, where

$$OA = a = 8{\cdot}60 = 2 \times 4{\cdot}30$$
$$OB = b = 7{\cdot}78 = 2 \times 3{\cdot}89.$$

The two planes passing through Q and A respectively and parallel to the plane OBC are considered as being separated by the 4·30 distances, OQ and QA. Likewise OR and RB are the 3·89 distances. That the a axis is directly associated with the 4·30 value and the b axis with the 3·89 value is definitely fixed by the indices (200) and (020) respectively, given in his Table II.

It seems, then, that the values used for the a axis and the b axis of the elementary cell proposed were both produced by the same set of planes, and when the 4·30 value is discarded, as it seems evident that it must be, the axial dimensions proposed by Herzog lose their significance, and therefore a number of conclusions must be discarded. (1) That four anhydro-glucose units are contained in the elementary cell is now of course without foundation. (2) The assumptions that certain interference maxima are produced by impurities in the fibre, or that there are two types of carbohydrates embodied in the cellulose of the fibre, are now also without adequate basis. (3) The correspondence between the 4·30 value and a certain interference maximum obtained from mercerised cellulose likewise now has no significance. These conclusions at least must be discarded if the only basis for them lies in the elementary cell as suggested by Herzog. A lattice based upon the 'line diffraction patterns' seems to be in better agreement with the properties of the fibres, both physical and chemical. This structure is discussed in detail by Sponsler and Dore in "Colloid Symposium," Monograph 4, pp. 174-202, 1926, and in the papers mentioned above.

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University of California at Los Angeles.

The Lower Palæolithic Implements of Sligo.

WHEN we published in NATURE an account of the discovery of Lower Palæolithic Implements in Ireland, we expected that the announcement would give rise to a certain amount of disturbance among the more old-fashioned archæologists of that country, but we did not contemplate, or believe it possible, that this announcement would result in the appearance (NATURE, Nov. 5, pp. 652-3) of such a series of statements as that to which Prof. Macalister and his associates have been so unwise as to append their signatures. Incredible as it may appear, it is nevertheless a fact, as is clear from the particulars published in NATURE (Nov. 5), that these investigators have not even correctly located the site at Rosses Point, Sligo, where the collapsed rock shelter exists, the details of which, as given in NATURE (Aug. 20), are preserved in excellent photographic and other records, which are to be made public shortly in the memoir to be published by us, but have mistaken the promontory of The Rosses for Rosses Point, which constitutes the northern projection of the former. Prof. Macalister and his associates clearly indicate in their note in NATURE that they visited this spot unknowingly, and thus failed to observe the collapsed rock shelter—or the Raised Beach of powdered shells. In view of this faulty observation it is not surprising to find that these investigators state that "there is no Raised Beach . . . in the district." This claim, however, is in direct opposition to the opinion expressed in the Geological Survey Memoir, "The Counties of Sligo and Leitrim," p. 27.

Prof. Macalister and his associates are clearly, therefore, engaged in the abortive task of attempting to criticise a site which has not been dealt with by us. When they were confronted with the fact of the discovery of palæolithic implements in (*a*) a rock-shelter, and (*b*) Boulder Clay in Sligo, the only course they could take in order to support the ancient order of archæology was quite obvious. All they imagined must be done was to deny that the rock-shelter is ancient, and that the specimens found in it, and in the Boulder Clay, are humanly flaked. It is true that these are matters open to discussion, but we have confidence that competent archæologists, not unscientifically determined to deny the presence of palæolithic implements in Ireland, will give little heed to the arguments and assertions of Prof. Macalister and his associates. In fact, all those with the requisite knowledge enabling them to give a judgment of value upon the matter have, without one exception, at once accepted the Sligo specimens as of human origin.

As an example of the confusion of thought of our opponents, it may be pointed out that in neither of our notes to NATURE did we refer to the Mousterian culture as of Early Palæolithic age. Yet we are informed that such a relegation is untenable. We fail, also, to appreciate the relevance, or importance, of the statement that Mousterian artefacts are not as a rule of impressive size. Do our critics wish to suggest that this prevents the Sligo specimens from being regarded as of this age, and further, do they claim that the examples of very large implements from High Lodge, Suffolk, and other places, including Le Moustier itself, are also barred from a Mousterian status? As for the assertion that the change of colour produced on the surfaces of stones by weathering is not to be described as 'patination,' this is a dogmatic claim—unsupported, as are most of the statements contained in the note under discussion, by any evidence.

It is not for us to explain why the palæolithic people of Sligo chose to flake limestone into implements, or to give reasons why the efforts of Prof. Macalister and his associates failed to produce a conchoidal fracture in this material. But the fact remains that the ancient people did both these things, not once but many times, as may be seen by an examination of the material collected in Sligo, and exhibited at the rooms of the Society of Antiquaries of London until Dec. 6.

We, of course, regret that our critics failed to find any artefacts when visiting the Sligo coast, but this is possible of explanation on two grounds: either that the previous searching was so thorough as to leave nothing to be found, or—as is more probable—because Prof. Macalister and his associates did not know what to look for and preserve. It is not necessary for any demonstration to be given of the manner in which the Sligo specimens were flaked, as a study of these by anyone familiar with the flaking of stone will show clearly, and beyond any question, that the method described in NATURE (Sept. 24) was indeed carried out in ancient times. Further, it is to be doubted—even if such a demonstration were given—whether Prof. Macalister and his associates would understand it. They are evidently unfamiliar with the Mousterian technique by means of which Levallois flake-implements were detached from prepared cores. The Sligo method—with two minor differences—is absolutely true to type, yet our critics describe it as 'complex.' This it may appear to them, but it is otherwise with archæologists who have made a study of these matters.

Prof. Macalister and his associates, with a thoroughgoing disregard of ordinary scientific procedure which would have necessitated an examination of the Sligo specimens before passing judgment upon them, nevertheless do not shrink from inferring, in the columns of NATURE, that they are of natural origin. On the other hand, their supporter, Mr. Warren, regards the same specimens, with the exception of those found in Boulder Clay at Ballyconnell, as made by man. This, to say the least, is unfortunate, especially in view of the inherently bad case which our critics have to defend. Lastly, we may direct attention to Mr. Warren's statement that, apropos of the Sligo material, there is "no passable resemblance in any one of these flakings to any form of prehistoric implement, either palæolithic or neolithic." This strange claim is indeed a classic example of the truth of the saying that given sufficient rope, certain people are bound to hang themselves. Anyone interested in this matter who has visited the exhibition of the Sligo specimens at Burlington House will, we have no doubt, agree with us that Mr. Warren, together with Prof. Macalister and his associates, have suspended themselves in a very thorough and fatal manner.

J. REID MOIR.

One House, Ipswich,
Nov. 8.

J. P. T. BURCHELL.

Manoilow's Blood-test for Sex.

IN NATURE of Nov. 5, Mr. Perkins makes a valuable contribution to the study of chemical manifestations associated with sex, but he gives an erroneous impression of Dr. Manoilow's work on sex-identification by blood-tests in two respects. (As I am in possession of a recent review of this work by Manoilow himself, which it is hoped to publish soon, I am able to correct these wrong impressions.) In the first place, the workers mentioned by Perkins are mostly disciples, who have merely either applied

Manoilow's technique to some additional organisms, or have attempted to reduce the complicated reaction evolved by Manoilow to a simpler one. In the second place, Manoilow worked for some years on the serum of "cows and oxen, horses, cocks and hens," as well as man, before he published (*Wratchebnaia Gazeta* (*Medical Journal*), 15, 21-22; 1923) the earlier accounts of his work on the identification of sex in man and other animals by a biological reaction of the blood.

In discussing the results of applying his test, Manoilow shows that although in some categories of individuals—as those furnishing samples of blood from venereal clinics—he was able to determine sex accurately in 100 per cent. of cases, in others the percentage of accurate determinations was less than 100, but in the latter instances the degree of accuracy is high, and mostly significant. It is clear, therefore, that Manoilow has discovered a series of phenomena of fundamental importance in the study of sex, whether his test be infallible or not. The word discovery is used advisedly, because the problem was attacked deliberately. Whether this reaction be found eventually to define particular sex-attributes or sex-products, or only a particular metabolic condition closely associated with sex, we are indebted to Manoilow for opening up this avenue of research, the vista of which beckons with the promise of great results in the future.

Now the reaction as evolved by Manoilow is not only delicate, as Perkins points out, but also intricate, and it is doubtful whether any worker would attain to the original researcher's standard of success in its use, without both meticulous attention to the detail of the test, and considerable experience in applying it. It is the object of the account mentioned above to present to English workers full details of the test.

At about the time Manoilow succeeded with his test for sex, it was suggested independently in NATURE (vol. 111, p. 879; 1923) that a chemical test for sex might be found to be possible in invertebrates, because of the common occurrence of a difference in colour of the pigments in the gonad of males and females of the same species. Thus the underlying idea of this suggestion was not that a universal test might be found for sex, but rather that specific chemical tests might be devised for differentiating sex in given species. It would seem that the basis of this latter idea might be usefully incorporated in the evolution of the Manoilow and similar tests. It is possible that a slight variation in the technique of the reaction in each species might give constant differential results correlated with the two pure positive sex-conditions, for the primary object of the test is the infallible determination of pure males and pure females.

J. H. ORTON.

Marine Biological Laboratory,
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Parental Care in the Cichlid Fishes of the Victoria Nyanza.

ACCORDING to various natives from different places on the shore of the Victoria Nyanza, many of the lake fishes (all except the silurids, according to one fisherman) carry their fry in their mouths. One variation of the story makes the eggs pass internally from the ovary to the pharynx: in another the eggs or fry are gathered up from the nest in case of danger.

The account was received with almost the same caution accorded to the story of the monstrous serpent of the lake, but it has been found to apply to several cichlids.

Eggs have been found in the mouths of *Haplochromis macrodon* (at Kisumu from a small native papyrus seine on Aug. 17) and *H. nubilus* (at Bukoba from a cast-net on Sept. 7). Newly hatched young were found in the mouth of one specimen of *H. nubilus* taken in a cast-net at Bukoba on Sept. 6. Two specimens each with young advanced beyond the stage of complete absorption of the yolk-sac were taken in the same manner on Sept. 6 and 7. One *Tilapia variabilis* taken from a large native papyrus seine at the mouth of the Kibos River near Kisumu on Aug. 14 had young in its mouth with the yolk-sac almost completely absorbed. Advanced young were taken from *H. crassilabris* at Kisumu on Aug. 17.

One haul with a seine on Rusinga Island at the mouth of the Kavirondo Gulf on Sept. 1 yielded 19 cichlids. Seven of these had eggs or young in their mouths. These were placed in an aquarium, and included various stages from eggs which hatched within an hour to young in which the yolk-sac was completely absorbed. The seven fish were: one *Macropleurodus bicolor*, five *Haplochromis nubilus*, and one *H. ishmaeli*.

On Aug. 24 one *H. ishmaeli* was kept alive of two taken with young in the mouth. This fish and its fry were placed in an aquarium, and towards evening it was observed that the fry had gathered up into a fairly dense shoal near the parent's mouth and their apparent number had decreased. Parent and fry died shortly afterwards.

In all cases the parent concerned was the female.

The Tilapia parent and young were kept in a vessel for one week. Although the fish was not supplied with food, the young were not eaten, which is not in keeping with a theory that the fish taken with small fish in the mouth were caught in the act of eating them.

In several cases the mouth of the mother was packed quite full of eggs or young, so that the soft part of the lower jaw was noticeably distended.

The nomenclature used herein is after Tate Regan (*Proc. Zoo. Soc.*, 1922).

MICHAEL GRAHAM.

Fishing Survey of Lake Victoria,
Kisumu, Kenya Colony,
Sept. 16.

Application of the Interference Method to the Determination of the Surface Area of Metallic Nickel Films.

WITH the quantitative establishment of the interference theory of the production of colours on metallic copper (*Proc. Roy. Soc.*, A, vol. 115, p. 570; 1927) and its application to the study of the sintering of reduced copper films by heat treatment (*Jour. Chem. Soc.*, July, p. 1597; 1927) the behaviour of nickel films becomes of increasing interest. Spectrophotometric observations on the growth of oxide films on nickel showed again that interference was the primary cause of the colours developed during oxidation, and hence the same method is applicable to the study of nickel films. Moreover, the dispersion shown by nickelous oxide is very much smaller than that shown by copper oxide.

Taking advantage of the indifference of metallic nickel to carbon at low temperatures (Ni_2C seems to be formed at 2100° C., but rapidly dissociates at lower temperatures) the nickel was electrolytically deposited on china clay coated with graphite. The nickel film was activated by oxidation in air and reduction by hydrogen at 520° C., and the conductivity of the film was plotted against the equivalent air thickness corresponding to the colour shown

by the partially oxidised rod. From the slope of the straight line so obtained the surface area per unit mass may be calculated.

Let M be the mass of the nickel being oxidised, and S be its surface area,
c be the initial conductivity of the metal,
t be the thickness of the oxide film when the initial conductivity has fallen by Δc, and
μ be the refractive index of the oxide for middle of the absorption or reflection band in the spectrum of the film.

Then

$$\frac{S}{M} = \frac{74{\cdot}7}{6{\cdot}4 \times 58{\cdot}7} \cdot \frac{\mu \cdot \Delta c}{c \cdot t}.$$

For the electrolytic metal the preliminary results gave $3{\cdot}94 \times 10^3$ sq. cm. per gram; on activation by alternate oxidation and reduction at 520° C., the value fell to $3{\cdot}10 \times 10^3$; this catalyst was oxidised and reduced at 400° C. On re-oxidation at 400° C. the active portion of the surface, which oxidised very easily, had the increased area of $1{\cdot}4 \times 10^4$ sq. cm. per gram. The area of the supporting material was $2{\cdot}14 \times 10^3$ sq. cm. per gram of nickel, showing that the surface of electrolytic nickel is 1·84 times the apparent area, and that the apparent surface may be increased considerably by reduction at 400° C.

F. HURN CONSTABLE.

St. John's College,
Cambridge.

Thermal Degeneration of the X-ray Haloes in Liquids.

THE theory of X-ray diffraction in fluids put forward some years ago by the writer with Dr. Ramanathan (*Proc. Ind. Assoc. Cult. of Science*, vol. 8, pp. 127-162; 1923) indicates that the diffraction halo exhibited by liquids under ordinary conditions should be strikingly modified by rise of temperature. As explained in that paper, it follows from thermodynamic considerations that at ordinary temperatures the molecules of a liquid are ordered in space with a high degree of regularity, and the comparative sharpness of the X-ray halo at such temperatures is a consequence of this fact. With rise of temperature, however, the molecules are thrown into increasing disarray, as is shown by the considerably enhanced scattering power of the liquid for ordinary light. Accordingly, we should expect the X-ray halo to become more diffuse and faint; it should also contract to some extent, owing to the diminished density and consequent increase of the mean distance between neighbouring molecules. Vice versa, if the liquid is supercooled until it congeals into a glassy solid, we should expect the halo to become sharper and brighter, and at the same time to dilate somewhat.

These consequences of the theory as well as the influence of the asymmetrical shape of the molecules on the structure of the X-ray haloes, were set out clearly in the paper, though at the time it was written no experimental evidence could be adduced in support. It is satisfactory to note that an examination of the subject undertaken by Dr. N. K. Sethi and Mr. S. S. Ramasubramanian in the writer's laboratory has shown the predicted degeneration of the diffraction halo with the rise of temperature to be an experimental fact. There is found, as expected, a progressive change of the halo from a comparatively sharp and bright ring in the amorphous solid at low temperatures to a fainter and more diffuse aureole in the liquid state at high temperatures. C. V. RAMAN.

210 Bow Bazar Street,
Calcutta, Oct. 16.

Solution of the Equation $\sin\theta/\theta = c$.

A MUCH simpler solution of the above equation than that given by Mr. V. Naylor in NATURE of Oct. 1 may be derived by expanding the expression on the left into a series of ascending powers of θ, and transferring the higher terms by successive approximations to the other side as terms in powers of d, where $d = 1 - c$. The solution so obtained is:

$$\theta = \sqrt{6(d + 0{\cdot}3d^2 + 0{\cdot}137d^2 + \ldots)}$$

This expression is so convergent that the second term does not affect the value of θ by half a second for values of θ up to 2°·6, the third up to 15°, and higher terms only affect the result for angles more than 30°. For small angles, or for a fair approximation with larger angles, we may simply write the solution $\theta = \sqrt{6d}$, or for θ in degrees, $140°{\cdot}345\sqrt{d}$. If c be very near unity, the complement has fewer significant figures than the reciprocal, while the terms in d^2 and d^3, when required, are so small that they can be worked by slide rule or three- or four- figure logarithms for adding to d. A. E. LEVIN.

1 Denbridge Road,
Bickley, Kent, Oct. 8.

Viscosity of Metals: Bismuth.

SINCE publishing the concluding part of my investigations on the viscosities of metals (*Phil. Mag.*, April 1927, Supp.) I have come across the following data for bismuth—a metal I could not procure in the form of a wire. In an attempt to study, for a different purpose, the elastic properties of pure bismuth wires prepared from electrolytically deposited metal, J. E. Harris (*Phys. Rev.*, First Series, **35**, pp. 95-119) tabulated the values of log. dec. for different amplitudes for a wire of length 106 cm.; diam., 0·25 mm.; period, 10·498 sec.; moment of inertia of the solid, 133 gm. cm.^{2}; which on extrapolating for zero amplitude give $\lambda_0 = 0{\cdot}00978$. These results give for the coefficient of viscosity of bismuth, at 23°·7 C., $13{\cdot}71 \times 10^8$ poises—a value quite in a line with others obtained by me with thirteen metals and seven alloys.

As these experiments were not conducted in an air-free chamber the above result for bismuth is, however, likely to be slightly higher. G. SUBRAHMANIAM.

Vizianagaram,
S. India, Sept. 1.

The Temperature Variation of the Elasticity of Rochelle Salt.

MR. R. MORGAN DAVIES'S letter on this subject in NATURE of Sept. 3, recalls at once the analogy between piezo-electric phenomena and the reciprocal relations between strain and magnetic properties shown by ferromagnetic metals.

In particular, there is a stationary value in the Young's modulus—temperature curve for nickel at about 400° C., the Curie point for that material (*Proc. Phys. Soc.*, London, vol. 27, Dec. 15, 1914).

A close examination of the temperature variation of the thermal expansion of a piezo-electric crystal would be expected to reveal a discontinuity at the temperature of abrupt change in the piezo-electric modulus which, if present, would be analogous to that found by the writer in the thermal expansion of nickel (*Phil. Mag.*, June 1904), and confirmed by Colby (*Phys. Rev.*, **30**, pp. 506-521; April 1910).

E. P. HARRISON.

H.M.S. *Vernon*,
Portsmouth, Oct. 19.

The Empire Mining and Metallurgical Congress in Canada.[1]

AT the Second (Triennial) Empire Mining and Metallurgical Congress, opened on Aug. 20, at Montreal, then continued across Canada to the Pacific, and eventually ended at Quebec on Sept. 26, the underlying motif was the question of mineral resources.

At the opening session a resolution that the question of a review of the mineral resources and industries of each administrative unit throughout the Empire be transmitted for consideration and report, respectively, to the individual societies represented on the Empire Council, was adopted unanimously, after discussion and support by representatives from Australia, South Africa, India, the Crown Colonies, and the home country; while at the final meeting of that Council at Quebec a recommendation was adopted that for the co-ordination of such reports the Council should appeal for financial support and then set up an executive commensurate with the support forthcoming.

Canada, which through its governments and its mining industries had so largely borne the expense of organising this Congress, contributed to the question an exposition and display of her own wonderful mineral resources. Abundant brochures and booklets had been prepared and were distributed by the Department of Mines, the development department of the Canadian Pacific Railway, and the Canadian banks. In these the position was presented that the present mineral resources of Canada were responsible for that country standing third among the nations of the world, and second within the Empire, as a producer of gold; for Canada supplying something like ninety per cent. of the world's nickel, seventy-five per cent. of the asbestos; and something like ten per cent. respectively of the world's lead and zinc; and if the British Empire produced but a small percentage of the world's copper, Canada at least was the greatest producer and possessed the greatest copper mine within the Empire. All this with but half a per cent. of the world's population!

Present production is, of course, not necessarily a safe guide to mineral resources, these depending upon the unworked reserves. But the rapid rate of increase in Canada's mineral production, instanced by an increase from a value of sixteen million sterling in 1906 to fifty million sterling in 1926, is sufficient evidence that the extent to which the resources have hitherto been depleted by production has been more than made good, as we know it has, by both flattering developments of the known deposits and by new discoveries. Canada, indeed, has this century been the country of new discoveries: the silver field at Cobalt, Ontario, was discovered in 1902; the goldfield at Porcupine, Ontario, now containing the second largest gold mine in the world, in 1906; the relatively richer Kirkland Lake goldfield, Ontario, in 1912; while the promising gold-copper deposits at Rouyn, Quebec, were discovered in the present decade. It is therefore safe to say that Canada's mineral production and reserves will continue to increase, and that where exhaustion may loom in some older mineral countries, buoyancy reigns in this country of all variety of geological formation and all vastness of unexplored extent.

All the foregoing districts were visited, and in addition such older established fields as the Sudbury copper-nickel field, Ontario; the asbestos areas at Thetford and Black Lake, Quebec; the Sullivan lead-zinc mine, the Britannia copper mill and the Mountain-Copper mine, British Columbia; the Saskatchewan lignites; and the Alberta coalfields. For lack of time the important Portland Canal district in north-west British Columbia, and other less important districts, could not be visited. Everywhere opportunity was provided to observe geological occurrence, mining method, mechanical treatment, and metallurgical treatment; and in the end the visitors had a good general idea of the importance and outlook of each district.

Structural geology and regional petrography being all-important in the consideration of mineral deposits, no proper appreciation of the mineral resources of Canada is possible without some knowledge of the great natural petrographic provinces into which the Dominion may be divided. There is first the great pre-Cambrian area of hard ice-levelled outcrops which, sweeping widely around Hudson Bay, embraces entire Quebec; Ontario in far greatest part, crossing into the United States; the northern three-quarters of Manitoba and the northern half of Saskatchewan; the north-eastern corner of Alberta; a large portion of the North-West Territories; and altogether more than one-half the superficies of Canada. In this ancient country-rock, otherwise sterile and forbidding, and within the relatively small area explored, occur among others the productive Sudbury, Cobalt, Porcupine, Rouyn, and Flin-Flon deposits, that is to say, deposits respectively of copper-nickel, silver, gold, gold-copper, and copper-zinc. In this area also, in addition to the smelters in the Sudbury district, are the Port Colborne refinery on Lake Ontario, the smelter and refinery at Deloro, and the Hamilton Works of the Steel Company of Canada.

Next in mineral importance comes the Pacific Highland of British Columbia embracing the Rockies and the Coast Ranges, where tilted and folded sedimentaries ranging from pre-Cambrian to Tertiary, alternate with intrusives and volcanics. In this scenic realm occur among others the Premier gold-silver mine and the Hidden Creek copper mine to the north-west, the Britannia copper mine on the Howe Sound to the south, and the Sullivan lead-zinc mine in the Boundary District. Here also are the famous Trail smelter and refinery and the Anyox smelter. Between these two great metalliferous provinces come the Great Plains which, embracing the remainder of Manitoba, Saskatchewan, and Alberta, certain coal and lignite, oil and bituminous sand, building stone and other non-metalliferous minerals, representing a mineral wealth and reserve

[1] The constitution and *raison d'être* of this Congress were outlined in NATURE of Aug. 13.

second only to the riches of their fertile soil. Finally, to the east come two smaller divisions, the Atlantic Provinces and the St. Lawrence Lowlands, where occur asbestos, coal, oil, shales, gypsum, and other non-metalliferous minerals.

Physiographically, half of great Canada is rocky, one quarter is covered by thick and valuable forests, somewhat less than a quarter by rich fertile soil, while the remainder is occupied by lakes or buried under moss. The agricultural and lumber industries take precedence of the mineral industry, both in their greater value and in their longer establishment. The mineral industry, started later, now challenges this precedence and, making valuable the rocky and inhospitable places of the Dominion, has earned the sympathetic consideration of the Government.

In the matter of prospecting this consideration almost becomes co-operation. The mineral discoveries in the past have largely been fortuitous and in Ontario largely in process of railway construction. But to-day geology helps. Dominion and Provincial geologists are early in the field anxious and ready to point the way to areas where rocks and structural conditions are favourable to discovery in new fields or to recurrence in known fields. Indicative of the importance which the Government attaches to the geological study of mineral deposits, Dominion geologists accompanied the Congress throughout, while Provincial geologists were detailed to be of service in their particular areas. Instrumental or geophysical prospecting plays little part, dependence being placed upon the close observation of surface indications and the intensive examination of available exposures.

All types of ore deposit are represented, some here, others there, magnetic segregations, replacements, fissure fillings, disseminations, steep lodes, flat beds, stepped lenses, irregular masses. There are also all variations in relation to dependence on proximity to the surface, from pronounced secondary enrichment as in the upper levels of the Premier gold-silver mine in British Columbia, to absence of all signs of secondary enrichment as in the pre-Cambrian area, where any such effect of weathering has long since been removed by glaciation. Surface discoveries in this latter area have accordingly this greater importance that they represent primary ore which is as likely to increase in value with departure from the point of discovery as to decrease, and in general character is not likely to vary. They have also this further importance that being in rock which, though now at the surface, was nevertheless under pressure of depth at the time of their formation, further development in depth is as likely to disclose an increase in size as a decrease, no further consolidation having to be expected. In this area it has been the repeated experience that the surface or shallow indications did not do justice to the value and size afterwards disclosed; indeed some valuable ore bodies developed underground were not even represented at the surface.

In the testing and development of discoveries, not only do shaft sinking and tunnel driving proceed apace, but diamond drilling even more so. So flattering have recent developments been on particular discoveries that early results are everywhere now regarded as an urgent necessity, as witness the fact that recently a diamond drill was despatched to a prospect in Central Manitoba by aeroplane. Nor does such drilling necessarily slacken when a sufficient mining equipment is functioning and underground levels and roads are rapidly opening out; at appointed intervals to right and left and underneath the drill keeps in advance, defining the limits of the known ore-bodies and probing for others. In this way mineral reserves become indicated before being actually developed and a proper scale of operations is projected at an earlier date.

With regard to mining methods, Canadian mining is not yet very deep, the deepest shaft being one just over 4000 feet in the Porcupine district; nor by reason of many workings close together have special methods had to be devised to meet the pressure of heavy ground; standard methods are in use everywhere. Shaft mines are represented by general practice in the pre-Cambrian area where the deposits stand steeply and where sufficient mass can rarely be recovered from open pits; they are represented also in the shallow coal and lignite fields of the Great Plains. Tunnel mines worked from the hillside are the feature of the Pacific Highlands. Among these, deserving of especial mention is the Sullivan lead-zinc mine in the Boundary district which works a flatly inclined massive sulphide bed, in places of immense size. Here the present mining method is to support the roof, leaving regular mineral pillars, the intervening excavations being as large as the strength and solidity of the roof allows. Actually some of the resultant excavations are so large that their limits could only be made visible by searchlights, and climbing within them from one level to another gave at times the impression of mountain climbing at night. In these Highlands and adjacent country the coal seams, being contorted and folded, are worked from the hillside. Openpit mining is represented by the asbestos mines in Quebec, where the pits, and equally the resultant dumps, are of staggering proportions; by the Copper Mountain mine in south-east British Columbia; and by the mining of some thick and shallow coal beds in Alberta.

In the beneficiation of the material mined, that is, in the milling processes preparatory to metallurgical treatment and in the metallurgical processes themselves, Canada has much to show.

In milling practice most impressive and convincing was the separation by differential flotation of lead and zinc sulphides from one another, and both from the worthless portion of the complex fine-grained ore at the Sullivan mine. With the first successful introduction of the flotation process in 1910, this property, which had been lying in abeyance for lack of any suitable treatment, became once again of interest; now, with the further development of that process to differentiate between sulphide and sulphide, it has become one of the most profitable lead-zinc mines in the world.

The mill there is a triumph of applied science. Arriving at the mill head, the ore is mechanically crushed, conveyed, weighed, sampled, and ground to pulp with water. This pulp is then churned and infused with air, while reagents are added. These reagents, though added in such infinitesimal quantity as only to contaminate, are of such potency that when the first is added the lead sulphide floats in the resultant froth, and the zinc sulphide afterwards with the second, the stony material sinking to be discarded. Broken down with water these froths separately are settled and filtered, the relatively dry sulphides dropping on to conveyors to be carried to railroad wagons waiting at the tail end, sampling taking place on the way. Hundreds of tons a day of each sulphide and a thousand tons together are thus recovered, with no man handling the material.

Scarcely less fascinating but not so modern is the recovery of asbestos fibre from its serpentine matrix. First comes again the effective release of the valuable material by appropriate comminution, the last stage being here by an impact blow in air. The effect of this comminution is that while the serpentine is reduced to granular powder the asbestos fibre is teased into light fluffy masses. Passing this mixture under stationary vacuum cleaners the fluffy asbestos is sucked up and away while the worthless granular material passes on, eventually to reach the dump waste.

Pure metallurgical practice in Canada is even more impressive. Pyrometallurgy is represented by roasting, matte-smelting, and converting, in the well-established production of nickel metal and matte and blister copper at Sudbury, Ontario; in the grand-scale beneficiation of lead and copper at Trail, British Columbia; and in the hopeful erection stage for the production of gold-copper matte at Rouyn, Quebec. Fire also effects the final melting and casting of fascinating yellow gold at Porcupine; of shining white silver at Cobalt; of resplendent red copper, of dull white lead, and of crystalline white zinc at Trail; and of hard white nickel at Sudbury.

It is nevertheless in electro-metallurgy that Canada secures pride of place, taking advantage of abundant current generated by cheap water power. At the Trail smelter, fire for roasting, solvents for dissolving, current for deposition, and fire again for melting, is the sequence by which 280 tons of refined zinc bars are produced each day, the only other comparable electrolytic zinc plants in the world being at Great Falls, Montana, and at Risdon, Tasmania, these being smaller. Here also 400 tons of electrolytically refined lead and 60 tons of refined copper are produced daily, together with about 20,000 ounces of silver and 100 ounces of gold gathered from the electrolytic cells. The long extended halls in which the thousands of depositing boxes necessary for these tonnages are accommodated are impressive in their immense size and in their attendant equipment, travelling cranes sweeping overhead to bring in the heavy anodes and to withdraw the loaded cathodes, and ground trams for the transport of lighter units.

At Trail, in the production of the refined tonnages mentioned above, all modern metallurgical operations and all modern metallurgical appliances are represented, and the whole complex becomes the largest non-ferrous metallurgical works in the world, electrolytic refining being its special feature.

Hydro-metallurgy is represented at Porcupine and at Kirkland Lake, more purely perhaps in the latter district. There is nothing new in the procedure. But the ordered design and simple lay-out manifest the assurance which came from knowledge of the problem. Dull, uninteresting-looking ore enters at one corner of the building while fascinating gold bars leave at a far corner, with no apparent connexion between the two. But there it was, the trained man's capacity and intelligence!

The heart of one and all of these vigorous mineral enterprises is at the office and laboratory. The knowledge of which use is made comes from all over the world. Mineral resources are not to be measured only in terms of the earth's physical endowment, but also in terms of the vigor and intelligence with which they are sought and turned to account. In this matter Canada is worthy of her sons, while they in turn are blessed in her mineral fertility.

The Empire as a unit produces something like a quarter of the world's mineral output, lacking in but few mineral or metal commodities. The mother country of itself contributes practically nothing to the output of the non-ferrous major base metals, or to that of the precious metals. Yet in her sons, by research, experiment, and invention, she has contributed worthily, to wit: the Bessemer process which, originally revolutionising steel making, is now an important factor in the beneficiation of copper, nickel, and associated precious metals; the Macarthur-Forrest cyanide process for the recovery of gold and silver, which revolutionised precious metal mining; and, finally, the impulse through Elmore, Sulman, Picard, and others, to the present perfection of the flotation process by which the base metal mining industry has been equally revolutionised and mankind benefited.

A further contribution of the mother country to the mineral industry has been that of capital. In South Africa, Australia, India, and in Canada, British capital from the mother country has been of use, in large measure profitably to those supplying it. It is Canada's hope that one result of this Congress may be that more of such British capital may be forthcoming for the development of her resources, to the particular advantage of those venturing it and to the advantage of the Empire as a whole. Capital is particularly wanted for the initial stages, the testing and development of discoveries. British capitalists considering to take an interest in Canadian mining must accept the position that Canadians believe in, and by recent experience are justified in believing in, the great mineral possibilities of their country, and that they apply this belief to each individual mine and discovery; boldness with discrimination is therefore required. On the other hand, such capitalists may assure themselves that the Canadian public is itself

willing and anxious to share in mining risks. The government is good and stable, and sympathetic to pioneer effort, readily making roads and railroads. The country abounds in cheap power, in water, and in timber; and labour is plentiful and efficient.

The Canadian mineral industry will continue to develop. Capital will be attracted, and the desire of Canadians that more of that capital shall be British is both real and honest, springing from the fact that, sharing them, they admire British ideals and British institutions, and highly value the British connexion. Though much has been done in opening out Canada, Canadians realise that much more remains to be done and some things to improve, and they would have this further development conducted so far as possible in harmony with British ideals.

On their side the British visitors, from wherever they came, were moved by the warmth of their reception everywhere, and stirred to admiration by the monuments of Canadian construction and enterprise. In the fellow-feeling and confidence therefrom engendered lies the gain to Canada. The gain to the visitors lies in having seen what has been accomplished in Canada.

Lest it should appear that the Imperial note has been stressed unduly, the following concluding paragraph of the report on the Congress by the representative of the *Engineering and Mining Journal* of New York may be quoted. "I was not part of the Congress—merely an onlooker, a correspondent, reporting what I saw and heard. I am not even British, and this has been a British party. Nevertheless I was accorded every privilege and every consideration, wherever we went. Collectively, and individually, I have never seen a more interesting, sociable, and friendly group of people. Possibly one reason for this is the fact that mining is distinctly a world-wide industry and that mining people have much in common no matter whence they come; but behind that is probably the simple fact that they are British." S. J. TRUSCOTT.

Directional Wireless as an Aid to Navigation.

By Dr. R. L. SMITH-ROSE.

AFTER several years of struggle with a rather conservative race of navigators, the wireless engineer and scientist are becoming successful in the application of directive wireless transmission or reception to both aerial and marine navigation; and it can now be said with some confidence that in a very few years time the wireless direction-finder, or some alternative means of navigation by wireless, will be considered as essential as a compass on board every ship of any importance. Already a considerable number of ships of all nationalities, with those of Great Britain leading the way, are fitted with a direction-finder, an instrument which enables a ship to take bearings on wireless transmitting stations and to fix its position with some accuracy at times when all other navigational methods fail.

The application of wireless transmission as an aid to navigation is conveniently divisible into two parts according as the directive characteristic is applied at the transmitting or the receiving end of the wireless link. Although both forms are probably of about the same age, the directive receiver has developed the more rapidly and will thus be considered first.

THE DIRECTIONAL RECEIVER OR DIRECTION-FINDER.

Stated briefly, the fundamental principle of the wireless direction-finder is the rotation about a vertical axis of a plane vertical loop or its equivalent in space. The electro-motive force induced in such a loop by an arriving stream of electro-magnetic waves is proportional to the cosine of the angle between the plane of the loop and the direction of the waves. Thus as the loop is rotated about its vertical axis the strength of the received signal varies from a maximum to a minimum or zero, in accordance with the well-known figure-of-eight polar diagram. A consideration of this diagram shows that the rate of change of signal strength with rotation is greatest at the minimum position, which is therefore always used for direction-finding.

(*a*) *Accuracy of the Direction-finder.*—There are several manufactured forms of direction-finder employing the above principle, and their accuracy when used under the best conditions may be said to be about 1°. Under most practical conditions, however, the instrument is subject to certain errors in determining the direction of a distant transmitter. In part these errors may be due to an actual deviation of the waves from their rectilinear path in crossing a coastal boundary, for example, when a maximum deviation of about 5° may be produced for wave-lengths of the order commonly used in marine direction-finding. On the other hand, the errors may arise from the presence of local conditions near the direction-finder, such as trees, metalwork, and overhead wires, the currents induced in which result in secondary fields being superimposed on the primary wave field and so produce a minimum signal in a false position of the direction-finder. As a result of several years' investigation these errors are now well understood, and in most circumstances they may be avoided or compensated for after reduction to a minimum.

(*b*) *Position of the Direction-finder.*—In the application of direction-finding to marine navigation, a point of some debate has been the most desirable location for the instrument, on shore or on board ship. When erected in suitable surroundings, the shore direction-finder has an accuracy superior to that of the ship installation, for in the latter case the wireless bearing is taken relative to the ship, and reference must be made to the compass in order to determine the orientation of the

ship at the instant the bearing was taken. Moreover, the ship direction-finder is subject to a local error of a quadrantal nature due to the currents induced by the arriving waves in the metalwork, hull, stays, etc., comprising the ship itself. On the other hand, it is natural to find that the average ship's navigator does not care to entrust himself to the observations of an individual on shore with whom he is not in personal touch; and particularly at critical times in stormy or foggy weather, he much prefers to have the instrument on board ship and operated under his immediate control.

Furthermore, the ship fitted with a direction-finder is enabled to take bearings upon the transmissions from other ships; and at least one instance can be quoted in which a ship in distress, after signalling its inaccurately estimated position, has been found at a position one hundred miles away by means of a direction-finder on the rescuing ship. A possible future development of the ship direction-finder is the provision of a safeguard against collisions at sea in times of thick fog.

(*c*) *Conditions for Freedom from Night Errors.*—It is now well known that wireless direction-finders, even in the most favourable situations, are subject to a variable error under certain conditions of transmission, which chiefly occur at night. These errors are due to the reception of waves deflected in the upper atmosphere, which therefore arrive at the direction-finder travelling in a downward direction. So long as these waves are polarised with their electric force in the vertical plane of propagation, the true bearing will be read off on the direction-finder. But if, as is frequently the case, the plane of polarisation of these waves is rotated, then the resultant magnetic field produced at the earth's surface will not be perpendicular to the plane of propagation and an apparent error will be recorded on the instrument.

The actual value of the error will depend upon the relative magnitude of the down-coming waves and the waves transmitted directly along the earth's surface, since it is determined by the direction of the resultant magnetic field due to both sets of waves. Close to the transmitter the ground wave predominates and no error is produced. At a distance of about 30 miles overland, the strength of the ground wave has become reduced, and the angle of incidence and relative strength of the downcoming wave have increased sufficiently to introduce an appreciable error in bearing at night. Fortunately for marine navigation, however, the attenuation of the ground wave is much less when travelling oversea, and the down-coming wave does not become effective until the distance from the transmitter is about 80 miles. Thus when, as is usually the case, the ship's direction-finder is operated on transmissions which are entirely across the open sea, the bearings are equally trustworthy by day or night up to distances of 80 to 100 miles.

FIXED BEACON STATIONS.

Concurrently with the development of the radio direction-finder on board ship, the United States lighthouse authorities have proceeded with the establishment of radio beacons, or fixed transmitting stations which send certain code signals automatically when once set in operation. A number of these stations are already working, and others are proposed or in course of erection. The majority are located on light vessels or near shore lighthouses in the vicinity of the chief harbour entrances, but others are situated on the Great Lakes in the north of the United States. Each station has a characteristic signal easily recognised by an untrained ear and distinctive from any other in the vicinity, and all the stations are clearly marked on charts at points well known to navigators, so that a radio bearing can be definitely identified and plotted on a chart with the same facility as a visual bearing.

It is interesting to note that while the number of British ships fitted with direction-finders is considerably greater than that of any other country, there was, until recently, no fixed radio beacon in the British Isles officially working for the use of these ships. Quite recently, however, the first of a general scheme of fourteen wireless beacons has been erected at Round Island, in the Scilly Islands, by the Trinity House authorities. Other beacons are in course of construction at Lundy Island and the Casquets. The Round Island beacon, now in operation, is situated near the lighthouse and employs a simple valve transmitter of moderate power working to an ordinary open aerial. The running of the station is entirely automatic, even to the replacement of the transmitting valves in case of failure; and the installation is maintained in working order by the staff of the lighthouse.

DIRECTIONAL TRANSMISSION.

(*a*) *The Beam System.*—In recent years the arrangement of groups of antennæ and reflector wires to give a concentrated beam of radiation has been developed to a considerable extent and is now coming into extended use for long-distance communication. If such a beam is made to revolve about a vertical axis, the device becomes analogous to a lighthouse, and signals are detectable at a distance only as the beam flashes past the receiver. By arranging a code of signals in such a way that they are transmitted automatically in succession as the radiating system rotates, then a vessel at sea would, in any position, receive a distinctive signal from which its bearing from the transmitter can be immediately ascertained. In order that such a scheme may be realised in practice, it is necessary that the dimensions of the aerial and reflector system shall be made reasonably small, which implies that the wave-length is correspondingly short. Up to the present, two stations have been equipped with such rotating beam transmitters; the first at Inchkeith, in which a parabolic reflector was used, and the second at the South Foreland, at which the antenna and reflector systems were in the form of plane grids or curtains. The wave-length employed was in the neighbourhood of six metres, and the limited range obtainable, together with the necessity of providing

special short-wave receivers on those ships using the device, have probably accounted for the unpopularity of the system.

(*b*) *Rotating Loops.*—An alternative method of directional transmission is to invert the direction-finder, and set up a closed loop or frame-coil, supplied with oscillatory current from a suitable transmitter. If the loop be rotated uniformly about a vertical axis, then the signal obtained at a distant receiver will vary according to a cosine law, passing through a zero or minimum when the plane of the loop is perpendicular to the direction of transmission. The orientation of the loop at this minimum signal position can most easily be determined by a timing method. A characteristic signal is emitted when the minimum radiation from the loop is in either the north or east direction, and by measuring the time interval between the reception of this signal and the passage of the signal through its minimum intensity, the bearing of a distant receiver from the transmitter can be easily obtained. Other and somewhat more complicated methods of deducing the bearing have been suggested, and consist in imparting to the radiation some characteristic which depends upon the orientation of the loop; for example, the wave-length may be varied continuously during rotation.

The rotating loop transmitter used with a timing method has been developed to a high degree in Great Britain by the Air Ministry, and its applicability to marine working is now under investigation. The method has considerable attractions, in that it can be operated on the wave-lengths usually employed in ship and aircraft communication, and in merely requiring at the receiving end a suitable watch and the ordinary type of wireless receiver. A further advantage lies in the fact that the directional part of the system is located in a fixed position on the ground, and that the observed bearings are independent of the direction in which the ship or aircraft is pointing, and are almost entirely immune from any disturbing conditions local to the receiver. It is therefore likely that this method will play an important part in the future of navigation wireless.

(*c*) *Course Setters.*—In concluding this survey, brief mention may be made of the so-called wireless course setter. The use of the directional transmitter has considerable advantages for the navigation of aircraft in that it can be installed at the home station, and the aeroplane has then merely to fly on a constant bearing line to arrive at its destination. To assist in this object an arrangement of a pair of loop transmitters was devised some years ago in Germany, the loops being identical and fixed together at some convenient angle. The loops may either be excited alternately at intervals of once a second, or they may be excited together, but each loop is arranged to emit a Morse signal which is complementary to that given by the other.

When the receiver is located on a line bisecting the angle between the loops, both signals will be received of equal intensity and will thus be indistinguishable from each other. On either side of these bisecting lines the signal from one loop will predominate over that from the other. Thus, while such a scheme is only available over definite courses or air routes, it has the advantage over other directional methods in requiring no special apparatus or timing arrangements, and it gives an immediate indication of any departure from the course caused by drift from wind or tide. Such a method has received considerable attention in America, where it is proposed to establish a network of wireless beacons along the main civil aviation routes.

Obituary.

Sir William Galloway.

THE death of Sir William Galloway, which occurred at his home in Cardiff on Nov. 2, removes an outstanding figure in the development of scientific coal-mining. Galloway made a number of important contributions to methods of coal-mining, but he will chiefly be remembered as the originator of the theory, now everywhere accepted, that the great explosions which used, in the absence of proper precautions, to sweep through the roads and workings of collieries, are due to the combustion of coal-dust raised into the air.

Galloway was born in 1840, and belonged to a well-known family associated in the west of Scotland with coal-mining and engineering enterprises. After studying at Giessen, and later at University College, London, he became a junior Inspector of Mines, first in Scotland, and afterwards in South Wales. His attention was thus directed to the causes of explosions. He soon saw that the theory then everywhere accepted, that the great explosions are propagated by the combustion of fire-damp, was quite incapable of explaining the actual facts; and in a series of papers published in the *Proceedings of the Royal Society* between 1875 and 1887, he formulated and supported the coal-dust theory. His conclusions were derived mainly from an analysis of the evidence afforded by actual explosions, and the demonstration from this that fire-damp could not have been present in appreciable proportion along most of the track of each explosion. The rest of his evidence consisted in the results of experiments on the surface in a gallery constructed for the purpose at a South Wales colliery controlled by his friend and countryman, Mr. A. Hood.

At first Galloway was only able to obtain ignition of a coal-dust cloud when about 1 per cent. of fire-damp was present in the air; but later he succeeded without the addition of fire-damp. The gallery was too short for the development of the extreme violence often displayed in underground explosions, and it was only in the long experimental gallery built in 1905 at Altoft's Colliery under Sir William Garforth's supervision by the Coal

Owners' Association, that a coal-dust explosion was obtained of sufficient violence to blow the gallery to pieces, and hurl masses of the boiler-plate of which it was constructed five hundred feet into the air.

For many years Galloway's conclusions were received with almost universal scepticism. The idea that colliery explosions are simply due to fire-damp was firmly rooted. It was, moreover, known that blasting with ordinary gunpowder was commonly carried out with impunity at working faces, provided that fire-damp was absent, though much coal-dust might be present. Owing to the conflict between his views and those of senior colleagues, he had to resign his position as inspector of mines. Gradually, however, confirmation came from other mining engineers or scientific investigators, and particularly from junior inspectors of mines, among whom the brothers W. N. and J. B. Atkinson and Mr. Henry Hall took a leading part. Meanwhile, Galloway held for many years the chair of mining at University College, Cardiff. He also became a well-known consulting mining engineer, and remained so until his death, retaining his activities and scientific interests to the last.

Galloway never tired of urging the necessity of precautions against coal-dust explosions. He laid most stress on keeping the roads wet, and providing dust-proof underground waggons; but he also pointed out, and proved by experiment, that the dust could be made safe by the addition to it of inert material. The latter precaution, independently initiated and vigorously developed by the late Sir William Garforth, has turned out to be practicable and effective; and our knowledge of the conditions under which coal-dust explosions occur, and what is necessary to prevent them, has advanced rapidly in recent years, a great part of the advance being due to the experiments carried out under Prof. Wheeler's supervision at the Experimental Stations at Eskmeals, and later at Buxton.

The death-rate from colliery explosions in Great Britain has been reduced to about a tenth of what it was when Galloway began his work. No better tribute than this could be paid to the inherent value of that work, since it is the attention which has been paid to the dangers from coal-dust that has brought about the reduction. But even if he had turned out to be wrong about coal-dust, those who knew him would still have loved and respected him for the greatness of his character. J. S. H.

THE memorial address on Prof. O. Wiener delivered by Prof. L. Weickmann before the Academy of Science at Leipzig on July 1 is reproduced in the *Berichte* of the Academy for that date. Otto Wiener, the son of Christian Wiener, professor of mathematics in Karlsruhe, was born on June 15, 1862, and after leaving school became a student in Karlsruhe, Berlin, and Strasbourg in succession. At Strasbourg he was associated with Kundt, and obtained his doctorate in 1887 with a thesis on the measurement of the thickness of the thin metallic films used by Kundt in his work on the passage of light through metals. After acting as assistant in Strasbourg and in Aix-la-Chapelle, Wiener was appointed professor at the latter in 1894, and at Giessen in 1895. After building a new physics institute there, he was appointed to Leipzig in 1899 and built a still larger institute, which was opened in 1905. He had much to do with the establishment of aeronautical and meteorological departments at Leipzig, and more recently was engaged in developing a kinetic ether theory of the universe. He is, however, best known for his optical researches. He died on Jan. 18 last.

News and Views.

ON Tuesday, Nov. 15, M. Paul Painlevé, professor of celestial mechanics at the Sorbonne, and French Minister for War, gave an evening discourse at the Royal Institution before a large audience. M. Painlevé's lecture took the form of a general review of the evolution of scientific conceptions on the structure of matter from the early speculations of Greek philosophers down to the most recent and advanced theories. He pointed out that this problem resides essentially in a change of scale, and put the question as to whether matter would appear continuous or discontinuous if our senses were refined far beyond the range of our most powerful instrument—the famous controversy of *plenum versus vacuum*. In turn, continuity and discontinuity have seemed to prevail as an explanation of matter and of light. The atomic theory, and the corpuscular emission of light on one hand, and on the other hand thermodynamics and the theory of luminous waves, are characteristic of these two tendencies. Turning to the question of the reality of molecules, M. Painlevé referred to the great number of very diverse methods agreeing to a remarkable degree of accuracy in their result as to the number of molecules in a unit weight, and mentioned in this connexion the researches of Prof. Perrin on the Brownian movement. He then dealt with the atomic microcosm, showing that the study of corpuscular radiations forces us to introduce the idea of discontinuity inside the atom and to regard all matter as made up of two final elements only—the electron and the proton. Towards the end of the lecture, M. Painlevé mentioned the difficulties which lie in the way of explaining the luminous spectra emitted by atoms, and expressed the hope that the new mechanics, by associating material corpuscles with these mysterious waves, would ultimately overcome those difficulties. He showed a series of interesting slides illustrating points which he had discussed in his lecture, such as atomic impacts and coloured regions with well-marked outlines indicating differences of molecular thickness in soap films. The audience frequently expressed appreciation of the lecturer's eloquent exposition of his subject.

ON Thursday, Nov. 17, M. Paul Painlevé lectured at the Institut Français du Royaume-Uni in Cromwell Gardens, South Kensington, on "Absolu et Relativité," under the chairmanship of Lord Askwith, chairman of the Council of the Institut. M. Painlevé emphasised the essentially scientific character of the theory of relativity, which has often been falsely represented as a metaphysical doctrine. He considered it important to distinguish carefully between the scientific theory of relativity and the "transcendental subjectivism, which assumes that our sensations alone are a fact, a reality, and that the universe is nothing but an illusion." Relativity demands the objective reality of the external world. What it does is to deprive time and space of the absolute character with which they have previously been wrongly endowed. They are so closely interconnected in our perception of the universe that we can not realise the absolute except as a combination of them. M. Painlevé went on to discuss the definitions of time and space measures in relation to the principle of casuality, and showed that it is necessary for the relativist to regard the notion of simultaneity of events occurring at different places as a partially relative one. The principle of relativity has introduced simplifications into the electro-magnetic interpretation of Fresnel's optics, but these simplifications require the assumption of a time system special to each observer. This requirement has given pause to many would-be adherents of the theory, while others have thought to find an essential contradiction in the theory. In M. Painlevé's opinion, the theory is coherent and logically sound. Einstein has given us a view of the universe which entails a revision of the fundamental principles of science but strengthens them enormously.

THE Council of the Royal Meteorological Society has awarded the Symons Memorial Gold Medal for 1928 to Prof. Hugo Hergesell, Director of the Aeronautical Observatory, Lindenberg, for distinguished work in connexion with meteorological science. The medal, which is awarded biennially, will be presented at the annual general meeting on Jan. 18, 1928. Prof. Hergesell has for many years played a prominent part in the development of meteorology. So far back as 1896 he was chosen as president of the International Commission for Scientific Aeronautics; and that Commission continued to organise upper air observations until the outbreak of the War. The data from 1900 to 1913 were published by Hergesell at Strasbourg, and he supplemented the work done there by ascents in widespread regions over the oceans. In 1914 he succeeded Assmann as Director of the Aeronautical Observatory at Lindenberg, which issues the daily weather reports of the upper air for the use of pilots over a large region: there he has shown very great organising ability, as is indicated by the scientific output of that institution. It has made and published an enormous mass of upper air observations, and has digested and discussed these in an admirable manner. Not only has the Director himself made important contributions to knowledge, but he has also trained a number of men some of whom have made world-wide reputations by advances of meteorological science. Prof. Hergesell is also editor of the *Beiträge zur Physik der freien Atmosphäre*, which he founded with Dr. Assmann.

WHEN Prof. J. A. Fleming retired from the chair of electrical engineering at University College, London, which he held for forty-two years, a committee was formed under the chairmanship of Mr. A. A. Campbell Swinton, to present University College with an oil portrait of Prof. Fleming, and also to present Prof. Fleming himself with a copy of that portrait. The committee, a very representative one, was fortunate in getting the portrait painted by Sir William Orpen, a former art student at the Slade School, University College. Sir William Orpen also arranged for a copy to be made which the committee intended for Prof. Fleming, who, however, has decided to present it to the Institution of Electrical Engineers. The original will be presented to University College by the committee on Wednesday, Nov. 30, at 5 P.M., and the copy will be presented to the Institution by Prof. Fleming on Thursday, Dec. 1, at 6 P.M., at the ordinary general meeting of the Institution to be held on that day.

THE amalgamation of the Röntgen Society with the British Institute of Radiology was formally completed at a joint general meeting of members of the two Societies on Nov. 17. Sir Humphry Rolleston was elected president for the ensuing session, with Sir William Bragg, Dr. Kaye, and Dr. Knox as vice-presidents. The president, in his inaugural address, referred to the history of the two constituent bodies, and sketched the possibilities of the widened scope of activity which should follow the amalgamation. This scope was exemplified in the following day's meetings. In the morning, papers were read on X-ray and radium protection by Dr. Kaye; and on X-ray measurements, by Prof. Crowther, Prof. Hopwood, Prof. Owen, Mr. C. E. S. Phillips, and Prof. Russ. In the afternoon, papers were read on the use of opaque injections as an aid to X-ray diagnosis; Sir J. Purves-Stewart dealing with the nervous system, Sir J. Thomson-Walker with the urinary system, Dr. Burrell with chest conditions, and Dr. Gibbons with gynæcological conditions. The Röntgen Society and the medical society, formerly known as the B.A.R.P., have each contributed much in the past to the progress of the study of radiology and of the application of X-rays and radium in medical practice, their united efforts should secure a mutual acceleration of effect, and it is to be hoped that the result of the amalgamation will be to enhance the status and value of British radiology in all its branches.

THE presidential address of Prof. C. H. Desch to the Sheffield Society of Engineers and Metallurgists, recently issued by the Society, is of unusual type, in that it concerns itself less with technicalities of science than with the geographical and social relations of Sheffield's industry. The treatment shows Prof. Desch's well-known breadth of knowledge and of

understanding. Without pure ores close at hand, in spite of distance from ports, Sheffield has long maintained a high position as a producer of fine quality steel and of cutlery made from it. This position was gained ere coal came into use, and the two main factors at first were water-power from the steeply-falling Don, and charcoal from the wooded slopes. The utilisation of these assets in days when workmen had not as yet been forced to become machine-tenders added another asset, that of traditional skill, an asset of prime importance which the nineteenth century squandered recklessly. Prof. Desch says that the cementation process for making steel is now known to have been a Tyneside invention of the early seventeenth century, but it developed at Sheffield, an example of cultural importation helping forward local relations between men and their environment, and he pleads for deeper study of these relations through the regional survey of Sheffield, which is getting to work. We are happy to note that Prof. Desch is the chairman of the committee concerned, and that the Geographical Department of the University of Sheffield is actively concerned in this valuable effort.

SOME aspects of the regime of the Nile are discussed by Dr. H. E. Hurst in the *Geographical Journal* for November. The problems relating to Lake Tana and the Blue Nile are of special interest at the present moment. The period of greatest importance in the irrigation of Egypt is from March to July, when the Nile is lowest and has to be supplemented by water taken from the river in December and January and stored in the Aswan reservoir. In April and May, when the Nile is at its lowest, the White Nile contributes 85 per cent. of the total discharge and the Blue Nile only 15 per cent. The portion of the Blue Nile supply which comes out of Lake Tana is only one-thirteenth of the total discharge of the Blue Nile. In other words, the greater part of this supply enters the river between Lake Tana and the Sudan. This part of its basin is little known. It is a deep rugged valley in which travel is difficult. At least two large streams enter the Blue Nile within a hundred miles of the Sudan boundary but their discharge has not been measured. Lastly, it may be noted that the White Nile is much more important than the Blue Nile to Egypt, and that it has now been shown that the Sobat and the Lake Plateau contribute about equal parts to the supply of water in the White Nile. The lake plateau supplies come mainly from Lakes Albert and Victoria, and the rest from the Semliki and Lake Edward.

THE essential features of several types of metallurgical photomicrographic apparatus were described in an article in NATURE of Oct. 8. We have since had an opportunity of examining the large metallographic microscope made by Leitz of Wetzlar. The component parts of this apparatus are mounted on saddles which are capable of being moved along an optical bench consisting of a triangular bar similar to that used in two of the instruments referred to in the article. The stage of the microscope consists of a right-angled casting screwed to the slide which is operated by rack and pinion at one side of the upright carrier. Two novel devices are incorporated in the camera of the Leitz instrument. The camera front has a small observation mirror at one side through which the entire area of the focussing screen can be seen. This is useful when the preliminary focussing and adjustment of the illumination are being made. By means of it also the image may be watched during the actual exposure. The other device consists of a telescopic magnifier which is fitted into one side of a box attachment at the end of the camera and is in such a position that the fine adjustment screw of the microscope is within reach of the hand when the operator is looking into the magnifier. With the aid of the magnifier the image may be finally focussed, even after the plate carrier has been inserted, by examining it on a projection screen which can be brought into position immediately in front of the plate carrier. These devices enable the operator completely to control the focussing without having to move from the side of the apparatus.

IN a paper on "Technical and Non-technical Management," read recently before the British Section of the Société des Ingénieurs Civils de France, Mr. Lucien A. Legros emphasised the dangers which may occur when industrial concerns are managed by persons without adequate technical knowledge. Management is usually divided into technical and non-technical departments, the former responsible for the processes of production and control of the employees and the latter concerned with the commercial side of the business. In most firms, Mr. Legros points out, there is a growing breach between the two functions of management, and there is a marked tendency for the technical side to become subordinate. But unless responsibilities are correctly allotted, and unless difficulties are mutually appreciated, management is not likely to be efficient. As it is, technical men have no commercial training, while non-technical managements have little knowledge of the conditions of the employees and of the relative values of skill, brawn, and brains, and do not appreciate the importance of research, standardisation, and technical education. Mr. Legros admits that there are many difficulties in the way of co-ordination. In a few cases, the representation of technical employees on the Board of Directors might prove useful, though 'works committees' would, he considers, in general be a better solution provided they are independent of both employers' federations and trade unions. Indirectly, 'welfare work' may also be of importance. Mr. Legros concludes that if production is to be increased, technical education must be reformed and apprenticeship improved, while the real wants of the large but silent majority of the workers—stability of employment, immunity from 'rate cutting,' increased facilities for approach to the management, promotion through ability, and good foremanship—will have to be considered by non-technical managers.

AN article by E. G. Fischinger in the *Elektrotechnische Zeitschrift* for June 2 gives an interesting history of one of the earliest high-tension lines in Europe. The power is generated at Luachhammer in Prussia and is transmitted at a pressure of 100,000 volts to the rolling mills at Riesa. It began working in January 1912. The chief difficulties encountered were with transformer breakdowns. After being in operation for some time, the mutual forces between the coils loosened them and the constant rubbing chafed away the insulation and caused short circuits. The strings of insulators supporting the high tension wires also caused trouble. This was traced to unequal expansion caused by heating and cooling, which developed cracks in the surface of the porcelain. This difficulty was overcome by using insulators of a new design. Like similar lines elsewhere, interruption of the supply was sometimes caused by large birds alighting on the wires and being electrocuted. In the south of France and in Switzerland, many eagles, large owls, and other birds of prey and capercailzie have been electrocuted by overhead high tension wires. Short circuits can be caused in this way. The author states that in the early days no less than thirty buzzards were electrocuted in rapid succession. He naïvely adds that after this the birds learned to keep away from the wires and there were no more short circuits. In our opinion, this diminution in the number of large birds, some of which are useful vermin killers, is much to be regretted. More thorough precautions should be taken to prevent such accidents. Other difficulties arise from the mechanical oscillations sometimes set up in the lines and from the ice formed on them in cold weather. The latter is easily got rid of, however, by slightly raising the temperature of the wires by sending an electric current through them.

IN the *Quarterly Review* for October, S. L. Bensusan gives a survey, based on personal investigation, of current agricultural conditions in England. While he admits that in many cases the farmer is suffering through no fault of his own, he considers that where natural conditions are at all favourable, the best men are either holding their own or making small profits. Failure to realise the transitional nature of the industry accounts for the losses of most of the unsuccessful farmers, the situation being aggravated by the pessimistic attitude adopted by the press and others. He points out that the real solution lies in the development of new fields of activity, newer varieties of wheat, for example, being a safer remedy than the raising of a tax on imported flour. Sugar beet, he considers, offers the most hopeful prospects at the present time and serves a double purpose in that it relieves unemployment by creating labour both in field and factory. However, the financial assistance from the Government is largely responsible for the present success of the industry, so that the farmer must be able to increase his yield per acre and also to ensure that he receives a fair price from the factory before he can hope to compete with foreign countries. Amongst other changes quoted are those concerned with stock, the methods now in use being uneconomic and not supplying the real needs of the market. Baby beef, small readily matured mutton and standardised pigs are the lines upon which the farmer must develop if he is to keep abreast with modern demands. Milk production should be one of the most profitable industries, particularly since the new methods of intensive grass farming have proved so successful.

IT is announced that Mr. John D. Rockefeller, Jr., has offered to the Government of Palestine a sum of 2,000,000 dollars for the building and maintenance of a museum in Jerusalem if the Government will provide the site. The offer has been accepted by Lord Plumer on behalf of the Palestine Government. One of the conditions of the gift is that the museum should be purely archæological. Steps are now being taken to expropriate a site known as Karm esh Sheikh, which is outside the walls near the north-east corner of the walled city and opposite Herod's Gate. This munificent gift will provide a much needed relief from the present inadequate accommodation.

MR. THOMAS ALVA EDISON has been elected an honorary member of the Institution of Electrical Engineers.

THE Council of the Yorkshire Philosophical Society has elected Mr. C. Tate Regan, Director of the British Museum (Natural History), and Dr. F. A. Bather, Keeper of the Department of Geology, British Museum (Natural History), as honorary members of the Society.

SIR CHARLES CLOSE, formerly Director-General of the Ordnance Survey, has been appointed by the Council of the Royal Geographical Society, president of the Society until the anniversary meeting in June next in succession to Dr. D. G. Hogarth, who died on Nov. 6.

THE Wellington (N.Z.) correspondent of the *Morning Post* announces that Dr. R. J. Tillyard, chief of the biological department, Cawthron Institute, Nelson, New Zealand, has been appointed chief entomologist to the Commonwealth of Australia. He will still remain in charge of the Empire Marketing Board's research work against the blackberry pest in New Zealand.

THE Secretary for Mines has appointed the following to be a Committee to report to the Safety in Mines Research Board from time to time on, and to superintend research required for, the improvement of mine rescue apparatus and equipment: Mr. Robert Clive (chairman), Mr. James R. L. Allott, Mr. G. L. Brown, Dr. J. S. Haldane, Mr. W. E. T. Hartley, Mr. P. S. Hay, Prof. J. A. S. Ritson, Mr. J. H. Thorne, Dr. R. V. Wheeler, and a representative of the Chemical Warfare Research Department. The Secretary of the Committee is Mr. E. A. Shearing, of the Mines Department, to whom all communications on the subject should be addressed.

THE library of the late Sir Arthur E. Shipley is to be sold by auction at the Corn Exchange, Cambridge, on Tuesday next, by Messrs. Catling and Son, 6 St.

Andrew's Street, Cambridge. Among the items to be offered are long runs of scientific series and serials. Catalogues are obtainable from the auctioneers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant master at the Wycombe Technical Institute mainly for mathematics and physics or engineering science—The Principal, The Technical Institute, Wycombe, Bucks (Nov. 28). A public analyst for the Borough of Lewisham—The Town Clerk, Lewisham Town Hall, Catford, S.E.6 (Nov. 29). Inspectors under the Agricultural Wages (Regulation) Act, 1924—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Nov. 30). A student probationer at the Millport Marine Station, Cumbrae, Buteshire—The Secretary, Scottish Marine Biological Association, 88 Bath Street, Glasgow (Dec. 3). A chief engineer to the Manchester Steam Users' Association—The Executive Committee, Manchester Steam Users' Association, 9 Mount Street, Albert Square, Manchester (Dec. 6). A woman biochemical research assistant at the Low Temperature Research Station, Cambridge; also two laboratory assistants, one for routine storage experiments, physical measurements, etc., and one for chemical analyses of animal tissues, preferably with working knowledge of bacteriology—The Superintendent, Low Temperature Research Station, Downing Street, Cambridge (Dec. 10). A headmaster of the Heaton Secondary School for Boys, Newcastle-upon-Tyne—The Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (Dec. 17). A plant physiologist and a plant pathologist for banana research at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (Dec. 30). A woman assistant lecturer in the Department of Hygiene and Public Health of the Battersea Polytechnic—The Principal, Battersea Polytechnic, S.W.11. A junior research metallurgist at the Mond Nickel Company, Ltd.—The Secretary, Research and Development Department, The Mond Nickel Company, Ltd., Victoria Station House, S.W.1.

Our Astronomical Column.

DISCOVERY OF A NOVA.—A new star of the tenth magnitude was discovered at Bergedorf Observatory by Prof. Schwassmann and Dr. Wachmann on Nov. 18 at 11 P.M. in R.A. $5^h\ 15^m\ 12^s$, N. Decl. 16° 38′. The position is in Taurus, close to the boundary of Orion, 9° east of Aldebaran, and about 12° from the middle of the Milky Way.

NEW COMET.—A new comet, the ninth of the year, and therefore designated 1927 *j* (the letter *i* is usually omitted in this connexion, to avoid confusion), was discovered by Dr. Schwassmann and Herr Wachmann at Bergedorf Observatory on Nov. 15 at $21^h\ 33{\cdot}3^m$ U.T., in R.A. $1^h\ 32^m\ 12^s$, N. Decl. 20° 53′, Daily motion—24 sec., south 2′, magnitude 14; the announcement was made by the I.A.U. Bureau at Copenhagen.

Assuming uniform motion, the new comet's position on Nov. 26 is R.A. $1^h\ 28^m$, N. Decl. 20° 30′, about 5° west of Beta Arietis; it crosses the meridian about 8.48 P.M., at an altitude of 59°, and is thus very well placed for observation. Its slow motion suggests (but does not prove) that it may be at a considerable distance from sun and earth, in which case there is a fair prospect of its brightness increasing. It is sufficiently near the ecliptic to lie within the zone covered by minor planet photographs, and presumably it was incidentally discovered in the course of minor planet work; but as the telegram contains no expression of doubt, it may be assumed that the image is of a decidedly cometary character.

THE RETURN OF ENCKE'S COMET.—This, the best known of all the short-period comets, was detected by Prof. G. van Biesbroeck at Yerkes Observatory on Nov. $13^d\ 1^h\ 19^m{\cdot}5$ U.T., in R.A. $22^h\ 57^m\ 8^s{\cdot}2$, North Decl. 8° 54′ 13″; mag. 16. Perihelion will be passed in 1928 on Feb. 19·71 U.T., the other elements being, according to L. Matkiewicz (*Astr. Nach.*, No. 5521), ω 184° 55′ 43″·20, i 12° 31′ 53″·43, Ω 334° 33′ 56″·43, ϕ 58° 9′ 27″·57, period 3·286435 years, equinox 1927·0. The comet is at present too faint for ordinary observers, but it should be visible with small instruments in the evening sky in January. After that it goes south, and must be left to southern observers.

This is the thirty-seventh observed apparition of the comet, a much larger number than that of any other comet; Halley comes second with twenty-eight. Encke has not been missed at a single return since 1819.

It is the eighth comet detected this year, and so bears the designation 1927 *h*; four of the eight were expected periodic comets, the other four were unexpected ones, though one of them (Gale) has proved to be a short-period comet.

SUNSPOT RECORDS FROM ARIZONA AND CALIFORNIAN TREES.—Some years ago, Mr. A. E. Douglas noted that a correlation could be traced between the sunspot curves and the size of the annual rings in the great trees of California. Since the tree records are available for thousands of years in the past, it is possible, once the relationship is established, to carry back the sunspot record into periods for which no data were formerly available. It will be remembered that Mr. E. W. Maunder noted a long period at the end of the seventeenth and beginning of the eighteenth centuries in which sunspots were exceedingly scarce, and the eleven-year cycle seemed to be in abeyance. Some people even suggested that the cycle might not have existed until the eighteenth century. The tree record gives new information on this point.

An article by Mr. Douglas in *Jour. Roy. Astron. Soc. of Canada* for September discusses the records of a number of Arizona pines. He states that he had noticed the flatness of the curve of sunspots as given by the trees at the period noted by Mr. Maunder before he saw the conclusions of the latter. Carrying the research further back, he has found other periods at which spot activity seems to have been temporarily suspended. Between 1000 B.C. and 300 B.C. activity was slight, then a more active period began. There were other lulls between A.D. 400 and A.D. 650, and between A.D. 900 and A.D. 1200. In the same number, Mr. R. E. De Lury discusses some fossil trees, the estimated age of which is 300,000 years, and shows that the eleven-year period was then in evidence.

This study also affords evidence of the close correlation between sunspots and weather that exists in some districts of North America; in Great Britain the correlation is much less evident, if it exists at all.

Research Items.

THE DOUBLE AXE IN ETRURIA.—In *Man* for November, Mr. J. A. Spranger has noted examples of the occurrence of the double axe in Etruria in vase paintings, cinerary urn reliefs, on bronze mirrors, as votive offerings, on coins, in tombs, and on a grave stele, with the view of their throwing light upon the Ægean or Asiatic origin of the Etruscans. It has, however, to be borne in mind that the occurrence of the cult does not necessarily mean that they brought it with them *ab initio*; it may have been introduced later in the course of their wide commercial relations. The evidence is by no means extensive, and, further, any conclusion must be tentative and liable to be upset by further discoveries. It would appear that the double axe was known from early Etruscan times, as is shown by the unique grave stele in the Florence Museum,—the oldest inscribed Etruscan monument known, and the only one bearing an unmistakable double axe. Further, the later Etruscans were aware of its value as a symbol of Dionysus, and a weapon connected with sacrificial rites. It is, however, at Vetulonia that the best evidence is found of its symbolic value, where it occurs as an emblem of power with the iron fasces in "the Tomb of the Lictor." Yet nowhere does it occur as a cult in the Cretan sense. It is rather evidence of 'Mycenæan' culture affecting the ancestors of the Etruscans.

OBSIDIAN.—In *Ancient Egypt* for September, Mr. G. A. Wainwright discusses the possible sources of the objects made of obsidian which have been found in ancient Egypt. As obsidian or volcanic glass is found only in certain areas, its presence in a non-volcanic country is a proof of trade communication. Unfortunately, it is not at present possible to identify positively by petrological tests the place of origin of any given piece of obsidian. Hitherto it has been generally thought, and almost universally the tendency among anthropologists to conclude, that obsidian in early times came from Melos; but it has also been recognised by some that other sources are possible. The abundant use of obsidian in Armenia and Mesopotamia militates against a Melian origin. Not only has obsidian been reported to occur in quantities in Armenia, but also the distribution of finds of obsidian implements in Armenia and Eastern Asia Minor and its relation to the distribution of flint implements, points to Armenia as a centre of use, with a peripheral contact with flint, where obsidian and flint are used side by side, until the flint entirely takes the place of obsidian. With this the distribution of obsidian in western Asia also well may be taken to agree. The farther from Armenia the rarer obsidian becomes, until in Anau, Turkestan, Palestine, and Egypt it becomes a rarity. On the other hand, its frequency in Mesopotamia, which is thus an exception in the peripheral distribution, may be accounted for by the facility of communication with Armenia by the river system. Several considerations equally point to an early connexion between the north and Egypt through Syria, such as, for example, the origin of barley, wheat, and the vine in Syria, or in the case of the last named, perhaps Armenia; as well as the intrusion of 'Armenoids' into Egypt in predynastic times. Armenia, therefore, rather than Melos, is the probable source of the Egyptian obsidian, communication being also easier in this case than with the Abyssinian obsidian fields.

NORWEGIAN DECAPODS.—Mr. James A. Grieg ("Decapoda Crustacea from the West Coast of Norway and the North Atlantic." *Bergens Museums Aarbok*, 1926. Naturvidenskabelig raekke No. 7), records some rare decapods obtained recently from the west coast of Norway and also gives a list of decapods collected by the *Michael Sars* between 1900 and 1914 during her expedition along the Norwegian coast and in the North Atlantic. There is not much system in the list, for we have Porcellana, Eupagurus, and members of the Thalassinidea sandwiched in, for apparently no reason at all, between species belonging to the Brachyura. It is interesting to compare these records with the British fauna. *Eurynome aspera* appears to be very rare, also *Stenorhynchus longirostris*, *Inachus dorsettensis* and *I. dorynchus*. Many other common British species apparently occur only occasionally in Norway. All breeding specimens are recorded, making these notes really valuable for reference. Amongst the four species of Pasiphæa, *P. multidentata Esm.* is well represented in the fjords, and it is shown that it is in berry from January to September, the breeding season thus spreading over a long period, for mature eggs occurred both in March and September, possibly showing two breeding seasons. Among the rare deep-water forms in the young fish trawl collected by the *Armauer Hansen* was one specimen of that peculiar crustacean *Eryoneicus faxoni* Bouv., 32 mm. long, which has been shown by Sund to be almost certainly the young of *Polycheles sculptus* Smith.

TRANSLOCATION IN THE COTTON PLANT.—Problems of vital interest to cotton growers are investigations of the factors regulating the shedding of buds and young bolls, the variations in form and development of the cotton plant from climatic and other causes, and the condensation of sugar to form cellulose in the lint hair. T. G. Mason and E. J. Maskell, of the Trinidad Cotton Research Station, have tried to elucidate these special problems by investigating the wider general problem of the translocation of nutritive substances in the cotton plant, and their local distribution to leaves, roots, flowers, seeds, and lint (*Empire Cotton Growing Review*, vol. 4, No. 4). Their results confirm in part some obtained for other species by Prof. O. F. Curtis, of Cornell University. A strain of Sea Island cotton was used in the experiments, and the work consisted essentially in the analyses of samples of leaves, stems, and bolls collected at specified times from plants treated in certain definite ways. The bark and wood were analysed separately. It was found that in the leaf both sugar and reserve carbohydrate fluctuated markedly, the quantity rising during the day and falling during the night. In the bark there were well-marked changes in total sugar concentrations, which followed closely on those of the leaf, with a lag of about two hours. No appreciable diurnal fluctuations could be demonstrated in the case of the wood, either in total sugar concentration or in reserve carbohydrate. Diurnal changes of sugar concentration in the boll were similar to those in the bark. The effects of ringing shoots were very marked. Above the ring sugar concentration rose rapidly; below the ring the concentration fell as rapidly. In further investigations on the particular channel of transport, it was found that sugar continued to pass down a stem through a region in which bark and wood were separated by a ring of paraffined paper, and would also pass down into a seven-inch flap of bark continuous with the bark of the stem at its upper end, but separated from the wood throughout the whole of its length. The authors conclude that the bark forms the main channel of longitudinal transport.

SOIL STERILISATION.—The Ministry of Agriculture has issued an illustrated leaflet (No. 209) describing practical methods of soil sterilisation for glasshouse crops. Although such treatment of the soil was formerly considered an expensive luxury, the modern grower has come to regard it as a necessary form of insurance, the question now being which method is the best to adopt. The two principal agents suitable for soil sterilisation are heat (steaming or baking) and chemical compounds such as cresylic acid. Special attention is paid in the leaflet to the former, as it is shown to be both more effective and economic. Small quantities of soil may conveniently be sterilised by baking, the best results being obtained if the soil is in good condition and reasonably moist when treated, and is then stored for six weeks before being planted. Overbaking renders the soil infertile. Steaming, however, is the more usual method of treating the soil, and many ways of applying it are described with several illustrations. The choice of the steaming method must depend on the degree of soil sickness, as some allow of a deeper penetration than others. Eel-worm trouble, for example, cannot be eradicated by a superficial steaming. A repetition of the treatment is recommended every four years if a satisfactory standard is to be maintained, and sterilising should be completed by the middle of January, as it is advisable to flood the soil after steaming, and sufficient time must be allowed for it to dry before the crop is planted. Preparation of the soil before treatment is essential for success; dry, open soils steaming better than wet ones. Nitrogenous manures should not be applied to recently steamed soil unless it is in very poor condition, as the treatment induces an accumulation of nitrogen. A dressing of potash, and occasionally of phosphate, however, may be given with advantage. With regard to chemical treatment, cresylic acid is the most usual agent employed, but it is much less effective than steam, owing probably to the difficulty of obtaining such intimate contact with the soil particles. Further, it is necessary to apply the acid annually, so that the higher cost of steaming is approximately counterbalanced by the less frequent applications required. Emphasis is laid on the necessity for care in all soil-sterilising operations, as the work is rendered useless if the proper precautions are neglected.

'EDELMIST,' A NOVEL FORM OF FARMYARD MANURE.—An illustrated account of a new method of making farmyard manure, which has aroused considerable interest amongst farmers in Central Europe, is given by A. Cunningham in the *Scottish Journal of Agriculture* (vol. 10, p. 434). The manure produced by this process is known as 'Edelmist,' and is claimed to be superior to dung produced in the usual way even under the best conditions. The chief feature in its preparation is that active fermentation is encouraged during the early stages, the dung being piled up loosely in shallow layers to secure the most favourable conditions for aeration. When the temperature has risen to 55°-65° C., the heap is thoroughly compacted by tramping, covered with a loose layer of fresh dung and allowed to remain untouched for 3 or 4 months. Several advantages are claimed as a result of the fermentation process, the most important being the fact that the easily decomposable organic constituents of the straw are broken down, so that any retardation in the rate at which the nitrogen becomes available to the plant is avoided. Further, the high temperature is probably fatal to weed seeds and plant or animal pests. The tramping which follows the fermentation stage results in the exclusion of air, and in consequence the manure contains relatively few organisms, and can therefore be stored for some length of time without suffering from undesirable changes. The losses incurred during the making of Edelmist are quoted as about one-half those of farmyard manure. The results of field experiments are somewhat variable, but the superiority of Edelmist over ordinary dung seems clearly indicated. The process is protected by British patent, the patentees providing plans for dungsteads, the cost of which they estimate would be repaid in from 3 to 5 years. Although the present results are quoted from Germany, where the farming conditions are somewhat different from those in England, yet the Edelmist process must be regarded as a distinct advance on the ordinary, and often very unsatisfactory, methods employed in the storage of dung in Great Britain.

RAINFALL IN BELGIUM.—It is satisfactory to note that the military occupation of Belgium from 1914 until 1918 did not result in the complete disorganisation of an important undertaking in the way of climatological research that had been begun in that country in 1909. In that year, a simple uniform system of rainfall measurement was organised with the object of obtaining a long series of daily observations which would enable the normal rainfall for each month of the year over the whole country to be obtained. Thanks largely to the efforts of J. Vincent, the number of observers supplied with standard instruments had reached 311 by the end of 1913. This number may seem small compared with the five thousand which represents roughly the number of contributors to the British Rainfall Organisation. It was reduced, moreover, to a bare hundred by the end of 1918. Nevertheless, this network has been found to be sufficiently close to determine the general characteristics of the rainfall of the country as a whole. The records for the seventeen years 1910 to 1926 have been utilised for this purpose by E. Vanderlinden, and the results of his researches appear in Vol. 2 of the *Mémoires de l'Institut Royal Météorologique de Belgique* under the title "Sur la distribution de la pluie en Belgique." In addition to ordinary monthly means for these seventeen years, corrected means are given which allow for the fact that these years were mostly characterised by rainfall in excess of the average for the forty years 1887–1926, judging from the records made at Uccle. The monthly means show that most rain falls in the south-east, where the highest ground is situated. It seems clear that the moist winds from the Atlantic yield up more of their moisture here than on the low ground nearer to the North Sea. There is an interesting discussion of the abnormally dry weather from Aug. 1920 to Oct. 1921, a drought apparently without precedent in Belgium in historic times. In this connexion accounts are given of all notable droughts of which records have been found since the year 1245. Some figures with regard to the maximum intensity of rainfall are worthy of note. They include a fall of 25 mm. in six minutes at Turnhout on July 10, 1889, and 200 mm. in three and a quarter hours at Louvain on May 14, 1906.

TESTING IRON BY MEANS OF RING SPECIMENS.—In practical work it is usual to make the ratio of the radial thickness of a ring specimen to its diameter to be about a tenth. In this case the average magnetic force on the inner circumference of the ring is about ten per cent. greater than at the outer circumference. In general, therefore, an error is introduced into the results owing to the distribution of the magnetic flux not being uniform. M. G. Lloyd, of the U.S. Bureau of Standards, has computed the errors involved for various ratios of radial thickness

to mean diameter on the assumption that the permeability is constant. In the *Journal of the Institution of Electrical Engineers*, p. 932, 1927, E. Hughes has made computations taking into account the variation in the permeability of the iron over the cross-section. Computing in this way, he finds that the errors given by Lloyd are almost invariably too small or too large. He discusses the relationship between the actual hysteresis loss in the ring and that found by using alternators and by using a ballistic galvanometer. Reference is made to the desirability of using a larger ratio of radial thickness of diameter than is customary, in order that any error due to mechanical strain produced by punching, etc., may be reduced.

STRENGTH OF ELECTRIC LAMPS.—The important paper on the mechanical strength of metal filament electric lamps which was read to Section G of the British Association at Leeds on Sept. 5 by Mr. Murgatroyd is published in *Engineering* for Nov. 4. The earliest filament lamps used platinum, which has a melting point of only 2028° Kelvin, whereas tungsten, which is now used, has a melting point of 3655° K. From theoretical considerations, Mr. Murgatroyd deduces that a temperature of about 6270° K. would be the most efficient for illumination. He also deduces that the larger the crystals of the metal used in a filament the stronger the filament should be. He says that the size, shape, and orientation of the crystal determines its mechanical strength. Using a simple apparatus he carried out 'shock' tests on electric lamps. He obtained the following results. An electric filament lamp is weaker mechanically when it is incandescent than when it is cold. Contrary to ordinary ideas, the gas in a gas-filled lamp does not add to its strength. Spiral filaments also are not necessarily stronger than straight filaments. He emphasises that the chief factor in determining the mechanical strength of a metal filament lamp is the structure of the filament material. Since high temperature tends to weaken a lamp, it might be thought desirable to increase its strength by working it at a lower temperature and therefore at a lower luminous efficiency. This, however, would be a retrograde step. The 60-watt gas-filled lamps which he tested when working normally were relatively strong in spite of the high temperature. This fact should encourage the user to insist on higher strength in all lamps without having to resort to uneconomical operation. For low candle-power lamps, a squat squirrel-cage type of mounting has many advantages in the present stage of development.

THE SLOTTED WING IN AEROPLANES.—In aviation a difficulty arises in connexion with the use of slotted wings from the fact that with the slot open the maximum lift usually occurs at an angle of incidence considerably higher than with the ordinary unslotted wing. In order to benefit to the fullest extent from the high lift co-efficient arising from the use of the slot, it has been necessary for the machine to have a high under-carriage, with some discomfort to the occupants both on taking off and on landing. An adjustable rear flap to some extent overcomes this difficulty (Aeronautical Research Committee: Reports and Memoranda, No. 1063 (Ae. 245); Model Experiments on R.A.F. 31 Aerofoil with Handley Page Slot. By H. B. Irving, A. S. Batson, and D. H. Williams.—London: H.M. Stationery Office. 6*d*. net). When down, such a flap, in effect, increases the angle of incidence of the wings and simultaneously possesses the additional advantage of giving an increase in maximum lift over that provided by the slot.

FLUID VORTICES.—With the object of supplying data for a more complete mathematical treatment of the vortices formed in a fluid about a body rotating in it, or if this should prove impossible, for a qualitative treatment of the problem, Messrs. T. Terada and K. Hattori, of the Aeronautical Research Institute of the University of Tokyo, have made a photographic study of the forms of these vortices under various boundary conditions. Spheres, cylinders, and discs have been rotated in cylindrical and rectangular vessels sometimes alone, sometimes in pairs, with the directions of rotation the same or opposite, and the torque on the outer vessel has been measured. The vortices produced in the liquid show great persistence and accommodate themselves to widely differing boundary conditions, behaving as if they were rings of deformable material possessing a form of elasticity. No hydrodynamic theory has been found capable of covering the whole of the effects observed. The paper appears in the August issue of the *Report of the Aeronautical Research Institute, Tokyo*, and is well illustrated by photographs.

VERTICAL ILLUMINATION OF METALLURGICAL SPECIMENS.—In the *Journal of the Royal Microscopical Society* for June 1927, Mr. Conrad Beck discusses from an optical point of view the best method of illumination of metallurgical specimens with the vertical illuminator, and, in particular, the method used by Mr. Harold Wrighton, whose photomicrographs showed a resolution of lines about 1/150,000 inch apart. Since the resolution depends on the aperture of the object-glass, the whole aperture must be utilised to make the best use of the magnifying power. This condition cannot be realised when a prism or an opaque reflector is used. To obtain the best results, a transparent reflector is necessary of a size at least as large as the back lens of the object-glass. Other two conditions are shown to be essential for perfect illumination: the light must (1) be centred and (2) be in focus upon the object. To fulfil the three conditions an optical bench arrangement is necessary. One lens is used to produce a suitably sized image of the source, and an iris diaphragm to vary the size of this secondary source. A second lens focusses the diaphragm at a position close to the back lens of the object-glass, whilst a second diaphragm allows the area of the field to be controlled exactly. The arrangement also permits the use of the method proposed by Prof. Carl Benedicks of obtaining various types of oblique illumination by the use of patch stops. The desired effect can be obtained by placing a suitable stop close to the first diaphragm.

THE THERMAL DISSOCIATION OF CARBONYL CHLORIDE.—Phosgene, or carbonyl chloride, decomposes on heating into carbon monoxide and chlorine, and measurements of the dissociation constant by chemical and physical methods are described by H. Ingleson in the *Journal of the Chemical Society* for September. The gas was heated in a quartz bulb and the chlorine determined iodometrically or by the rise in pressure measured on a manometer. The results from the two methods agree satisfactorily and the usual straight line relationship holds between the reciprocals of the temperatures and the logarithms of the dissociation constants. The approximate heat of the reaction was found to be 25,500 cal. at 416°, in agreement with the value obtained by Thomsen. The decomposition of carbonyl chloride appears to be catalysed by the chlorine which is formed, and this was first noticed by Christiansen.

Standardisation of Telephone Apparatus.

FOR many years it has been customary to test the efficiency of telephone receivers and microphones by comparisons against instruments selected as standards. The international committee on long-distance telephony has now specified a standard which is based on scientific principles. The European master standard will be kept in a special laboratory in Paris and will be available to any European administration or manufacturer for standardising instruments. The apparatus will also be available for researches on telephone phonetics, such as, for example, the comparative articulation efficiencies of the European languages.

In a paper read by Mr. B. S. Cohen to the Institution of Electrical Engineers on Nov. 17, a record is given of the methods hitherto employed for telephone apparatus and line transmission standardisation. He also describes the new methods and the modifications of the old methods now being introduced. The paper is largely based on the results obtained in the research laboratories of the Post Office.

Mr. Cohen adopts a nomenclature used by the Post Office which is becoming standardised. By the volume of a sound is meant its loudness or amplitude, and by distortion is meant imperfection in the reproduction of wave form. A distinction is made between articulation and intelligibility. Articulation means the comparative perfection in the reception of sounds not conveying ideas, whilst intelligibility means the comparative perfection in the reception of sounds conveying ideas. These depend on the volume and distortion of the sound as well as on external and extraneous noises.

It is not easy to understand what telephone engineers mean by a 'transmission unit.' Formerly it meant 'miles of standard cable.' This has become obsolescent and the transmission unit is now generally defined either as the logarithmic ratio of two powers or of two currents, the former being a logarithm to the base 10 and the latter being to the Napierian base. It is proposed to call the former the 'bel' after the inventor of the telephone, and the latter the 'néper.' Feeling runs so high between the advocates of these two units that, *faute de mieux*, it has been decided to sanction the use of both.

The method of testing articulation is to send twenty-five different sounds to a recording observer slowly and uniformly. The percentage of the sounds received correctly measures the articulation. It is satisfactory to learn that with good, solid back microphones there is practically no ageing effect. New microphones have to pass a comparative test against a standard. One of the tests of the new telephone receiver was to jar it by dropping it from a definite height on to a steel plate 100,000 times. This had little if any effect on its efficiency.

In the latter half of Mr. Cohen's paper he discusses the kind of apparatus most suitable as a telephone standard. He also discusses the frequency range for broadcasting, etc., recommended by the international committee. The 'ideal' range covers perfect reproduction of speech, music, and most noises. In this case all sounds having frequencies lying between 30 and 10,000 cycles per second must come through the apparatus. For 'high quality' speech and music, the necessary range includes all sounds having frequencies between 100 and 5000; whilst for 'good quality' articulate speech, only sounds having frequencies between 200 and 3000 are required. From the point of view of articulation, the mean speech frequency is 1500 cycles. This means that the removal of all the components of the sound which have frequencies above 1500 gives the same quality of articulation as the removal of all the frequencies below 1500 would give.

The Mellon Institute.

INTERESTING developments of the work of the Mellon Institute in the University of Pittsburgh, recorded in the last annual report, are the new departments for analytical chemistry under Dr. G. D. Beal and for 'pure chemistry' under Dr. L. H. Cretcher. When the Institute was originally established, the question of the position of research in 'pure' chemistry and other subjects was considered. No one will contradict the director's statement that "to the pure science investigator, who is the father of all our efforts in industrial research, falls the glory of making those discoveries that lie at the groundwork of all our knowledge of nature, and of all our powers of utilising natural products." But the practical question is whether 'pure' research should be centralised in another department of the University, under the control of a director specially interested in abstract science, and, if so, what *liaison* should exist between such department and the Institute; or whether an Institute primarily dedicated to industrial research should make provision also for 'pure' research. Apparently the original decision has been reversed, or perhaps it would be truer to say that the development of the work of the Institute has rendered necessary some provision for pure research. In a research institute of this magnitude, the need for advisory and consultative work both in analytical chemistry and in pure chemistry can readily be understood.

The progress of the Institute is exhibited in the report in the form of curves showing steady progress except for perturbations during the War period. The fellows, at present 102 in number, are at work in connexion with 58 industrial fellowships, and a sum of nearly £120,000 was paid during the last fiscal year in support of research in the Institute by the fellowship donors; and the total amount of money appropriated by companies and associations to the Institute during the first sixteen years of its work is approaching a million pounds, all of which was disbursed in sustaining fellowship research. These astonishing figures would have gratified the originator of the scheme, the late Prof. Duncan, and must give great satisfaction to the benefactor whose honoured name is associated with the Institute.

The Institute has published a bibliography of books, bulletins, journal contributions and patents issued from the Institute from the inauguration of the Industrial Fellowship system (March 1, 1911) to January 1, 1927. The director, Dr. E. R. Weidlein, expresses the hope that the list will serve a useful purpose, especially in libraries of other research laboratories. Incidentally, the publication gives convincing evidence of the success of the work initiated by Prof. Kennedy Duncan, of which particulars have been published from time to time in NATURE. The researches conducted in the Institute, with the financial support of industrial firms, cover a wide field in applied chemistry, physics, biology, metallurgy, and other subjects, and the long list of

patents in numerous countries proves their practical utility. That the work of the Institute is not directed solely to the private profit of the contributing firms is indicated by the list of contributions on smoke-abatement, research on which has helped to clarify Pittsburgh's notorious atmosphere. A possible criticism of the list is that it would have been preferable to restrict the entries to contributions of scientific interest to the exclusion of articles of a propagandist character, important as the work of propaganda undoubtedly is in relation to scientific research. For example, the article published in the *Ice Cream Trade Journal*, entitled "Scientific Research Proves its Value to Industry," was probably of ephemeral interest only.

Insect Flagellates and Disease—A Study in Adaptation.[1]

FLAGELLATES of the family Trypanosomidæ are for the most part parasites of the intestinal tract of invertebrates, chiefly insects. Infection is contaminative, one insect infecting itself from encysted stages of the flagellate voided in the fæces of another. In African sleeping sickness the trypanosome lives both in the tse-tse fly and in man. It seems clear that originally these pathogenic flagellates were limited entirely to insect hosts, as the majority of the members of the family still are.

It is found that certain lizards acquire an intestinal infection presumably by devouring infected insects. The flagellates finally adapt themselves to life in the lizard's intestine, whence in some cases they invade the blood stream. If the insect which causes the intestinal and blood infection when devoured by the lizard be one which sucks the blood, then such an insect might infect itself from the blood. The original contaminative method of infection of the insects from one another may still persist, though it may be no longer necessary. If it were lost a condition of affairs like that in *Trypanosoma lewisi* would be reached. The flea ingests trypanosomes from the blood of the rat, and later voids trypanosomes in its fæces, which when eaten by the rat lead to infection. The infection is associated with development in the hind gut of the flea. In the case of sleeping sickness, trypanosomes taken up from the blood of man by the tse-tse fly develop in the anterior part of the alimentary tract and are inoculated into the skin when the fly feeds. Infection of man is inoculative and not contaminative as in the rat. The flagellate in the fly has moved from a posterior to an anterior station, or else the tse-tse fly is not the original invertebrate host. Surra of horses is transmitted by tabanid flies in a purely mechanical manner. The fly bites an infected animal, and if it feeds again within a few minutes on another animal, the trypanosomes which remain alive on or in its proboscis are inoculated. The chances of survival of the flagellate would be greater if it could establish itself in the fly as a definite infection. It is possible that this has occurred in the tse-tse fly; it would explain the development in the anterior part of the intestine. In kala azar and oriental sore it has been shown that the parasites taken up by Phlebotomus develop in the anterior part of the intestine. Assuming that the sand fly is the transmitter of these diseases, it has yet to be determined how the flagellates are inoculated into human beings.

Flagellates have also adapted themselves to life in plants. Studying such infections in Central America, Strong has noted that plant bugs which harbour flagellates infect not only a Euphorbia but also a lizard which devours it. The inoculation of the flagellate from the lizard's intestine into the skin of a monkey caused an ulcer in which rounded forms of the flagellate persisted for more than two weeks. Though Strong's work undoubtedly requires confirmation, it illustrates how insect flagellates, originally confined entirely to the insect host, have adapted themselves to higher animals and plants and associated with the development of a complicated life history, have in many cases led to the production of definite disease.

[1] Substance of a paper read by Dr. C. M. Wenyon, C.M.G., C.B.E., F.R.S., to the Royal Society of Edinburgh on Oct. 24.

The Statistics of Accident Investigations.

AN important article has appeared in the *Journal of the Royal Statistical Society* (vol. 90, Part 3, 1927) on practical applications of the statistics of repeated events, particularly to industrial accidents, part of which had been read by Miss Newbold before the Society on April 26 last. Several times in these pages, articles dealing with accident investigations have been reviewed, and it is useful to have this very able summary of a number of separate lines of attack as well as the statistical details and tables. Research workers sometimes fail to understand some of the simpler laws of causation and reproduce their results in such a way as to render interpretation difficult or impossible. Averages are assumed without evidence to be what they seem to be, and comparisons are made between incomparable groups.

Miss Newbold's work shows the difficulties that confront the statistician when data have to be treated scientifically. She begins by a historical review of accident work and incidentally points out how complex are the problems involved. She considers the question first abstractly, looking upon an accident simply as an event, and assumes that we have a record of the numbers of such events happening to different people in certain periods of time and that the external conditions are uniform. Even with these assumptions, there arises the question as to whether the distribution of events among the individuals is a purely chance one, and if it is not, to what extent are the underlying peculiarities masked by chance variations and how far we are able to strip off the mask and see the form of these peculiarities.

This involves a discussion of the mathematical treatment of such data and a consideration of alternative methods. To know if a high accident rate in a department is due to a few people or to general conditions alike for all is of practical importance but is difficult to determine. On the whole, from a consideration of the work done so far, there is some indication that the same people are likely to incur both small and major accidents. Results, however, are not sufficiently definite to provide a basis for administrative proposals, but the weight of the gradually accumulating evidence and the improvement in statistical technique show clearly that the work is worth pursuing.

The discussion which followed the reading of the paper is also valuable, representing different points of view. Dr. M. Greenwood gave some details of how during the War the study of accidents began and the gradual development of the problem. Mr. D. R. Wilson spoke about the improvement in machinery during recent years, so that no longer was it necessary to 'wait and see' in order to determine if a machine was dangerous or not. He expressed the hope that the time would come when we should be able to know

beforehand those who were likely to get accidents and so prevent them from entering certain occupations. Dr. Millais Culpin gave some actual examples of how a man's temperament expressed itself in accidents and showed from his own researches that in different groups of people a considerable proportion possessed symptoms which would render them liable to accidents should they be exposed to risk.

University and Educational Intelligence.

CAMBRIDGE.—The late Miss McArthur, formerly of Girton College, has left the residue of her estate, stated to be not less than £4000, to the University for the award of a prize or prizes for the encouragement of the study of economic history.

C. Rimington, Emmanuel College, has been re-elected to the Benn W. Levy research studentship in biochemistry.

The Financial Board has proposed to the University the purchase of the Balfour Laboratory from Newnham College, with the view of its being adapted to meet the needs of the Faculty of Geography.

Dr. R. Chodat has been appointed to represent the University at the celebration of the seventieth birthday of Prof. A. Pictet in Geneva, and Prof. Inglis for the coming centenary of the Institution of Civil Engineers.

The governing body of Emmanuel College offers to a research student, commencing residence at the University in October 1928, a studentship of the annual value of £150, tenable at Emmanuel College for two years, and renewable, in exceptional circumstances, for a third year. Preference will be given to a candidate who has already completed at least one but not more than two years of research. The studentship will be awarded in July, and applications should be sent so as to reach the Master of Emmanuel (The Master's Lodge, Emmanuel College, Cambridge, England) not later than June 30.

EDINBURGH.—At the meeting of the University Court on Nov. 14, it was announced that Lady Lyell of Kinnordy has presented to the Department of Geology valuable collections of minerals, rocks, and fossils, together with cabinets for keeping them. In addition, Lady Lyell has given many geological books, papers of historical interest, and a collection of autographed letters from scientific workers of note to the late Sir Charles Lyell.

LONDON.—Messrs. J. Lyons and Co., Ltd., have contributed 250 guineas towards the establishment of the proposed chair of dietetics.

Dr. J. A. Braxton Hicks has been appointed as from Sept. 1 last to the University readership in pathology tenable at the Westminster Hospital Medical School. Dr. Hicks was educated at Epsom College (1896-1902) and Westminster Hospital Medical School. In 1907 he obtained the M.B., B.S. degrees with honours in pathology, and in 1910 the M.D. degree in pathology of London and the D.P.H. (Cambridge). Since 1910 he has worked in the Department of Pathology at the Westminster Hospital and Medical School, and since the laboratories were enlarged under the John Burford Carlill Bequest, he has been director of the laboratories at the Hospital and Medical School.

The King has approved the appointment of Prof. W. R. Halliday, professor of ancient history in the University of Liverpool, to be Principal of King's College, as from Jan. 1 next, in succession to Dr. Ernest Barker, who has resigned.

OXFORD.—Profs. E. S. Goodrich and F. A. Lindemann have been appointed by the heads of the scientific departments to serve on the Radcliffe Library Advisory Committee.

The Board of the Faculty of Medicine has elected Mr. Arthur P. Dodds-Parker, of Magdalen College, a member of the committee for the control of the Lewis Evans Collection.

Prof. A. G. Tansley, Sherardian professor of botany, delivered his inaugural lecture on "The Future Development and Functions of the Oxford Department of Botany" on Nov. 22.

The King has approved the appointment of Sir Edward Farquhar Buzzard to be Regius professor of medicine in the University, as from Jan. 1 next, in succession to Sir Archibald Garrod, who has resigned.

ST. ANDREWS.—The University Court has appointed Mr. D. E. Innes to be reader in geology in the University.

THE governors of Loughborough College invite applications for the award of five open scholarships in the Faculty of Engineering, each of the value of £75 per annum. The scholarships are open to British subjects from any part of the Empire, and are tenable at Loughborough College, Leics., England, for the period of the full diploma course. The entrance examination for the session 1928–29 will be held on April 24, 25, and 26, 1928. All applicants must be not less than sixteen years of age on Oct. 1, 1928. Further particulars and application forms may be obtained from the College Registrar.

THE Council of the Royal Meteorological Society, with the view of encouraging the study of weather in schools, invites teachers to send in essays on that subject, for which three prizes will be given. The Council considers that the essay should include a description of the work which is actually being carried out or has been carried out by the teacher and his class. The essays should be limited to 2000 words, but may be accompanied by examples of pupils' work. They should be received by the Society not later than June 30, 1928. It is hoped to publish the winning essay or essays in the *Quarterly Journal* of the Society. The essays should be forwarded to the Royal Meteorological Society, 49 Cromwell Road, London, S.W.7.

ACCORDING to the statement for the year 1926–27 issued by the Rhodes Trust, there were 187 Rhodes Scholars in residence that year, of whom 93 were from the British Empire and 94 from the United States; 64 completed or gave up their scholarships. Of those in residence, 4 were taking mathematics, 32 natural science or medicine, and 2 forestry or agriculture. Sir Robert Borden, sometime Prime Minister of Canada, was the Rhodes Memorial Lecturer for the year and delivered three lectures on "Canada in the Commonwealth"; the lecturer for 1927–28 will be Dr. Abraham Flexner, of the Rockefeller General Education Board, New York. During the past year the Rev. M. R. Ridley was appointed to the first Rhodes Travelling Fellowship; two further appointments, for which resident fellows, tutors, and lecturers at Oxford are eligible, will be made early in 1928. Information on the Rhodes Scholarships and Fellowships can be obtained from the offices of the Trust, Seymour House, Waterloo Place, London, S.W.1; in the United States, from President Aydelotte, Swarthmore College, Swarthmore, Pennsylvania; in Canada, from Mr. J. M. Macdonnell, National Trust Company, Limited, Montreal, P.Q.; in Australia, from Dr. J. C. V. Behan, Trinity College, Parkville, Victoria; in South Africa, from Mr. P. T. Lewis, Court Chambers, Keerom Street, Cape Town.

Calendar of Discovery and Invention.

November 28, 1660.—The first official record of the Royal Society reads as follows: "Memorandum that Novemb. 28, 1660, These persons following, according to the usuall custom of most of them, mett together at Gresham Colledge to heare Mr. Wren's lecture, viz. The Lord Brouncker, Mr. Boyle, Mr. Bruce, Sir Robert Moray, Sir Paul Neile, Dr. Wilkins, Dr. Goddard, Dr. Petty, Mr. Ball, Mr. Rooke, Mr. Wren, Mr. Hill. And after the lecture was ended, they did according to the usual manner withdraw for mutual converse. . ."

November 28, 1867.—In a letter of this date, Gassiott told Tyndall the following story of Davy entering Pepys' shop in the Poultry. Showing him a letter Davy said, "Pepys, what am I to do, here is a letter from a young man named Faraday; he has been attending my lectures and wants me to give him employment at the Royal Institution—what am I to do?" "Do?" replied Pepys, "put him to wash bottles; if he is good for anything he will do it directly, if he refuses he is good for nothing." "No, no," replied Davy, "we must try him with something better than that." The sequel was that Faraday was employed to assist Davy in the laboratory.

November 30, 1845.—One of the most remarkable days in the history of railways was Nov. 30, 1845, the day fixed by the Board of Trade for lodging plans and specifications for new lines. Extraordinary measures were adopted for producing the documents and for getting them to London in time. No fewer than 1200 companies were started that year, the capital represented by the schemes amounting to £560,000,000. In 1846, 600 railway bills were actually brought forward, and it was then that 'the battle of the gauges' set in. It was, however, only on Brunel's Great Western line that the 7-foot gauge was used.

December 2, 1846.—Some of the earliest experiments in arc lighting were made by Staite and Petrie, who worked together at various problems. To Petrie was due the invention of the first truly self-regulating arc light, while on Nov. 28 and Dec. 2, 1846, he demonstrated the use of his light from the portico of the National Gallery.

December 2, 1856.—On this day Friedrich and Wilhelm Siemens took out the British patent for their regenerative furnace, which a few years later found its most important application in the open hearth method of making mild steel by the Siemens Martin process—a process by which to-day more than 80 per cent. of the steel of the world is produced.

December 2, 1857.—"The advantages of science in nautical affairs," said Mr. Fillmore, President of the United States, on Dec. 2, 1857, "have rarely been more strikingly illustrated than in the fact stated in the report of the Navy Department, that by means of the Wind and Current Charts projected and prepared by Lieutenant Maury, the Superintendent of the Naval Observatory, the passages from the Atlantic to the Pacific ports of our country have been shortened by about forty days." A writer three years later calculated that Maury's work saved the country more than 2,000,000 dollars per annum, and that a British sailing vessel on passage from England to Australia saved £1200 by the use of his charts.

December 3, 1847.—It was on Dec. 3, 1847, that Lyon Playfair wrote to James Young telling him of a petroleum spring in Reddings Colliery, Alfreton, Derbyshire, and suggesting he might turn it to account. The flow of oil was only about 300 gallons a day and this rapidly diminished, but it was through this enterprise that Young was led to experiment on the distillation of oil from coal, and thus laid the foundation of the shale oil industry. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Nov. 10 (*continued from p. 754*).

EXPERIMENTAL PHYSICS.

R. S. Edwards: On the effect of temperature on the viscosity of air: New measurements have been made on the variation with temperature of the viscosity of air over the range of 15° C. to 444° C., to test the accuracy of the results obtained by F. A. Williams. The present measurements corroborate those of previous observers and not those of Williams. It is concluded that there is no breakdown of Sutherland's law in the region of 250° C., and that Sutherland's constant is constant over the whole of the range mentioned above.

P. Kapitza: Further developments of the method of obtaining strong magnetic fields. These fields are obtained for a short period of time only, as it is thus possible to apply large powers to the coil without overheating it. In this manner fields of 100,000 gauss have been obtained. It is now possible to use larger powers. In the place of accumulators a large generator by means of which powers up to 50,000 kilowatts can be obtained in the coil for $\frac{1}{100}$ sec. has been used. Up to the present, magnetic forces up to about 350,000 gauss have been obtained in a volume of 2 c.c.

F. H. Rolt and H. Barrell: Contact of flat surfaces. The object of this investigation was to inquire into the phenomenon of 'wringing' which is used extensively in forming combinations of gauge blocks of the Johansson type. These gauges, which are of hardened steel, have their important surfaces finished to a high degree of flatness, and when brought into intimate contact are found to adhere together very strongly. The adherence depends to a large extent upon the smoothness of the surfaces; so much so, that gauges having optically polished surfaces can be made to adhere when quite clean, whereas those having a 'lapped' finish require the introduction of a very fine film of oil or other liquid to produce the effect. Repeated wringing together of gauges causes slight but measurable wear of their surfaces. The adherence is explained as the molecular attraction between the surface molecules of the gauges. In the case of lapped surfaces, the average separation between the molecules on the two surfaces is considerably greater than with smooth surfaces, and the function of the oil film in the former case is to act as a link between the more widely separated molecules.

W. Mandell: The determination of the elastic moduli of the piezo-electric crystal Rochelle salt by a statical method. Rochelle salt possesses piezo-electric properties, the magnitude of the effect being several hundred times greater than with quartz. The effect is associated only with crystals having an asymmetric structure, and occurs when the crystal is submitted to mechanical stresses. It would therefore appear that the phenomenon may be closely related to its elastic properties. Elastic surfaces were obtained giving a numerical measure of the extension per unit length for unit tension for all directions in the crystal, whilst other surfaces give the amount of torsion per unit couple. Rochelle salt almost loses its piezo-electric properties in a very abrupt manner on raising the temperature above 23° C. The elasticity was measured by the 'bending-beam' method for temperatures above and below this critical point, but any change in elasticity due to molecular re-arrangement was too small to be measured by this method. Piezo-electric crystals exhibit a change in double refraction

when submitted to an electrostatic stress. Pockels carried out experiments to determine whether this electro-optical phenomenon was due solely to the mechanical deformation caused by the electric field or whether there was also a direct influence of the electrostatic force on light motion in these crystals. On inserting the values of the elastic moduli found in the present paper in Pockels' results, the electro-optical effect due to the electrostatic field is about five times greater than that obtained by the mechanical effect alone. Thus the result for Rochelle salt agrees with that for sodium chloride and silica, namely, that an electrostatic field *does* exert a direct influence in piezo-electric crystals.

W. G. **Burgers**: Investigation of the molecular arrangement of uniaxial optically active crystals. Crystals of *d*-potassium rhodium oxalate, sodium metaperiodate, ethylenediamine sulphate, guanidine carbonate, are either truly uniaxial or so nearly so that the difference is inappreciable. Their optical activity is to be ascribed to a special atomic arrangement in a certain unit of structure. The similarity between the rotatory dispersion curves of crystals and of solutions of *d*-potassium rhodium oxalate is not due to the presence of parallel molecules in the crystalline state. The molecules are spirally arranged in the crystal. Potassium lithium sulphate is an exceptional example of an optically active crystal. In this case there is special difficulty in making sure about the presence or absence of a lamellar structure.

H. E. **Watson**: The dielectric constants of ammonia, phosphine and arsine: The dielectric constants were measured at temperatures near to $-47°$, 16° and 100° C. and at frequencies of approximately 300, 1050 and 1800 kc. A heterodyne method was used. The results are independent of the frequency within the limit of experimental error. The quantity $\epsilon - 1$ is proportional to the den ity, although there is some uncertainty as to the compressibility correction. The results for the variation of ϵ with temperature are satisfied approximately by Debye's equation, and the mean values for the electric moments of the molecules calculated by it are $1{\cdot}49 \times 10^{-18}$ for ammonia, $0{\cdot}55 \times 10^{-18}$ for phosphine, and $0{\cdot}15 \times 10^{-18}$ or possibly less for arsine.

W. K. **Hutchison** and C. N. **Hinshelwood**: The relative stability of nitrous oxide and ammonia in the electric discharge. In discharge tubes at low pressure, ammonia is five to seven times as stable as nitrous oxide. Since this ratio remains of the same order when different electrode materials are used, and when the discharge is passed through the two gases either in series or in parallel, it is probably justifiable to conclude that ammonia requires ionic impacts of considerably more violence to decompose it than those required by nitrous oxide.

J. C. **McLennan**, R. **Ruedy**, and E. **Cohen**: The magnetic susceptibility of the alkali metals. Sodium, potassium, rubidium and cæsium are paramagnetic and not diamagnetic.

C. F. **Elam**: Tensile tests on alloy crystals (4). Experiments have been made on the distortion of crystals of a copper alloy containing 5 per cent. aluminium. Like the brass crystals already investigated, these slip for a longer period on one octahedral plane than would be expected from geometrical considerations. A cored structure does not appear to affect the slip-plane and the direction of slip, but the annealed crystal is harder than the un-annealed. In the early stages of deformation copper is harder, and hardens more rapidly for the same amount of shear than either of the alloys, but both the final breaking load and the elongation are higher in the case of the alloys.

D. W. **Dye**: A magnetometer for the measurement of the earth's vertical magnetic intensity in C.G.S. measure. The instrument consists of a Helmholtz coil system set up with its axis truly vertical. When the appropriate current traverses the coil system, the vertical component of the earth's field is exactly neutralised. The resultant field is horizontal and directed along the magnetic meridian. This condition is indicated by the help of a small vibration detector. The detector consists of a small and very light flat coil free to vibrate about a horizontal axis normally lying approximately in the plane of the magnetic meridian. The plane of the coil is vertical and the axis of vibration horizontal. The coil is traversed by a relatively large alternating current at its resonant vibration frequency. Under these conditions it is very sensitive to a vertical field. The condition of rest of the coil corresponds to a zero vertical field. The sensitivity is equivalent to about 1γ. The complete installation enables a measure of vertical intensity in C.G.S. units to be realised to an absolute accuracy of about 2γ. Base-line values should be realisable to a reproducibility of $0{\cdot}5\gamma$.

G. W. C. **Kaye** and W. F. **Higgins**: The thermal conductivities of certain liquids. The thermal conductivities of a number of common liquids have been determined by a 'plate' method, over a range of temperatures up to 200° C. The test layers had an area of about 20 sq. cm. and thicknesses up to 0·5 mm. The following table summarises the chief results:

Liquid.	Conductivity at 20° C.	Temp. coeff. α.
Water	$0{\cdot}0014_9$	$+0{\cdot}001_2$
Glycerine	$0{\cdot}00068_0$	$+0{\cdot}0005_3$
Castor oil	$0{\cdot}00043_2$	$-0{\cdot}0005_0$
Aniline	$0{\cdot}00041_2$	0·0000
Olive oil	$0{\cdot}00040_2$	$-0{\cdot}0003_5$
Cylinder oil	$0{\cdot}00036_6$	$-0{\cdot}0004_1$
Transformer oil	$0{\cdot}00032_1$	$-0{\cdot}0006_2$
Medicinal paraffin	$0{\cdot}00030_0$	$-0{\cdot}0000_7$
Paraffin oil	$0{\cdot}00029_8$	$-0{\cdot}0005_5$

THEORETICAL PHYSICS.

H. **Levy** and A. G. **Forsdyke**: The vibrations of an infinite system of vortex rings. In a previous paper the stability was examined of an infinite system of equal vortex rings situated in parallel planes with their centres evenly spaced along an infinite line and with their planes at right angles to that line. Instability was found to occur for disturbances confined to displacements of the centre of each ring along the central axis, the filament of each ring still remaining circular. The investigation is now extended to deformation of the vortex filaments. Conclusions are drawn regarding natural modes of vibration of the system; it is found, for example, that for any given ratio of radius of ring section to radius of ring there exists a critical ratio of ring spacing to radius, separating the region of stable oscillation from that of instability.

L. **Rosenhead**: Resistance to a barrier in the shape of an arc of a circle. The method is based upon the transformation introduced by Levi-Cività in 1906, and the approximation process used by Brodetsky. The value of the thrust and its line of action are obtained for barriers of both concave and convex camber, and for various angles of incidence. From these figures curves are plotted, from which the thrust for any particular camber and any possible angle of incidence can be obtained by interpolation. The results are interesting for the following reasons: (*a*) As the angle of incidence decreases, the centre of pressure, in the case of small concave cambers, moves

forwards until it reaches a maximum forward position, and then moves backwards. This is more marked the smaller the camber. (*b*) The effect of camber on the resultant thrust is much more marked with small angle of incidence than with large angle of incidence.

C. V. Raman and K. S. Krishnan: A theory of electric and magnetic birefringence in liquids. The local polarisation field acting on any molecule must depend on its orientation. The Langevin-Born theory is accordingly modified so as to take this 'anisotropy' of the polarisation field also into account and the modified expression for birefringence is in better accord with facts. As a rule the effect of the 'anisotropy' of the polarisation field is to diminish the magnitude of the birefringence to be expected, due to the fact that, in general, the longer linear dimension of a molecule tends to be also the direction of maximum electrical and optical susceptibility. The distribution of the molecules in a dense fluid therefore tends to be such that their mutual influence is equivalent to an apparent diminution in the anisotropy of the molecules.

E. T. Whittaker: On electric phenomena in gravitational fields. It is a consequence of general relativity that when electromagnetic phenomena of any kind take place in a gravitational field, they are influenced by the field; that is to say, the Maxwell's equations of the electromagnetic phenomenon must be replaced by other equations which involve the gravitational curvature of space. Two kinds of gravitational field are here considered, namely: (1) the field due to a single attracting mass and (2) a limiting case of this, which is called a *quasi-uniform* field: within these gravitational fields, electromagnetic phenomena are supposed to take place. The mathematical solutions of a number of problems correspond to well-known solutions in the classical Maxwellian theory. The results of the investigation are for the most part expressible only in terms of Bessel functions and of certain new functions which are introduced: but in some interesting cases the electromagnetic phenomena can be represented in terms of elementary functions, as for example the electric field due to an electron in a quasi-uniform gravitational field, and the spherical electromagnetic waves of short wave-length about a gravitating mass.

W. R. C. Coode-Adams: The refractive index of quartz. The characteristic frequencies in dispersion formulæ can now be obtained from the formula for optical rotation and applied to an equation of the Ketteler-Helmholtz type.

Physical Society, Oct. 28.—W. N. Bond: The theory of liquid flow through cones. An approximate general solution is given of the hydro-dynamical equations for liquid flow through conical tubes of circular section, the errors due to the approximation being small for converging cones of small angle and for flow through similar diverging cones up to the speed at which the theory predicts turbulent motion.—H. P. Walmsley: The structure of the smoke particles from a cadmium arc. Using the powder method of X-ray analysis, the particles dispersed in air from a cadmium arc are found to be isometric crystals of cadmium oxide. From X-ray data, a density of 8·16 was obtained for the primary particles in the smokes—the normal density of cadmium oxide. Photometric measurements of the breadth of the lines showed that the primary crystals were of colloidal dimensions, values of $5{\cdot}8 \times 10^{-6}$ cm. and $4{\cdot}9 \times 10^{-6}$ cm. being obtained in two cases. On aggregation, the ultramicroscopic crystals grow along binary axes of symmetry, *i.e.* they tend to unite on their 110 faces.

PARIS.

Academy of Sciences, Oct. 24.—The president announced the death of Sir George Greenhill, and E. I. Fredholm, *correspondants* of the Academy.—E. Goursat: A problem of Hamburger.—G. Bigourdan: A means of improving the determination of time.—Camille Matignon and Mlle. Germaine Marchal: The action of calcium, magnesium, and aluminium on beryllia. On heating a mixture of beryllia and metallic calcium in a vacuum at 800° C., the beryllia is partially reduced, from 30 to 33 per cent. of the theoretical proportion of metal being found. Substituting magnesium for calcium, some beryllium is still produced but in smaller proportion. With aluminium the reduction is doubtful.—H. Douvillé: The Cretaceous in the Bigorre region: its breccias and conglomerates.—Léon Guillet: The addition of nitrogen to special steels. Experimental results on the effects of heating in ammonia aluminium-chromium steels and nickel-chromium-aluminium steels, with special reference to the changes in hardness and elastic properties. The brittleness produced in certain steels by this treatment, known as 'Krupp's disease,' can be ameliorated by the addition of molybdenum in small proportions.—Emm. de Margerie: Report on the state of publication of the "Œuvres géologiques de Marcel Bertrand."—A. Bigot: Monasterian and post-Monasterian formations of Basse Normandie.—D. Mirimanoff and R. Dovaz: Repeated trials and the formula of Laplace.—Widder and Gergen: A generalisation of a theorem of Mandelbrojt.—Georges Valiron: The coefficients of the usual Taylor's series.—W. Sierpinski: Some properties of projective ensembles.—N. Lusin: Remarks on projective ensembles.—Emile Borel: Remarks on the notes of Sierpinski and Lusin.—J. Grialou: Weir with a thin wall; calculation of the yield.—D. Riabouchinsky: A problem of variation.—Elie Carafoli: A general method for drawing aviation profiles.—Pierre Vernotte and Marcel Pellegrin: The measurement of the thermal conductivity of metals. The method of the point of stationary temperature. A modification of the method of Kohlrausch.—Pierre Bricout: Quantitative study of the luminescence of mercury vapour excited by electronic bombardment. Measurements were made of the intensity of the radiation λ2536 when the energy of the exciting electrons was varied from 3 to 86 volts. Starting with simple hypotheses, an expression is deduced for the law of resonance of the non-ionised atom. This is shown to be in good agreement with the experimental data.—G. P. Arcay and M. Fallot: Remarks on the determination of the coefficient of magnetisation of certain liquids. Using the method of Sève two classes of liquid were observed; in one group, including collodion, glycerol, castor oil, and other oils, under the influence of the magnetic field (12,000 to 13,000 gauss) the new level was rapidly assumed and remained fixed; the other group, including solutions of gelatine, gum arabic, albumen casein, and gelatinous silica, presented an anomaly, the first rapid change of level being followed by a slow change, due to a slow increase in the magnetisation coefficient. This effect is probably due to the rigidité of the liquids.—Salomon Rosenblum: The slowing down of the α-rays by matter.—Pierre Jolibois and Henri Lefebvre: A new reaction of active nitrogen. Carbon monoxide under low pressure is slightly decomposed by strong sparks. The rate of production of carbon dioxide is increased seven times if the gas is diluted with pure nitrogen. The authors explain the phenomenon by assuming a catalytic action of active nitrogen in the course of reversion

to normal nitrogen.—P. Lasareff and V. Lazarev: The absorption spectra of borax glass coloured with copper salts. The borax glass was examined in two forms, one suddenly and the other gradually cooled. The absorption spectra were identical, but differed from that given by copper sulphate in solution. It is concluded that the coloration of the borax glass is not due to copper ions, but is produced by complex compounds of copper and borax.—C. Grard and J. Villey: The thermal conductivity of the light alloys. Magnesium with 4 per cent. of copper has both mechanical and thermal characteristics superior to those alloys of aluminium and copper commonly employed.—Albert Roux: The control of welds by the magnetic spectra.—Brutzkus: The calculation of gas analyses. In many technical reactions a certain gas mixture, submitted to a chemical treatment, is analysed before and after the treatment. For the interpretation of the results it is necessary to determine the quantities of gas which have disappeared in the course of the treatment without knowing the total quantity. The solution of this problem is given.—B. Bogitch: Some improvements in the electrical fusion of poor minerals. A description of a modification of the type of electric furnace employed.—J. Thoulet: A double circulation of the ocean, deep and superficial.—Marcel Mascré: The fixation of the chondriome of the plant cell. A comparative study of the effects of various fixing liquids containing formol with acetic, cyanacetic, monochloracetic, or trichloracetic acid. It is shown that the acidity (*p*H) is not the only factor.—R. Herpin: A case of incubation by the female in *Leptonereis glauca* which swarms on the surface.—Pierre P. Ravault: Histochemical researches on the distribution of lime in the wall of the normal human aorta.—Mme. Andrée Roche and Jean Roche: Researches on the existence of the lactacidogen in the blood.—Mme. Anna Drzewina and Georges Bohn: The influence of the walls of vessels on the reactions of animals.—Edouard Chatton and André Lwoff: The evolutive cycle of *Synophrya hypertrophica* (ciliated Fœttingeriidæ).

VIENNA.

Academy of Sciences, July 14.—R. Weiss and G. Schlesinger: Action of organic magnesium compounds on *o*-phthalonitril.—A. Müller and A. Sauerwald: New synthesis of 1, 6-dibrom-*n*-hexane and its action on *p*-toluol-sulphamide.—A. Kailan and A. Blumenstock: The rate of saponification of stearo-lactone with alcoholic alkali solution.—A. Kailan and L. Olbrich: The oxidation of hydrocarbons by air. Experiments were made with paraffin and naphthalene at 183° and with toluol at 99°·4, passing the oxygen through these substances at various rates and for varying lengths of time with and without catalysers. Thus when 600 litres of air was passed through 100 grams of paraffin in 100 hours, 8 per cent. of the residuum was changed into saponifiable constituents.—W. J. Müller: The anodic behaviour and passivity of nickel.—A. Köhler: Ore-containing rocks of the Lower Austrian forest quarter. Exposures were examined near Marbach and elsewhere in the Danube valley. Chemical analyses are given of quartz-syenite-porphyry, mica-diorite-porphyrite, hornblende-diorite-porphyrite.—M. Blau: Radium Institute Communication, No. 208. The photographic action of H-rays.—B. Karlik: Radium Institute Communication, No. 209. The dependence of scintillations on the nature of the zinc sulphide and the character of the scintillation process.—W. Schmidt: The thermo-plummet (*Wärme-lot*), an instrument for recording the temperatures of depths in standing waters.

Official Publications Received.

BRITISH.

Transvaal University College, Pretoria. Bulletin No. 12: Rainfall and Farming in the Transvaal. Part i: A Preliminary Investigation into the Variability of the Rainfall of the Transvaal, by Prof. F. E. Plummer; Part ii: Rainfall in relation to Agriculture in the Transvaal, by Prof. H. D. Leppan. Pp. 63+17 maps. (Pretoria.)

The Quarterly Journal of the Geological Society. Vol. 83, Part 3, No. 331, October 20th. Pp. 345-550+plates 24-42. (London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.*

Aeronautical Research Committee: Reports and Memoranda. No. 1098 (Ae. 277): The Distribution of Pressure over a Monoplane and a Biplane with Wings of Unequal Chord and Equal Span. By A. S. Batson, A. S. Halliday and A. L. Maidens. (A.3.l. Pressure Distribution, 14.—T. 2406.) Pp. 28+13 plates. 1*s.* 3*d.* net. No. 1100 (Ae. 278): Wind Tunnel Experiments on the Effect on the Maximum Lift of Withdrawing and Discharging Air from the Upper Surface of an Aerofoil. By W. G. A. Perring and Dr. G. P. Douglas. (A.3.a. Aerofoils-General, 177.—T. 2470.) Pp. 5+7 plates. 6*d.* net. (London: H.M. Stationery Office.)

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 2, No. 4, October. Pp. 285-396+vii. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

University of Cambridge: Solar Physics Observatory. Fourteenth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1926 April 1—1927 March 31. Pp. 8. (Cambridge.)

Proceedings of the London Mathematical Society. Second Series, Vol. 26. Pp. ii+558. (London: Francis Hodgson.)

The Dioptric Bulletin. Edited by John H. Sutcliffe. Vol. 29, No. 9, September: The Transactions of the British Optical Association. Pp. 395-645. (London: British Optical Association.)

Bulletin of the Madras Government Museum. New Series, Natural History Section, Vol. 1, No. 1: The Littoral Fauna of Krusadai Island in the Gulf of Manaar; with Appendices on the Vertebrates and Plants. By various Authors. Pp. v+196+26 plates. (Madras: Government Press.) 8 rupees.

FOREIGN.

Report of the Oceanographical Investigation. No. 2: Report of the Current Observations. The First Report, Results of the Current Measurements in the Adjacent Seas of Tyôsen, 1923–1926. Pp. iv+68+32+50+ii+20 plates. (Fusan, Chosen: Government Fishery Experimental Station.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 70: Effect of Combined Fat and Vitamin A Deficiency on Growth and Organ Weight of Albino Rats. By Waro Nakahara and Yasuko Yokoyama. Pp. 63-78. 25 sen. Nos. 71-72: The Crystal System of α-Thallium, by Genshichi Asahara and Toshiwo Sasahara; The Crystal Structure of α-Thallium, by Toshiwo Sasahara. Pp. 79-94+plates 13-17. 40 sen. No. 73; Studo pri Magnezioksiklorida Cemento per X-Radio. De Tutomu Maeda. Pp. 95-102. 20 sen. No. 74: On the Nutritive Value of Fats and Lipoids. By Katsumi Takahashi. Pp. 102-132. 50 sen Nos. 75-76: La Akva Vaporpremo de Magnezioksiklorida Cemento, kaj la Stato de Akvo en Ghi, de Tutomu Maeda; La Malmoligho de Magnezioksiklorida Cemento, kaj la Funkcio de Libera Akvo, Kristalakvo kaj Adsorbita Akvo, de Tutomu Maeda. Pp. 133-154. 40 sen. No. 77: On the State of the Moisture adsorbed on Acid Earth. By Hajime Isobe. Pp. 155-190+plates 18-20. 60 sen. No. 78: On the Behavior of 2·6-Dioxyquinoline obtained from β-Acid of "Roh-Oryzanin" upon the Polyneuritis of Pigeon. By Yoshikazu Sahashi. Pp. 191-200. 20 sen. No. 79: On the Anomalous Dispersion and Absorption of Electric Waves. By San-ichiro Mizushima. Pp. 201-248. 60 sen. Nos. 80-83: The Radioactivity of the Rubidium extracted from the Lepidolite and Zinnwaldite of Japan, by Satoyasu Iimori and Jun Yoshimura; Lepidolite from Nagatori, Chikuzen Province, and the Lithium Content of Japanese Mica, by Satoyasu Iimori and Jun Yoshimura; Alkali Metals in Beryl from Ishikawa, Iwaki Province, by Jun Yoshimura: The Determination of the Helium Content of some Japanese Minerals, by Jirô Sasaki. Pp. 249-260. 20 sen. No. 84: New Method for Measuring the Cutting Force of Tools and some Experimental Results. By Masatosi Okochi and Makoto Okoshi. Pp. 261-302+plates 21-26. 1.50 yen. (Tokyo: Iwanami Shoten.)

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 24: Rural School Supervision. Abstracts of Addresses delivered at the Second Conference of Supervisors of the Southeastern States held at Raleigh, North Carolina, December 6 and 7, 1926. Pp. vi+58. 10 cents. Bulletin, 1927, No. 26: Trends in the Development of Secondary Education. By Eustace E. Windes. Pp. ii+41. 10 cents. Washington, D.C.: Government Printing Office.)

The Semi-Centennial of the Hokkaido Imperial University, Japan, 1876–1926. Pp. iv+210+4 plates. (Sapporo.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 558: An Analysis of the Arc and Spark Spectra of Scandium (Sc I and Sc II). By Henry Norris Russell and William F. Meggers. Pp. 329-373. (Washington, D.C.: Government Printing Office.) 20 cents.

The Rockefeller Foundation. Annual Report 1926. Pp. xiii+466 (31 plates). (New York City.)

Suomen Geodeettisen Laitoksen Julkaisuja: Veröffentlichungen de Finnischen Geodätischen Institutes. No. 9: Relative Bestimmungen der Schwerkraft auf den Dreieckspunkten der Südfinnischen Triangulation in den Jahren 1924–1925. Von U. Pesonen. Pp. 129. (Helsinki.)

Svenska Hydrografisk-Biologiska Kommissionens Fyrskeppsundersökning år 1926. Pp. 41. (Göteborg: Elanders Boktryckeri A.-B.)

United States Department of Agriculture. Technical Bulletin No. 21: Beaver Habits and Experiments in Beaver Culture. By Vernon Bailey. Pp. 40+14 plates. 20 cents. Technical Bulletin No. 15: The Citrus Insects of Japan. By Curtis P. Clausen. Pp. 16. 5 cents. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

SATURDAY, NOVEMBER 26.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Newcastle-upon-Tyne), at 3.—Mr. Cox: Modern Surveying Instruments (Lecture).—The following papers will be open for further discussion:—Feeding and Treatment of Animals Below Ground and Stabling, by W. S. Rider; Remarks on the Mines (Working Facilities and Support) Act, 1923, by J. S. Robinson.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. Holst: Samuel Wesley and Robert Pearsall (II.).

INSTITUTE OF BRITISH FOUNDRYMEN (East Midlands Branch) (at Technical College, Derby), at 6.—J. E. Fletcher: The Control of Hardness, Softness, and Soundness in Grey Iron Castings.

INSTITUTE OF BRITISH FOUNDRYMEN (Newcastle and District Branch) (at Neville Hall, Newcastle-on-Tyne), at 6.15.—W. West: Oil Sand for Motor Cylinders.

MONDAY, NOVEMBER 28.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—H.E. the Spanish Ambassador: A Short Explanatory Lecture on a Film showing the Visit of the King and Queen of Spain to the Djebala and Riff Country of Morocco.—At 8.—Prof. H. C. H. Carpenter: Alloy Steels, their Manufacture, Properties, and Uses (Cantor Lectures) (III.).

INSTITUTE OF ACTUARIES, at 5.—H. E. Raynes: The Place of Ordinary Stocks and Shares (as distinct from fixed Interest bearing Securities) in the Investments of Life Funds.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—B. S. Cohen: Apparatus Standards of Telephonic Transmission, and the Technique of Testing Microphones and Receivers.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Capt. C. H. Kuhne: Military Transport Vehicles—Recent Development and their Commercial Significance.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—B. Underwood: Case of Pain and Swelling in Submaxillary Gland caused by Pressure of Denture.—I. S. Spain: The Uses of Nitrous Oxide and Oxygen in Dentistry.

ROYAL AERONAUTICAL SOCIETY (Leeds Branch).—Prof. B. M. Jones: The Control of Stalled Aeroplanes.

MEDICAL SOCIETY OF LONDON.—T. P. Legg and others: Discussion on the Society's Report on the late Results of Operation for Carcinoma of the Breast.

TUESDAY, NOVEMBER 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William H. Bragg: A Year's Work in X-Ray-Crystal Analysis (II.).

INSTITUTION OF CIVIL ENGINEERS, at 6.—G. L. Watson: The Design and Construction of the Sewage-Treatment Works of the City of Trenton, New Jersey, U.S.A.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—Dr. G. D. Bengough: Corrosion.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. C. V. Drysdale: The Wave Theory and Measurement of Lens Aberrations (Traill-Taylor Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.15.—Informal Discussions on Oil-Electric Automatic Control of a Hydro-Extractor, J. V. Levett and others, and The Contractor's Place in the Industry, H. Moss and others.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. C. Freeman: The Production and Modern Application of Dissolved Acetylene.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Y. K. Suominen: The Latest Pictures of the Finnish People.

WEDNESDAY, NOVEMBER 30.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. Blair Bell: The Prevention of Cancer.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—C. W. Osman: The Granites of the Scilly Isles, and their Relation to the Dartmoor Granites.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 7.—Miss M. Partridge: Simple Household Repairs.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—P. R. Coursey and H. Andrewes: Battery Eliminators.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—B. Reed: Boiler Performance.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (jointly with Glasgow University Geological Society) (in Glasgow University), at 7.30.—Prof. P. G. H. Boswell: Refractories.

ROYAL SOCIETY OF ARTS, at 8.—Prof. H. E. Armstrong: Marcellin Berthelot and Synthetic Chemistry.

THURSDAY, DECEMBER 1.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 3.—L. E. Buckell: Colour Lighting for Home Decoration.

LINNEAN SOCIETY OF LONDON, at 5.—Miss D. Aubertin and G. C. Robson: Discussion—Are the Mollusca a Monophyletic Group?—A. T. Hopwood: Exhibition of Vertebrate Remains from the Miocene of Kenya Colony.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. R. E. M. Wheeler: London before the Norman Conquest (III.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. B. Matthews: Electric Ploughing.

ROYAL AERONAUTICAL SOCIETY, at 6.30.—Major J. D. Rennie: The Problem of the Long Range Flying Boat.

CHEMICAL SOCIETY, at 8.—Dr. T. A. Henry and H. Paget: Action of Beckmann's Chromic Acid Mixture on some Monocyclic Terpenes.—R. Grindley and Dr. F. L. Pyman: The Condensation of Glyoxalines with Formaldehyde.—W. Hubball and Dr. F. L. Pyman: Glyoxaline-4(5)-formaldehyde.—G. F. Smith and Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XXVI. Consecutive Changes in the Mutarotation of Galactose.—O. L. Brady and C. V. Reynolds: Triazole Compounds. Part II. Methylation of some 1-Hydroxy-1:2:3-benzotriazoles.—D. R. Boyd and D. E. Ladhams: The Reaction between Diaryloxy-isopropyl Alcohols and Phosphorus Oxychloride in the Presence of Pyridine.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Sir William H. Bragg: Application of X-rays to the Study of the Crystalline Structure of Materials (Thomas Hawksley Lecture).

FRIDAY, DECEMBER 2.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion:—Dr. C. Chree, Mr. Jolly, Mr. Greaves, and others: Magnetic Field Observations and Observatory Records. Chairman, Sir Frank Dyson.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.—Dr. W. L. Watt, Dr. Finzi, and others: Discussion on Deep X-ray and Radium Therapy as Applied to the Mouth and Upper Respiratory Tract.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—E. G. Herbert: Cutting Tools Research Committee. Report on Cutting Temperatures: Their Effect on Tools and on Materials subjected to Work.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—A. L. Ayre: Essential Aspects of Form and Proportions as affecting Merchant Ship Resistance, and a New Method of Estimating E.H.P.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Fuel Section) (at Engineers' Club, Manchester), at 7.—Dr. J. A. Bowie: Coal and Co-partnership.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group, Informal Meeting), at 7.—A. H. Blake: The Pictorial Aspect of Old Buildings.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—Questions and Discussions.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. S. W. Wooldridge: The 200-foot Platform in the London Basin.—Dr. A. K. Wells and Dr. S. W. Wooldridge: On the Rock Groups of Jersey with special reference to Intrusive Phenomena at Ronez.

PHILOLOGICAL SOCIETY (at University College), at 8.—Dr. O. Večadlo: Purism.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB.—J. Lee: Automatic Telephones.

SATURDAY, DECEMBER 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. Holst: Samuel Wesley and Robert Pearsall (III.).

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Address by Chairman.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Nature in the Alps.

MONDAY, NOVEMBER 28.

UNIVERSITY OF LEEDS, at 5.15.—Prof. B. M. Jones: The Dynamics of the Lifting Wing.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—J. R. Bond: Soil Cultivation.

TUESDAY, NOVEMBER 29.

UNIVERSITY OF BRISTOL (Physiological Theatre), at 8.15.—Dr. H. Devine: The Reality of Delusions (Long Fox Memorial Lecture).

WEDNESDAY, NOVEMBER 30.

KING'S COLLEGE, at 5.30.—H. Ward: The Training College.

UNIVERSITY COLLEGE, at 5.30.—H. Jenkinson: Seals, Mediæval and Modern.

LONDON SCHOOL OF ECONOMICS, at 6.—J. J. Walsh: Office Machinery: Management Statistics.

THURSDAY, DECEMBER 1.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. v. Mises: Economic Theory and the Social Problem. (Succeeding Lecture on Dec. 6.)

SATURDAY, DECEMBER 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Daryll Forde: Natural Man.

CONGRESSES.

DECEMBER 7 AND SUCCEEDING DATES.

FIFTH PAN-AMERICAN CHILD CONGRESS (at Havana, Cuba).

DECEMBER 13 TO 16.

INTERNATIONAL CONFERENCE ON LIGHT AND HEAT IN MEDICINE AND SURGERY (at Central Hall, Westminster).—Papers by Prof. Leonard Hill, Prof. I. M. Heilbron, Dr. F. Hernaman-Johnson, Dr. F. H. Humphris, Dr. H. S. Banks, Dr. E. P. Cumberbatch, Dr. J. Saidman, Dr. L. G. Dufestel, and Dr. F. Nagelschmidt.