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Metric and British Measures.

IN view of the vigorous and sustained efforts of the exponents of the metric system, and the eminent names that are to be found among them, it is perhaps not a little surprising that it makes so little progress towards general acceptance in Great Britain. The Weights and Measures Act of 1897 legalised the metric denominations for use in trade, and was expected to lead to its advantages being so generally recognised that the Imperial system would soon disappear. Twenty-five years have now elapsed, and the position is almost unchanged. In fact, the policy of compulsory introduction of the metric system by law, which formerly was always strongly supported, was ruled out by the Metric Committee of the Conjoint Board of Scientific Societies in its Report in 1919, and though the report of this Committee was not adopted by the Board, the subject of compulsion is not likely again to be seriously considered for some time at least. Even the Decimal Association has recognised this position, and now advocates a modification of the Imperial system which will serve as a first step towards facilitating the ultimate end it has in view. A modification of some sort is now being called for with increasing insistence, so that it may be desirable to examine the principal considerations involved.

A fundamental distinction must, at the very outset, be drawn between the importance of stability in the units of quantity and of dimension respectively. The units of mass and capacity, speaking generally, serve simply for determining a certain quantity of goods, and the margin of tolerance is usually fairly large; and even if this margin is greatly exceeded, the loss, to one or the other party to the transaction, is the value represented by the amount of the error alone. An alteration in the magnitude of these units, therefore, if not very large, would pass almost unnoticed. Material weights, and to a certain extent measures also, can be adjusted without any great difficulty, though the recalibration of weighing machines would not be quite so simple. The unit of length is of a different character. Size, which determines the interchangeability of parts and fittings, is not capable of ready adjustment, and an error in dimensions often involves the waste of the whole article. A change from one unit to another, not commensurable with it, must therefore introduce serious difficulty, in that apparatus designed to suit one unit cannot easily be adapted to be of service under the other. The only kind of change which could be accepted without much inconvenience would be one which left the new unit expressible, in the terms of the old, by a simple ratio, the absolute change of magnitude being of minor

importance. It was this point which went far towards determining the general trend of the Report of the Committee of the Conjoint Board.

The present policy of the Decimal Association must be examined with this difference in mind. The Association suggests a step-by-step transition, leading to a gradual familiarisation of the country with metric units, until the opposition is so far reduced that a compulsory metric system Act becomes possible. As a first step, the pound avoirdupois is to be readjusted so as to become exactly equal to half a kilogram—an increase of about 10 per cent. The official policy of the Association is to alter the ounce, dram, and grain similarly, retaining their present ratios. Dr. Guillaume prefers, if there is to be a "piecemeal" policy, to make the new pound (500 grams), contain 20 ounces, 250 drams, and 10,000 grains, the percentage changes in magnitude being of about the same order, but not all in the same direction.

It will be seen that, in itself, a change of this sort could probably be made without serious difficulty, if it were thought to be necessary. That is to say, if a deliberate and agreed decision had been come to that the metric system exclusively was to be employed in Great Britain, the transition might well have been begun in this way. In the absence of such a decision, the position is less clear. A certain amount of inconvenience must inevitably arise, particularly in the introduction of a new series of weights and measures in retail trade; and although the ultimate introduction of the metric system might be facilitated by the proposed modification, it is scarcely likely that those who are opposed to the end in view will offer any less opposition to the means employed. Faced with the ultimate proposal, that the inch should be altered to constitute one-fortieth of a metre—and this is probably the least objectionable line of action open—no concession is to be expected from opponents in favour of a first step, which does not, in itself, present very obvious advantages. It is probably far too seldom realised that the great objection to the metric system is based upon the incommensurability of the British and metric units of length. The real battle lies between the inch and the centimetre. If the alteration of either, to make it commensurable with the other, could be admitted, then its ultimate abolition could follow without much difficulty.

The view is quite widely held that the Imperial units are, as magnitudes, more suitable for commercial purposes than the metric. There is, therefore, at least a possibility that the solution of the metric controversy may be found in the development of a system based upon the British units, but so modified as to be capable of treatment on pure decimal lines. The Report of the Committee of the Conjoint Board suggests that the possibilities of such a solution should be explored, and one experiment in this direction has already been tried with success. The troy pound was abolished in 1878, but the troy ounce was too firmly established to be dismissed entirely. Trade in the precious metals, however, is now carried on in terms of troy ounces only, and bullion weights are made up solely in decimal multiples and sub-multiples of that unit. There has certainly been some activity in this direction in recent years, and should a really logical system upon a decimal basis be devised and secure general acceptance in the countries now using Imperial units, it may be found that these units are, after all, destined to survive. R. J. T.

Influenza.

Influenza: Essays by several Authors. Edited by F. G. Crookshank. Pp. xii+529. (London: W. Heinemann (Medical Books), Ltd., 1922.) 30*s.* net.

A VALUABLE series of essays is given in this volume, bringing our knowledge of this devastating disease up-to-date, and at the same time demonstrating the nebulous character of this knowledge and our impotence in face of its recurring pandemics. From the wider point of view the contributions of Drs. Crookshank and W. H. Hamer are especially valuable. The seven chapters contributed by Dr. Crookshank would have been even more valuable than they now are, had he condensed them and treated his subject more systematically. They bear evidence of previous separate publication, with considerable repetition and occasional laxness in sequence of matter.

The rest of the volume is occupied by chapters on the clinical and therapeutic aspects of influenza, which need not detain us, and by a chapter of 175 pages dealing with the bacteriology of influenza, which would have gained greatly by severe condensation.

The chief interest of the volume, however, consists in a full statement of the special views respecting influenza which the lucid and skilful writing of Dr. Hamer, ably seconded by Dr. Crookshank, has rendered important; and every one wishing to study the epidemiology of influenza, and to learn another view than that apparently favoured in the official report of the Ministry of Health, will need to study these chapters carefully.

The question at issue is whether influenza, in the various forms which are usually recognised as this disease, is a single specific disease, due to a special contagium, which may or may not be the Pfeiffer bacillus; or whether the same virus may not also be the cause of "phases" of influenza, including cases

in which the nervous centres are seriously affected, and in which the varieties of disease included in the Heine-Medin symptom complex occur.

Dr. Hamer evidently looks to a filter-passing organism as the likely key to the position, and avers that "most of the 'causal organisms' of bacteriology can be shown to be mere upstart associated organisms or secondary invaders." Using Dr. Crookshank's conception that three fundamental factors are concerned, namely, the disease, the epidemic, and the epidemic constitution, Dr. Hamer advocates the hypothesis that *the* cause of the disease, of the epidemic, and of the epidemic constitution "is the mutating *vera causa* or primary influence," which may be some ultra-visible organism. Much stress is laid on the epidemics which commonly precede and follow, or are associated with, typical influenza. Dr. Hamer evidently thinks that much of the trench fever in the recent war was influenza. This may be so, in a proportion of the cases in which an error of diagnosis was made; but this would not apply to the cases of true trench fever, the communicability of which by body lice has been demonstrated. A reference to Malta fever is similarly confusing; for if this is to be regarded as belonging to the large influenzoid group, it is remarkable that it should be entirely preventible by boiling all goat's milk which is consumed by human beings. In Dr. Hamer's words, "in thickly inhabited areas of the globe a kind of law of coincidence or of overlapping of cerebro-spinal fever and poliomyelitis and pandemic influenza" is visible. This relationship it is maintained is "not simply and solely one of concurrence, but of regulated development in definite sequence," and Creighton, our leading historical epidemiologist, is quoted in favour of the contention that we must keep in mind "gradations, modifications, affinities," and be "careless of symmetry, of definitions or clear-cut nosological ideas, or the dividing lines of a classification."

With this general proposition we are in accord, and we may agree also that fixity of type of epidemic diseases and their causal organisms is not to be assumed; but, taking the three diseases just named, it requires much imagination even to assume that they can all be due to variants of a common infection. Our knowledge of the infecting agent in poliomyelitis is now considerable; and although the proof that the meningococcus is the cause of cerebro-spinal fever is not absolutely complete, the converging evidence of bacteriology and vaccinal treatment is strongly in favour of this conclusion. Without adequate reason, to assume that the contagia of diseases which are commonly associated are variants of a common contagium is a retrograde scientific step; it appears much more probable that the true explanation of the frequent association or sequence of influenza, poliomyelitis, encephalitis lethargica, and cerebro-spinal fever is that the "epidemic constitution" in these years favours the whole group of infections and not merely one of them—influenza. There is close analogy between this view and the view which explains the coincidences and sequences in seasonal and pandemic occurrence of scarlet fever, puerperal fever, rheumatic fever, diphtheria, to which attention has been directed in investigations by Longstaff and Newsholme. It can scarcely be contended that all these diseases are manifestations of a common infecting agency.

The view just stated appears to be confirmed in the article in the present volume by Dr. Dwight Lewis of Newhaven, U.S.A. Classical influenza, in his view, is caused by the Pfeiffer bacillus, but "the various waves of the so-called pandemic of influenza were caused by consecutive and increasing prevalences of correlated diseases due to the activation of carriers of the organisms of these diseases, whether by the influenza bacillus or by the streptococcus." There is no difficulty in believing in what we may call a first-cousinship of diseases, in the influence of one or other of these in increasing the virulence of another, and especially in believing in the death-dealing quality of their combined operation, as, for example, that of the organism of influenza and of the *Streptococcus hæmolyticus*.

The criticisms in the last chapter of the Government report on influenza are interesting. There is just enough truth in the statement that "what is not recorded, or is not known to be recorded, does not officially happen," to give it tang.

Dr. Crookshank appears to differ gently from Dr. Hamer in the description of the intercurrent maladies as "phases of influenza," and suggests that these "specialised" epidemics should be described as *influenzoid*. With considerable imagination, he suggests that the recognition of these would be the first step towards the foretelling of the imminence of pandemic influenza. If this ever become practicable, it will constitute an important advance in our knowledge; but meanwhile we are all familiar with sporadic cases of these diseases which are not followed by epidemic influenza.

In short, this contribution to the subject is provocative of thought; and we hope also that it will lead to more exact epidemiological as well as bacteriological investigation. It presents a better philosophy of epidemicity than is usual; and Dr. Crookshank's contributions on this aspect of the problem will repay study. We rather think, however, that he is somewhat astray in apparently thinking that the importance of "epidemic constitution"—as a factor in producing pandemicity—is not generally recognised. This is the

mystery of mysteries, and we have not yet approached its solution. But we must approach it; for recurring pandemics of influenza like the recent one are more serious to civilised mankind than even the Great War.

History of Electrotherapy.

An Essay on the History of Electrotherapy and Diagnosis. By Hector A. Colwell. Pp. xv+180. (London: W. Heinemann (Medical Books) Ltd., 1922.) 17*s.* 6*d.* net.

AN essay of 171 pages indicates a healthy respect for the subject treated and this is handed on to the reader who peruses it. Dr. Colwell has in some ways been fortunate in his subject, because it is one which yields to historical treatment when approached by a scholar. Of the evidences of this latter quality there is plenty of proof throughout this essay; there is a happy blending of historical accuracy, judgment in selection of facts, and a sense of the real importance of the subject of electrotherapy. The parent subject is now rather apt to be somewhat eclipsed by the more youthful one of radio-therapy, yet the benefit derived from electro-therapeutic measures in diagnosis and in the treatment of many diseases is a matter which need not be laboured.

Perhaps more than in any other branch of the healing art, the scientific advance of the subject to its present position has been one long series of spasmodic efforts interspersed between long periods of quiescence and indeed neglect. The neglect was probably the rational outcome of the conditions of quackery which often showed itself in the application of electricity to the ills of the human body. It is probably not very far from the truth to correlate this halting progress of the subject with the parallel state of affairs in the study and researches of a physical character into the nature of electricity itself.

It is interesting to read that a professor of physics, one Jallabert of Genoa, is to be regarded as the first scientific electrotherapist; for it is a matter of history that, in 1747, in collaboration with the surgeon Guyot, the electrical current was employed by him to produce muscular contractions in injured limbs, thus giving them the exercise necessary for the restoration of their normal functions. Though this is the case, the founding of modern electrotherapy occurred almost a century later as a result of the work of Duchenne of Boulogne.

The essay traces the growth of the subject to the present day. The last forty pages are devoted to the subject of radiology, but perhaps the lapse of time since the discovery of X-rays has been insufficient for a successful treatment of the subject on historical lines. Four pages of notes and an index complete a volume which is very well produced and illustrated by a number of plates of great individual interest.

The author is to be congratulated on an essay which marks out so clearly the milestones which have been passed and the obstructions which have been met in the journey of electrotherapy to its present-day status.

Mustard Gas Poisoning.

The Medical Aspects of Mustard Gas Poisoning. By Prof. A. S. Martin and Dr. C. V. Weller. Pp. 267. (London: Henry Kimpton, 1919.) 42*s.* net.

THIS volume is a belated account of investigations carried out at Michigan during the war; in 1917 it would have been eagerly welcomed, at the date of publication which it bears it would have been decidedly interesting, at the present time it will only be so to specialists and historians. It tells, with a wealth of detail which seems needless, of the effects of β-β-dichlorethyl sulphide, or mustard "gas," on various animals and on men accidentally gassed with it at factories in America where the substance was manufactured for gas offensive purposes during the war.

The substance is a general protoplasmic poison, readily penetrating the epidermis and other tissues; once inside the cells it is probably hydrolysed, and the extensive damage is due to local liberation of hydrochloric acid. The chief effects are therefore a destruction of all the cells with which the substance comes into contact; the eyes, lungs, and skin are the most likely to be affected, and the danger lies chiefly in the fact that the substance has but little smell, so that dangerous concentrations may be encountered without arousing suspicions in those unacquainted with the properties. As the substance is a liquid of high boiling-point, soil or other materials which have been fouled with it may remain a source of danger for days.

Treatment of the affected parts is directed chiefly to the alleviation of symptoms; chlorine destroys the substance, so that local application of hypochlorites is useful in the treatment of skin burns, which are the most troublesome effects likely to be met with in men whose eyes and lungs are protected by the wearing of respirators.

The reviewer himself worked out the chief physiological effects of this substance on animals in the spring of 1916, at the suggestion of his colleague Dr. H. W. Dudley; the results were reported through the proper channels, but were not published. The Germans first used the substance some fifteen months afterwards.

The work before us is the most complete and accurate

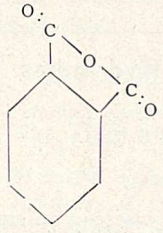
account of the subject of mustard gas poisoning extant. Let us hope that it will be long before such a book is needed again; should there be another big war in our time, this work will provide a complete account of the properties of a substance which, had it been used earlier in the recent war, would almost certainly have proved a deciding factor.

C. LOVATT EVANS.

Tinctorial Chemistry and Histology.

Untersuchungen über Echtfärbung der Zellkerne mit künstlichen Beizenfarbstoffen und die Theorie des histologischen Färbeprozesses mit gelösten Lacken. Von Prof. Dr. Siegfried Becher. Pp. xx+318. (Berlin: Gebrüder Borntraeger, 1921.) 10*s.* 6*d.*

THERE have been several attempts to evolve a scientific basis of the staining processes which are used in histology, but nothing as comprehensive as the book under review has so far been produced. It is the outcome of more than twenty years of research on the application of tinctorial chemistry to histology. The book contains a remarkable amount of sound chemistry, and one cannot but wonder how a professor of zoology and comparative anatomy could have found the time to acquire such profound knowledge of a subject so removed from his special lines of thought and study. Dr. Becher has been very successful in the manner in which he has combined histology with chemistry, and even the few peculiarities in his chemical terminology and chemical formulæ, such as, for example, his eccentric formula:



for phthalic anhydride, only add to the peculiar charm of the book. They vouch, at least, for the fact that the author has not blindly copied his chemical matter, which is too often the case when biologists develop chemical tendencies.

That the rituals of histology will have to give place to chemical common sense is evident from Becher's researches, which show conclusively that successful staining depends on one factor only, namely a well selected "triple-alliance" (a *bon mot* presumably chosen by Dr. Becher before the War) of tissue, mordant, and stain. Careful considerations of the individual and combined chemical properties of these three factors lead to success, their neglect spells failure. This is the *leit-motif* of the whole research, which is abundantly supported by more than 2000 experiments. Becher's researches lead him also to the following generalisations, namely (1) the solubility of the "lakes" (metallic compounds of organic colouring matters) is of great importance, for good staining depends not on the solubility of the dye, but on that of the "lake," and (2) that all "lakes" of the hydroxy-anthraquinones are of general use for nuclear staining. The hydroxy-anthraquinones have been specially studied by Becher and the attention of histologists may be directed to pp. 271-275, which give a practical summary of these results.

However, not only histologists, but also chemists will find much in this book that will be of interest to them. There is too much belief in the infallibility of Griebler's stains in histological circles and the British dye industry would, perhaps, be well advised to pay some attention to this particular aspect of tinctorial chemistry. That not only Germany but also other countries manufacture dyes which give good histological results is again also evident from the work under review, since Dr. Becher has successfully used French, Swiss, Dutch, Belgian, and British dyes.

Reference might, perhaps, be made to a few minor errors, such as the statement on p. 121 that ellagic acid was synthesised by Georgievic in 1913, whereas it was actually synthesised by Perkin and Nierenstein in 1905. Such slight defects, however, detract little or nothing from the value of the book, which is certainly the best of its kind so far published.

M. NIERENSTEIN.

Mineral Resources of Yugoslavia.

The Geology and Mineral Resources of the Serb-Croat-Slovene State: Being the Report of the Geologist attached to the British Economic Mission to Serbia. By D. A. Wray. (Department of Overseas Trade. Ref. No. F.E. 383). Pp. 111. (London: H.M. Stationery Office, 1921). 3*s.* 6*d.* net.

THE Department of Overseas Trade has rendered a distinct service to economic geologists in publishing an account of the mineral resources of Yugoslavia, because our knowledge of this subject has hitherto been decidedly fragmentary. A few of the mineral deposits have long been well known, such as the mercury mines of Idrija, the copper mines of Majdanpek and the iron mines of Vares, but systematic information was lacking, and this has now been supplied by the painstaking work of Mr. D. A. Wray.

After a brief introduction dealing with the more important general and economic features of the new

state of Yugoslavia, we have first a brief but clear account of the geological structure of the region under discussion; it is greatly to be regretted that this part of the work was not illustrated by a geological map of some kind, even though it were only a small sketch map, as this would have been extremely helpful for a proper understanding of the somewhat complex geology. The various mineral deposits are next described in much detail, this constituting the principal and indeed the most valuable portion of the work. Under the heading of coal it is shown that true bituminous coal is very scarce, but that there are considerable reserves of lignites, which amount probably to about 1900 millions of tons, whilst the possible reserves are even greater. With the exceptions of some of the smaller beds of Liassic and Cretaceous coal in Serbia, all the coals are of Tertiary age and are for the most part of inferior quality, their calorific power lying usually between 4000 and 5000 calories. They can, however, be used successfully on railways, for steam raising and for domestic purposes, but are not suited for metallurgical operations or other work where high temperatures are required. Apparently the coal resources of the State would cover satisfactorily the great majority of its requirements, were it not for the grave lack of means of communication, which also has hindered in no small degree the development of the various coalfields.

There are quite a number of deposits of iron ore; according to Dr. Katzer, the Government geologist, the more or less known reserves of iron ore amount to some 22 million tons, of which 15 millions are limonite. Mr. Wray is of opinion that "the total reserve tonnage may safely be computed at 30 to 40 million metric tons." The iron industry is, however, quite insignificant; there are a few small blast-furnaces, chiefly in the Vares district, charcoal being apparently the only fuel used; one of these furnaces, situated at Krapuli, 2 kilometres south of Vares, is said to have a daily output of more than 100 tons of pig iron, probably the largest ever obtained from a charcoal furnace. Owing to the want of good coking coals and the defective means of transport, there seems at present little probability that this industry can attain dimensions of any importance.

There are well-known copper mines at Majdanpek, which have been worked since Roman times; the output from 1870 to 1890 is stated to have totalled about 2500 tons of copper. Another important group of mines is that of Bor, now being worked by a French company; the production is said to have gone up to the high figure of 7575 metric tons of copper in the year 1911–12. The famous quicksilver mines of Idria have been worked ever since the fifteenth century, the annual output since 1900 having been of the order of 500 tons.

Among the other minerals that have been or are being worked may be named iron pyrites, manganese ore, chrome ore, antimony ore, gold, lead ore, zinc ore, bauxite, meerschaum and rock-salt.

It will be clear that Mr. Wray has done his work extremely well and has collected a great bulk of very valuable information. It is, however, to be regretted that he did not submit his proofs for revision to some competent metallurgist, as several blunders forming serious blemishes in the report would in this way have been detected. For instance, Mr. Wray states that there are at Majdanpek "three furnaces of the 'Knudsen' type (Sulitelma and Co., Norway)," whereas the Knudsen process is conducted in a special form of converter, and was worked out by the inventor at the well-known Sulitelma mines. Again, his description of the "Majdan" furnaces, evidently a primitive form of blast-furnace, is quite unintelligible; he writes: "The pig-iron came out in part with the scoriæ, and in part remained in the bottom of the furnace. The latter product was much preferred, as by the continual action of swiftly-moving hammers (driven by water-power) it lent itself directly to treatment." It is obvious that if this material was pig-iron, it could not have been worked under the hammer, and we are left in doubt whether it was malleable iron or steel, or whether it really was pig-iron which was converted into malleable iron in some kind of a finery; either of these might be the correct explanation, whereas the statement as it stands is obviously incorrect.

H. L.

Hydraulics.

Hydraulics with Working Tables. By E. S. Bellasis. Third Edition. Pp. viii + 348. (London: Chapman and Hall, Ltd., 1920.) Price 18*s.* net.

HYDRAULICS is largely an empirical science and as experience accumulates it is to be expected that the formulæ expressing the flow of water in particular conditions will be modified either in form or by a change in the experimental coefficients. The author of the book before us has had considerable experience in the irrigation department of India, and it might have been expected, therefore, that new data confirming or modifying generally accepted formulæ would have been incorporated; particularly additions to knowledge in those cases in which the experimental work has been small might have been forthcoming in this work. We look in vain, however, for such new data; the author has been content to discuss certain principles, to accept the generally accepted formulæ and to illus-

trate their applications in connexion with important practical problems. To determine the flow in pipes and channels the author adheres to the old Chezy formula and gives tables of values of the coefficient C. He not unreasonably points out that this formula has the advantage of simplicity over the logarithmic formulæ, but he does not adduce evidence from his experience as to the comparative accuracy of the results they give. Thus the serious student of hydraulics can scarcely be satisfied with the treatment.

The chapter dealing with variable flow in open channels is of considerable interest and importance, and contains valuable suggestions to those who deal with such channels, especially when the streams are dammed by weirs and barrages. The correct form of the surface up stream from such barrages is, however, not satisfactorily discussed; the problem is admittedly a difficult one, but of importance, and needs more adequate treatment than that given by the author.

The brief chapter on unsteady flow deals with the time of emptying vessels and with waves in open channels; there are also brief remarks on the effects of waves and floods assisting in scouring or causing deposits. The work concludes by a brief chapter on the dynamic effect of flowing water.

The student will find this work suitable for reading in conjunction with some work on hydraulics which deals with the subject from the fundamental rather than from the practical engineer's point of view. The development in the volume under notice is not sufficiently logical for the student desirous of understanding thoroughly the fundamentals of the subject, but he as well as the practising engineer will find it both useful and interesting. F. C. L.

Our Bookshelf.

Applied Entomology: An Introductory Text-book of Insects in their Relations to Man. By Prof. H. T. Fernald. (Agricultural and Biological Publications.) Pp. xiv+386. (New York and London: McGraw-Hill Book Co., Inc., 1921.) 21*s.* net.

TEXT-BOOKS of applied entomology are usually compiled according to one of two methods. In one type of book the various injurious insects are classified and enumerated under their respective orders and in the other type they are dealt with under the crops or other objects with which they are associated. The first method, which is the one adopted by Prof. Fernald, is unquestionably the better way of presenting the subject to the elementary student. The alternative method is more adapted to the needs of a practical reference book, in which the primary consideration is to render the information available by means of the most convenient, although not necessarily the most scientific, manner of presentation.

Prof. Fernald has carried out his task with conspicuous ability, and the book is certainly worthy of the Massachusetts school of entomology. Within a compass of less than 400 pages he manages to give the essential facts concerning the biology and control of all the more important insects affecting man, either directly or indirectly, in the United States. The general introductory chapters are perhaps a little too much abbreviated; nevertheless, they contain the essential elementary facts concerning the structure and metamorphoses of insects, and the principles of control commonly in vogue. Twenty-four orders of insects are recognised, and each is dealt with in turn, whether it contains injurious species or not. The student is thus enabled to view the class Insecta more or less as a whole, and appreciate the place of each order in the scheme of nature. The work is adequately illustrated and well printed. A few misprints are noticeable in the explanatory text relating to eight or nine of the illustrations, but they are not sufficiently serious to detract from the value of the book. A. D. IMMS.

Exploration of Aïr: Out of the World North of Nigeria. By A. Buchanan. Pp. xxiv+258. (London: John Murray, 1921.) 16*s.* net.

THE journey which Mr. Buchanan describes in this volume was undertaken at the instance of Lord Rothschild. Its object was to link up the chain of zoological geography across the country lying between Algeria and Nigeria. Starting from Kano in Northern Nigeria, the author traversed the French Territoire Militaire du Niger of the Western Sudan and reached the mountainous region of Aïr, which had not been visited by any European since Dr. Barth passed through it seventy years ago. Mr. Buchanan's style is vivid and his narrative racy; he touches but lightly on the hardships he had to endure in this arid section of the African continent. He is at his best when he describes the vicissitudes of tracking down some much coveted specimen. His accounts of the natives with whom he came into contact, although not sufficiently detailed to be of much value to the ethnologist, will give the general reader a very good idea of the character of these peoples. He devotes a chapter to the Touaregs of Aïr, in which he gives a very fair account of the more salient elements of their culture and of their costume, of which the veil worn by the men is the most characteristic feature. It is to be regretted, however, that he has not given a more detailed description of a people so little known.

The Principles of Radiography. By Dr. J. A. Crowther. Pp. vii+138. (London: J. and A. Churchill, 1922.) 7*s.* 6*d.* net.

DR. CROWTHER'S book is intended primarily for those beginning the study and practice of medical radiology, to whom it should be of considerable service. The author gives in a lucid and practical manner an account of the principles involved in the production of a skiagram and the mode of construction and action of the apparatus used. The subject-matter of the book forms part of a series of lectures given by the author to candidates for the Diploma in Medical Radiology and Electrology at Cambridge University.

The elementary principles receive full treatment, nearly fifty pages being devoted to their consideration. After a description of the properties of X-rays and the peculiarities of X-ray tubes, the production of high-tension currents is treated. The remaining chapters are devoted to the various parts of an X-ray installation, the actual taking of skiagrams, and the localisation of foreign bodies.

The description given to Fig. 25 will no doubt be altered in a future edition and the X-ray tube depicted in Fig. 26 be given terminals of different signs. Though written by a physicist, it is evident that the writer has had some practical experience in the radiography of the human subject, which enhances the value of the book.

The Principles of Mechanical Refrigeration. (A Study Course for Operating Engineers.) By Prof. H. J. MacIntire. Pp. viii+252. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 12*s.* 6*d.*

THE engineering courses at our Universities and Technical Schools deal as a rule much more thoroughly with the conversion of heat into work than with the conversion of work into heat, or rather, into the absence of heat. This holds to a considerable extent for American universities and colleges, and it is for engineers so trained that the present volume is intended. Attention is directed chiefly to the details in which refrigerating machinery differs from the machinery with which the average engineer is familiar. It is probably due to the simplicity of the new problems which the ammonia refrigerating plant brings before the mechanical engineer that ammonia owes its popularity. The actual cost of producing a given amount of refrigeration is almost the same by the three or four methods at present in use, and the author of the present work thinks that the carbonic acid has many advantages over the ammonia method. Ethyl chloride used with a rotary compressor is extensively used in the American Marine, and much more information on the use of this material would be welcomed by refrigerating engineers in this country. The book contains tables of the properties of refrigerants compiled from Bureau of Standards reports, which are more up-to-date than any with which we are acquainted in books published in this country.

The Stagery of Shakespeare. By R. Crompton Rhodes. Pp. xii+102. (Birmingham: Cornish Bros., Ltd., 1922.) 4*s.* 6*d.* net.

MR. RHODES'S little book is an important contribution to the study of the stage-craft of Shakespeare and his contemporaries. His method has been to compare closely the stage directions of the quarto editions of the plays and those of the First Folio. He finds that in the quartos which are generally recognised as pirated, the stage directions have the character of observations rather than of instructions, as might be expected from the circumstances of their origin. As a result of the comparison, Mr. Rhodes is able to offer a number of suggestions as to the use of the curtains to provide a recess on the stage and the use of the balcony covering the three terms used by Shakespeare, "aloft," "above," and "at a window." His deduction that in those cases in the First Folio, where there are no stage directions or very few—"The Two Gentlemen of Verona," "The Merry Wives of Windsor," "Measure for Measure," "The Winter's Tale," and "King John," —we are dealing with a text assembled from the players' parts, deserves attention in the consideration of a difficult problem, for the solution of which Sir Sydney Lee's theory of transcripts in private hands does not appear entirely convincing.

Twenty-Five Years in East Africa. By Rev. John Roscoe. Pp. xvi+288+xix Plates. (Cambridge: At the University Press, 1921.) 25*s.* net.

IN this volume, Mr. Roscoe has given an account of some of his experiences and observations of the manners and customs of the natives of East Africa during his twenty-five years' service as a missionary in that area. In particular his aim has been to describe the condition of the country and the natives when first he took up his work. From this point of view, his book forms a useful pendant to the more strictly ethnographical works he has already published dealing with the Baganda and other Bantu tribes. The connected narrative adds colour to these analytical studies. When Mr. Roscoe first arrived in the country the Uganda railway, of course, was not in existence, and he gives a vivid picture of the difficulties encountered by the traveller, arising both from the character of the country and the untrustworthiness of the native carrier, the only means of transport. To many of his readers the most interesting section of the book will be that dealing with the events, of which he was an eye-witness, leading to our assumption of the Protectorate over Uganda. In this account, curiously enough, Sir Frederick Lugard is mentioned only incidentally.

Joseph Glanvill and Psychical Research in the Seventeenth Century. By H. Stanley Redgrove and I. M. L. Redgrove. Pp. 94. (London: William Rider and Son, Ltd., 1921.) 2*s.* 6*d.* net.

JOSEPH GLANVILL is no doubt best known to the modern reader as the source of inspiration of Matthew Arnold's well-known poem, and secondly as author of a treatise on witchcraft which W. E. H. Lecky described as "probably the ablest book ever published in defence of the superstition." It is not so generally known that Glanvill was an ardent advocate of the experimental method and a sturdy opponent of dogmatism. He was not only a Fellow of the Royal Society, being elected in 1664, and a friend and admirer of Robert Boyle, but in addition to making three communications to the society which appeared in the Transactions, he was the author of an account of the advances in the various departments of scientific knowledge since the time of the ancients. Incidentally in this work he suggested that the Torricellian vacuum was not an absolute void. In the short account of Glanvill under notice his various activities are noted and his views set forth, for the most part, in his own words. The authors are, however, chiefly interested in his psychic investigations, on account of which he may be considered, legitimately, to be the founder of modern psychical research.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Difference between Series Spectra of Isotopes.

PROF. P. EHRENFEST and Prof. N. Bohr, in their letters to NATURE of June 10, have raised the interesting question of the difference to be expected between the spectra of isotopes. Much confusion, as their letters clearly indicate, exists on the subject, and while not in disagreement with any of their conclusions, I should like to make a few remarks which may tend to elucidate the matter somewhat further.

Prof. Ehrenfest raised the question in relation to the spectra of the isotopes of lithium—the subject of an investigation by Prof. Zeeman—and pointed out that the factor $M/(m+M)$ in the Rydberg constant was only deduced by Bohr—and subsequently used by Fowler to obtain the best estimate we have for the ratio m/M, in his Bakerian lecture—for the case of an atom with a *single* electron. He justifiably rejects any conclusions founded on its application to atoms with more than one electron, and Prof. Bohr entirely concurs. Ehrenfest's illustration of an atom in which the mass of the nucleus, on account of symmetry, does not enter into the spectrum at all, is perhaps a sufficient indication of the difficulty of the problem, if such symmetrical atoms can exist, a matter which appears improbable.

The spectra of the lithium isotopes are at present peculiarly interesting since the announcement that Prof. M'Lennan has isolated them and found a difference which is greater than that calculated by the Bohr formula, and in fact three times this value, while 3 is the accepted atomic number of lithium. The quantum theory is unable to explain this large separation, and its exponents must doubt the fact that M'Lennan's new series is the spectrum of an isotope. There are two alternatives—it may be a combination series or a spark series. In an investigation which the present writer made a year ago, on some of the simpler possible orbits in a lithium atom with only two electrons, a specially simple class of orbits was found. Although the work is not yet published, it is possible to state that its result gave, as the principal spark-line of lithium, a value very close to λ 6708, the red line shown in the ordinary spectrum. This line had already been suspected, by several spectroscopists, to have a spark component.

In these simple orbits of a lithium atom positively charged, the two electrons are behaving very differently. The orbit of one of them is only about $\frac{1}{10}$ the linear dimensions of that of the other, so that the Bohr formula for one electron is nearly applicable. In fact, the orbits are very closely analogous to those now generally accepted for the neutral helium atom, which can take two forms, in both of which the orbit of one electron is very small compared with that of the other; the orbits differ mainly in the fact that in ortho-helium they are practically coplanar, and in parhelium practically perpendicular.

I have found it possible by a choice of the simpler orbits, and by the supposition made by Sommerfeld and others as to the invariability of the energy W for all possible orbits, to show that the inner orbit has a radius only about $\frac{1}{10}$ of that of the outer. Thus the Bohr formula is again nearly true, and the Rydberg constant in the ordinary helium series is not very different from its value in the Pickering series. Such results are suggestive, and appear to indicate that when there are many electrons in an atom, a ratio roughly of order $\frac{1}{10}$ exists between the orbital radii of the two outer consecutive electrons. An immediate consequence is that the Bohr formula would never be very far wrong in its use for a rough determination of the separation to be looked for in the spectra of isotopes. If the correspondence with these results does not, however, extend to heavier atoms, we are precluded from making any prediction without the knowledge of the general position—on the average—of the centre of mass of an atom. In a problem of this nature no general treatment is possible, and no general simple law of separation down the Periodic Table is to be expected.

J. W. NICHOLSON.

Balliol College, Oxford, June 12.

A Possible Reconciliation of the Atomic Models of Bohr and of Lewis and Langmuir.

BROADLY speaking, the merits of Bohr's atomic model lie in its very accurate explanation of the reaction of atoms and molecules with radiation, while those of the Lewis-Langmuir model lie in its very satisfactory representation of the mechanism of chemical combination, but the merits of either model are lacking in the other. Both must therefore possess properties which are accurate representations of the truth, and the problem remains to devise a third model which will incorporate those properties in its structure. The following considerations lead to a modification of the Lewis-Langmuir model, which appears to be a satisfactory solution of the problem—so far as I am aware it is new.

Consider first the well-known Lewis-Langmuir model for any atom. It is built up of the central nucleus and its surrounding electrons the mean positions of which are fixed with respect to one another and to the position of the nucleus. Now in order to account for the reaction between the atom and radiant energy it is necessary to assume that these electrons possess acceleration of some kind. The particular kind most agreeable with the results of experiment is the orbital acceleration assumed by Bohr. But since the electrons are fixed (or can be assumed to move but very slightly from their fixed mean positions) in the Lewis-Langmuir model, orbital acceleration is impossible.

Now, apparently, a way out of this difficulty is to assume that the electron shells are fixed and the nucleus rotates on an axis.

By the Theory of Relativity it is immaterial whether—viewing a given atom—we regard the electrons as describing orbits around a fixed nucleus (not fixed in position only) or whether we regard the nucleus as rotating inside the electron shell or shells with each electron fixed relatively to the others. That is, the nucleus possesses acceleration with respect to the electrons, or what is the same thing, the electrons possess acceleration with respect to the nucleus in spite of the fact that they are fixed relatively to outside systems such as other electron shells. Therefore this model when viewed with respect to the electron shells is precisely the same as the Lewis-Langmuir model, and, furthermore, with respect to the whole atom it possesses all the merits of Bohr's model. That is, it appears to be a satisfactory reconciliation of the two atomic models.

Furthermore, the proposed model possesses the further merit that by its aid we can predict the existence of isotopes. Thus if the nucleus of a given atom possesses more than one stable axis of rotation with respect to itself, or to its surrounding shells of elec-

trons, or to both, and these axes are associated different amounts of energy, it is possible for the mass of the atom to be different for the different positions of the nuclear axis, since by the Theory of Relativity energy possesses mass. That is, the model proposed predicts the existence of isotopy. If the direction of the nuclear axis as described above is determined by the structure of the outer shell of electrons, we should expect the existence of different axes in the same atom to be favoured in those atoms the outer shells of which are complete (inert gases), nearly complete (halogens), or just forming (alkali metals). An inspection of Aston's list of isotopic elements shows that it is in the neighbourhood of the inert gases that the phenomenon of isotopy chiefly occurs.

W. HUGHES.

63 Goldington Avenue, Bedford.

The Intensity of X-ray Reflection from Powdered Crystals.

IN the May number of the *Philosophical Magazine* which has just reached us, Mr. C. G. Darwin has presented a most valuable discussion of the reflection of X-rays from imperfect crystals. He shows that, on account of the difficulty in determining the effective extinction coefficient of the X-rays in such crystals, it is very difficult to calculate with accuracy the intensity of the reflected beam. Hence he is unable to make a satisfactory comparison between the theoretical formulæ and the existing experiments on the intensity of X-ray reflection. This result is in general agreement with the conclusion reached by one of us (*Physical Review*, July 1917) on the basis of somewhat similar considerations.

Mr. Darwin concludes that a more satisfactory test might be made on powdered crystals, since in this case the only factor contributing appreciably to the extinction is the ordinary absorption of the X-rays in the powder, which can be measured directly. We had arrived at the same conclusion, and have made quantitative measurements of the intensity of the X-rays scattered by powdered crystals.

In our most recent experiments, the Kα line from molybdenum ($\lambda + 0{\cdot}708$ Å.), after reflection from a crystal of rock-salt, was allowed to fall upon a plate of powdered sodium chloride. The first order reflection from the [100] faces of the powdered crystals then entered the ionisation chamber. The method was thus similar to that employed by W. H. Bragg (Proc. Phys. Soc., Lond., 33, 222, 1921) except that the primary rays were homogeneous. The ratio of the energy reflected into the ionisation chamber due to this first order line to that incident upon the plate was $2{\cdot}94 \times 10^{-4}$, with a probable error of about 10 per cent. The theoretical intensity of the line was calculated from a formula identical in significance with Darwin's formula (10·4) (*loc. cit.*), except that correction was made for the absorption of the X-rays in the crystal mass. We thus obtained the value $2{\cdot}7 \times 10^{-4}$, which is in satisfactory agreement with the experimental measurement. Thus, at least to a close degree of approximation, the theory of X-ray reflection based upon the classical electrical theory gives accurate results.

This comparison of theory with experiment may be viewed in another manner. Any formula for the intensity of X-ray reflection must depend upon the value of a function ψ, the magnitude of which is determined by the distribution of the electrons in the atoms. The theoretical value $2{\cdot}7 \times 10^{-4}$ mentioned above is based upon the value $\psi^2 = 0{\cdot}59$, *i.e.* upon the assumption that the intensity is 59 per cent. as great as it would be if all the electrons in sodium and chlorine were grouped together at the centres of their respective atoms. This value was estimated by one of us (*loc. cit.*) on the basis of some of W. H. Bragg's measurements of the relative intensity of the different orders of X-ray reflection from rock-salt. The corresponding value of ψ^2 as determined by the measurements of W. L. Bragg, James and Bosanquet is 0·43 (*Phil. Mag.*, July 1921). To obtain our experimental value $2{\cdot}9 \times 10^{-4}$ for the intensity of reflection from powdered crystals, the value of ψ^2 must, however, be 0·64. The difference between the latter two values of ψ^2 supports Darwin's suggestion that the method employed by Bragg, James and Bosanquet for studying the intensity of X-ray reflection is not wholly trustworthy.

We hope in the near future to be able to report experimental results of a considerably higher degree of accuracy than those described above.

ARTHUR H. COMPTON.
NEWELL L. FREEMAN.
Washington University, Saint Louis, May 30.

Discoveries in Tropical Medicine.

I AM much astonished to learn, for the first time, from Dr. L. W. Sambon's letter in NATURE of May 27, that during the whole period of my work in India (from April 1895 to February 1899) he "was almost daily at Manson's house" and was allowed to read my private letters to Manson and to "discuss every detail." Are we to understand by this that his almost daily visits to Manson's house continued for all this period, and that during it he read all my letters to Manson, numbering 110, and averaging a thousand words each in length; or merely that he read a few of the letters which Manson showed to him from time to time? Dr. Sambon would appear to claim the former interpretation of his words, because he proceeds to suggest that he is intimately acquainted, in consequence of his knowledge of these letters of mine, with all details concerning the relations between my work and the theories of Manson. If so, I can only say that I am amazed and hurt. Many of my letters to Manson were of a very private nature, and it is difficult for me to believe that he would have handed over the whole of this correspondence without reserve to a gentleman who was at the time a stranger to me and was in no way concerned with my affairs.

Moreover, when Manson sent some of my letters to Lord Lister he was, of course, careful to inform me of the fact; but he never mentioned the name of Dr. Sambon, so far as I remember, in all the fifty-six letters which he wrote me in reply to mine, as surely he would have done had he decided to submit my letters to a third person without my previous consent. Nor did Sir Patrick Manson ever mention this matter to me during the many years which have elapsed since the correspondence referred to ceased. On the other hand, if Dr. Sambon did not see all my letters to Manson, including the private letters, he cannot possibly have that close knowledge of my work which he seems to believe he possesses.

The remainder of Dr. Sambon's communication in NATURE referred to makes me still more doubtful regarding the interpretation which is to be placed upon his words; for it seems to me that he does not understand the said relations between my work and the theories of Sir Patrick Manson. May I also take the opportunity to state that I for one can scarcely accept as sound any of the conclusions which he has set forth in your columns in the letter referred to.

RONALD ROSS.

The Oldest known Rocks of the Earth's Crust.

MAY I welcome Prof. A. P. Coleman's letter on "Geology and the Nebular Theory" in NATURE for June 17, p. 775? It must be admitted that the achievement of A. C. Lawson at Rainy Lake in 1887, the elucidation by Sederholm of the floor of Finland, and the illuminating work of Canadian geologists, including Coleman, Adams, and Barlow, on the Grenville Series, have been slow in penetrating academic circles in the British Isles. The doorways were almost closed against them, and against the views of French geologists also, by the dead-weight of theories of dynamic metamorphism. Yet our confidence in a fundamental "Lewisian" gneiss was well shaken thirty years ago by Sir A. Geikie's announcement that this rock penetrated a sedimentary series (see A. Geikie, "Text-book of Geology," 4th ed., vol. 2, p. 890); and a more detailed acquaintance with the ground would have led the same observer to withdraw his statement (*ibid.*, p. 895) as to a "violent unconformability" between gneisses and Dabradian sediments in north-west Ireland. Some of us have lost no opportunity of comparing the conditions in our homeland with those of broader Archæan areas. But even in our narrow lands, as I have ventured to urge from 1900 onwards, the teaching of the rocks themselves is unmistakable. The oldest known rocks are sediments, and the streaky structure of our ancient gneisses again and again records the stratification of ordinary sediments invaded by a granite magma.

I have recently put this view before those who may not be geologists in a volume of "unconventional essays," containing a chapter on "The search for the foundation-stones," where Prof. Coleman will find that his expositions have not been thrown away upon those whom he has so kindly guided in the field.

GRENVILLE A. J. COLE.

An Exception to the Principle of Selection in Spectra.

IN a recent communication (*Phil. Mag.*, April 1922) Messrs. Foote, Mohler, and Meggers have described the excitation of a certain type of combination lines in a new form of discharge tube in which the *applied* electrostatic field can exert no influence upon the radiation. Thereby they made it somewhat doubtful whether these and other exceptions to the principle of selection can be attributed to the incipient Stark effect of the applied field, as suggested by Sommerfeld and others. In reply to this, Prof. N. Bohr has pointed out (*Phil. Mag.*, June, 1922) that, "owing to the screening from external forces, the experimental arrangement described would be especially favourable for the accumulation of ions in the region of the discharge tube," and that "the field due to the neighbouring ions and free electrons, to which the emitting atoms have been subject, may be of the order of magnitude claimed by the quantum theory for the appearance of the new lines." Consequently Prof. Bohr thinks that the results of Foote, Mohler, and Meggers do not furnish a sufficient basis for the conclusion they have drawn.

Recently, however, in the course of an investigation on the absorption spectrum of potassium, the results of which will be published shortly, the combination lines $1s-2d$ ($\lambda 4642$) and $1s-3d$ ($\lambda 3649$) have been obtained as absorption lines. The existence of free electrons and the consequent electrostatic field of atomic origin in the absorption tube is highly improbable. The present experiment therefore seems to support the conclusion drawn by Messrs. Foote, Mohler, and Meggers.

S. DATTA.

Spectroscopy Laboratory,
Imperial College of Science and Technology,
South Kensington, S.W.7.

The Melbourne University Bill.

IN the issue of NATURE for March 16, which has just reached Australia, there is a leading article on the Melbourne University Bill. That Bill was drafted more than eighteen months ago, and though we have a Government in sympathy with the highest ideals of our University, it is still a Bill and has not yet become an Act of Parliament. In the article in question reference is made to a statement drawn up by the University Association of Teachers, in which the council of the university is criticised for failure adequately to protect the interests of the university and its staff.

It would be unseemly, and probably uninteresting to a large section of your readers, to enter into the merits of a "family quarrel" which is the result of misunderstanding and is, we hope, of a temporary character. A letter was sent by the council to the Minister for Public Instruction immediately after the council was informed that the statement to which you refer had been forwarded to members of the Cabinet by the University Association of Teachers. Let me point out a fact of which you may not be aware, namely, that while the association contains the majority of the teaching staff it does not represent the whole body of professors and lecturers. The statement of the association is crude and contains serious inaccuracies. I shall deal only with the two criticisms of the council which you single out.

(1) It "failed to protect the interests of the university by not raising fees." That is not a mere financial question—it involves a question of general policy. In view of the fact that an important section of our community believes that the university should charge no fees (the University of Western Australia is free), would it not be childish to raise the fees before Parliament has settled what our grant is to be, and till we know definitely whether that grant will enable us to pay adequate salaries without raising them?

(2) The council failed "by asking for an inadequate increase of the State Grant." I wish we could have an increase of the grant for the asking. I think the attitude of the council is clearly indicated by an extract from the letter to the Minister for Public Instruction already referred to. You will there find the following:

"The council is placed in a false position by being obliged to correct these statements, for it does not wish it to be inferred that it thinks the proposed increase of the University Grant sufficient for what are now in 1921 its legitimate needs."

The management of the university council may not satisfy the impatience of some, but no one interested in university education need fear that it will fail for lack of whole-hearted zeal.

J. H. MACFARLAND,
Chancellor.

The University of Melbourne, May 5.

[The two criticisms to which Sir J. H. MacFarland, chancellor of the University of Melbourne, refers, were made by the University Association of Teachers, and we expressed no opinion upon them, but we remarked, "It is obvious that if a university staff is thoroughly discontented its efficiency is bound to suffer." The suggestions made at the end of our

article were offered in the hope that they would assist in settling the difficulties that had arisen between members of the staff and the council.—EDITOR, NATURE.]

Ball Lightning.

AMONGST the notes in NATURE of August 4, 1921 (vol. 107, p. 722), is a reference to the occurrence of ball lightning during a thunderstorm at St. John's Wood on June 26. The phenomenon, it is added, is of great rarity. The following therefore, apparently another instance of this phenomenon, may be worthy of record in NATURE. It was communicated at the time to the Meteorological Office in Sydney. On the evening of January 13, 1920, a very severe thunderstorm with heavy rain occurred in Sydney. About 9 P.M. I went out on to the verandah of my house at Neutral Bay, which overlooked the harbour, to watch the progress of the storm. This was soon after its beginning, and the lightning was very vivid and frequent and the rain heavy. Looking towards Mosman Bay, I saw descending, rather slowly in an oscillating way, a large ball of light, seemingly about the size of a Chinese lantern. This took about two seconds to descend and be lost to sight in the hollow towards which Mosman Bay itself lay. The light seemed to have a violet tinge. No rays emanated from it. No noise was heard.

J. B. CLELAND.

The University, Adelaide, South Australia,
May 8.

Ouramoeba

I SHALL be glad to know whether any readers of NATURE interested in the Rhizopoda have met with specimens of Leidy's *Ouramoeba botulicauda*? While examining some squeezings of Sphagnum from Woodbury Common, near Exeter, a few days ago, I found an active individual and had it under observation for some time. Fig. 14 on Pl. IX of Leidy's "Freshwater Rhizopods of North America" might have been drawn from my specimen.

It is now generally conceded that the characteristic jointed appendages are filaments of a parasitic alga, and Archer described amoebae in this condition, from Ireland, in 1866, but I am anxious to ascertain whether similar observations have since been made in other parts of Great Britain? F. R. ROWLEY.

Royal Albert Memorial Museum, Exeter, June 8.

DR. W. L. POTEAT of Wake Forest College, N.C. (U.S.A.), published in NATURE of May 24, 1894 (vol. 50, p. 79), a letter recording his finding of Ouramoeba in Wake Forest, N.C., and asking for citations of other records. To this inquiry Mr. Rowley's note furnishes a late reply, for there has been no other (in NATURE) in the interval. There is now, however, a good deal of literature on the subject. Ouramoeba, as Dr. Poteat was the first to demonstrate beyond doubt, is simply Amoeba spp. (*A. nobilis* Penard, *proteus* Rösel, *binucleata* Gruber, *villosa* Wallich) infested with fungal spores and filaments. In 1898, Mr. Martin F. Woodward of the Royal College of Science sent Dr. Poteat drawings of an infested Amoeba presumably found in the neighbourhood of London (*Science*, N.S. viii., 1898, p. 781). There does not appear to be any other record for England. The latest memoir by E. W. Gudger, "On Leidy's Ouramoeba," is in Journ. Elisha Mitchell Sci. Soc., xxxii., 1916, p. 24.

R. KIRKPATRICK.

British Museum (Natural History), London, S.W.7.

The Elliptic Logarithmic Spiral.

WITH reference to Dr. Rowell's letter in NATURE of June 3, p. 716, it may be pointed out that his curve, so far from being new, is briefly discussed in Besant's "Dynamics" (Besant and Ramsey, "Treatise on Dynamics," pp. 101-2). The equations of the curve may be written

$$x = \alpha\xi + \beta\eta \,\Big\}$$
$$y = \gamma\xi + \delta\eta \,\Big\}$$

where (ξ, η) lies on a certain logarithmic spiral. The curve is thus obtainable from this spiral by a homogeneous strain, whence, amongst others, it will have the property that its various branches cut a radius vector at the same angle: this angle differing for different radii vectores. C. E. WRIGHT.

Artillery College, Woolwich, June 19.

Seasonal Incidence of the Births of Eminent People.

IN ôrder to find, if possible, the causes which underlie the production of increased numbers of eminent intellects at certain periods (as, for example, the year 1809 and a year or two before and after it), I collected statistics of the dates of birth of more than two hundred eminent persons. The list consists chiefly of creative intellects,—poets, literati, musicians, painters, architects, men of science, explorers, and inventors, with a few statesmen and military men. Analysis of the dates shows that the greater number of these persons were born in the colder months of the year; but the distribution of the numbers is somewhat erratic. February is distinctly the richest month, having produced a galaxy of eminent persons; December comes next; August and June are the richest among the warm months.

Sixty pre-eminent names, chosen for no reason but their pre-eminence, were found to be distributed as follows:—In warmer months: April, 4; May, 6; June, 7; July, 2; August, 5; September, 3; total, 27. In colder months: October, 4; November, 1; December, 9; January, 5; February, 9; March, 5; total, 33.

The difference is more evident when the months are taken in groups of three, as follows: December to February, 23; March to May, 15; June to August, 14; September to November, 8.

In order to find whether this distribution corresponds with the ordinary distribution of births through the twelve months, I compared the numbers with the average of twelve years taken at a venture from the Registrar General's Quarterly Returns, namely, the period 1844–55. The figures are too numerous for quotation, but it may suffice to say that I could find no correspondence between the ordinary distribution of births and the distribution of births of eminent persons. In the Registrar General's Returns the order of average frequency for the quarter-years was as follows: April to June, July to September, January to March, October to December.

Climate can scarcely explain the distribution, (See letter from Dr. Robert W. Lawson, NATURE. June 3, p. 716.) Cold weather is not unhealthy for children, and in fact the diseases of the hot months are among the most fatal for them. I suggest that the reproductive organs, especially the germ cells, are more vigorous at certain seasons, producing offspring of higher quality. The many eminent persons born in the winter months, December to February, were conceived in the spring, the time of increased vigour of most living things; whereas the few born in the autumn months, September to November, were conceived in the winter. F. J. ALLEN.

Cambridge, June 17, 1922.

The Paris and Liége Meetings of the Institution of Mechanical Engineers.

THE summer meeting of the Institution of Mechanical Engineers was held on June 12-21 in Paris and Liége. In Paris the meetings were held in the Hall of the Société des Ingénieurs Civils de France. At the opening session M. Max Laubeuf, the president of the French society, and the engineer who more than any other has been responsible for the development of the submarine, received the president, Dr. H. S. Hele-Shaw, and members of the Institution of Mechanical Engineers, and addressed a few words of welcome. M. Laubeuf had expected to be away from France at the time of the meeting, and the formal address of welcome was therefore delivered by the vice-president, Prof. Leon Guillet.

The first paper was by Prof. Edouard Sauvage, on feed-water heaters for locomotives, in which various types were described, and the economies that might be expected from their use discussed. The second paper was an important contribution from Sir Vincent Raven on the electric locomotive. Broadly speaking, there are three types of locomotives required for the successful working of railways, namely: shunting, freight or goods, and passenger locomotives. For passenger traffic it is not so easy to standardise locomotives as for the other purposes, and considerable difficulties are met with in designing high-speed locomotives of great power. Particulars of a number of electric locomotives designed by the author and others were given, but the most interesting was an experimental locomotive that had been designed by Sir Vincent Raven, and built by the North Eastern Railway to haul a train of 450 tons, of sufficient power to start from rest on a rising gradient of 1 in 78, to reach a speed of 65 miles an hour on the level, and to run with safety at 90 miles per hour. The paper is an important one, and will arouse considerable interest. The chief engineer of the Paris-Lyon Railway, who is considering the same problems, spoke enthusiastically of Sir Vincent Raven's work. The agreement of these two engineers to compare their experiences is a real example of that *entente cordiale* which such gatherings must of necessity do so much to encourage. Lord Montagu of Beaulieu, in a paper on mechanical vehicles and road surfaces, directed attention to the economic importance of good road surfaces.

The first paper read on the second morning at Paris was a very important contribution by Prof. A. Rateau on the subject of rapid high-altitude flying. The author pointed out that the aeroplane is the only vehicle in which the resistance to travel is independent of the speed, and is directly proportional to the weight for the same angle of incidence. For high speeds, the aeroplane must select a height at which the density of the air is most suitable, and, providing the power of the engine can be maintained, high speeds can most easily be obtained at high altitudes. The rarefaction of the atmosphere at high altitudes makes it impossible without some special device to maintain the power of the engine, and, furthermore, pilots and passengers cannot exist in the rarefied atmosphere without special provision of oxygen, or being in an air-tight chamber to which air can be supplied under pressure. Prof. Rateau has attempted to overcome the former difficulty by using exhaust gases from the engine to drive a turbine compressor which will supply air to the engine at ground-level pressure, and also, it is hoped, to the pilot and passengers in the air-tight chamber. Although in this country, in France, and in Germany a good deal of attention has been paid to supercharging of the engine in order to maintain power, Prof. Rateau's paper is the most serious contribution that has been published on the subject. In certain trials the turbo-compressor was made to revolve at speeds up to 53,000 revolutions per minute, giving a peripheral speed of 670 m. per second at the tips of the compressor. In the gas turbine, speeds were attained which gave stresses due to centrifugal force equal to 123,000 times the weight of the material. Moreover, the turbine is worked at a temperature of from 650° to 750° C., and thus very unusual demands are made upon the material.

Prof. Rateau's paper was followed by one on air-compressors by Mr. W. Reavell, of Ipswich, and this again by a paper on the supersaturated condition as shown by nozzle flow, by Prof. A. L. Mellanby and Mr. W. Kerr. It has been suggested that an explanation of the discharge through a nozzle being greater than that required by theory can be found by the assumption that the rate of change of pressure in a nozzle is so great that supersaturation of the steam takes place. The assumption is apparently justified by Wilson's experiments, but it is difficult to see how the conditions for a Wilson effect could be obtained in a nozzle. Prof. Mellanby's experiments confirm those of other workers in showing that the flow is greater than could possibly obtain if the steam did not become partially supersaturated. In the apparatus used search tubes were placed in the nozzles to determine the drop of pressure along the nozzle, and from an examination of these and the discharge through the nozzles, the condition of the steam was obtained. The experiments show that the flow at and near the dry state is excessive when compared with the theoretical, but that the form of the flow curve over a small range of superheat beyond the initially dry condition is not in agreement with the assumption of complete supersaturation.

The last paper read at Paris was one by Prof. F. C. Lea on the effect of temperature on some of the properties of metals, in which it was shown that the effect of temperature on the elastic properties of metals may be more important than upon the ultimate breaking strengths. The significance of this paper was well illustrated by the difficulties referred to by Prof. Rateau in his paper on turbo-compressors.

An interesting and important public lecture was given by Prof. E. G. Coker, on Recent Photo-Elastic Researches on Engineering Problems. The lecture was illustrated by a number of large scale experiments, showing the stress produced in wheel teeth transmitting power and in material being cut in the lathe in planing machines and in milling machines. The experiments aroused much interest and enthusiasm, and the lecturer is to be very sincerely congratulated upon the success of a lecture necessitating the conveyance to France of so much delicate apparatus.

A distinguished gathering was held at the Hôtel Continental on Thursday, June 15. Prof. Leon

Guillet, responding to the toast of the French engineering society, replied eloquently, recounting the work that had been done concurrently by French engineers and men of science in the many developments that had taken place during the last century.

Following the very successful meetings in Paris, members of the Institution journeyed to Liége to participate with l'Association des Ingénieurs sortis de l'École de Liége in the celebration of the seventy-fifth anniversary of the foundation of the Liége Society, which coincided also with the seventy-fifth anniversary of the foundation of the Institution of Mechanical Engineers. In connexion with this anniversary an international scientific congress and exhibition had been arranged by the Liége Society, and this was opened by the King of the Belgians on June 18. The members of the Institution of Mechanical Engineers received invitations to the opening ceremony. The King in his opening address referred in particular to the importance of the work of men of science and of engineers in developing the resources of the world. On the days following the opening of the exhibition a number of papers were read at various sections of the Congress, and visits were arranged to works in the neighbourhood of Liége. Representatives of the French engineering society journeyed to Liége with the members of the Institution of Mechanical Engineers, and the association of the three societies proved of the greatest interest. It is believed and hoped that the celebrations will do much to bring about that rapprochement between the three peoples which is so essential for the future welfare of Europe and the world.

Absolute Measurements of Sound.[1]

By Dr. ARTHUR GORDON WEBSTER, Professor of Physics, Clark University, Worcester, Mass., U.S.A.

IT is now more than thirty years since it occurred to me to devise an instrument that should be capable of measuring the intensity or loudness of any sound at any point in space, should be self-contained and portable, and should give its indications in absolute measure. By this is meant that the units should be such as do not depend on time, place, or the instrument, so that, though the instrument be destroyed and the observer dead, if his writings were preserved another instrument could be constructed from the specifications and the same sound reproduced a hundred or a thousand years later. The difficulty comes from the fact that the forces and amounts of energy involved in connexion even with very loud sounds are extremely small, as may be gathered from the statement that it would take approximately ten million cornets playing *fortissimo* to emit 1 horse-power of sound.

Before we can measure anything we must have a constant standard. In sound we must construct a standard which emits a sound of the simplest possible character, which we call a pure tone; it will be like that emitted under proper conditions by a tuning-fork, which is described by saying that the graph representing the change of pressure with the time shall be that simple curve known as the sinusoid or curve of sines. From this connexion we say that the pressure is a harmonic function of the time. Unfortunately, the pressure change is so small that at no point in a room, even when a person is speaking in a loud tone, does the pressure vary from the atmospheric pressure by more than a few millionths of an atmosphere. Thus we require a manometer millions of times as sensitive as an ordinary barometer, and, in addition, since the rhythmic changes occur, not once in an hour or day, but hundreds of times per second, if we wish the gauge to follow the rapid changes accurately, we have many mechanical difficulties.

The problem of a standard of emission has been solved by a number of persons, including Prof. Ernst Mach and Prof. Ludwig Boltzmann, and Dr. A. Zernov, of Petrograd, a pupil of the celebrated Peter Lebedeff. The problem of an absolute instrument for the reception and measurement of a pure tone has been also successfully dealt with by a number of investigators, among whom may be mentioned Prof. Max Wien, of wireless fame, the late Lord Rayleigh, and Lebedeff. But there remains a third step in the process, which is as important as the first and the second. Given the invention of the proper standard source of sound, which I have named the "phone," because it is *vox et praeterea nihil*, and of a proper measuring instrument, which should evidently be called a phonometer, there still remains the question of the distribution of the sound in space between the phone and the phonometer. Any measurements made in an enclosed space will be influenced by reflections from the walls, and, even if we had a room of perfectly simple geometrical form, say cubical, and were able to make the instruments of emission and reception work automatically without the disturbing presence of an observer, it would still be impossible to specify the reflecting power of the walls without a great amount of experimentation and complicated theory. Nevertheless, this is exactly what was done by the late Prof. Wallace C. Sabine, of Harvard University, who employed the human ear as the receiving instrument. Those who have made experiments upon the sensitiveness of the human ear for a standard sound will immediately doubt the possibility of making precise measurements by the same ear at different times, and particularly of comparing measurements made by one ear with those made by another. Nevertheless, Sabine attained wonderful success and was able to impart his method to pupils who carried on his work successfully, so that he was able to create the science of architectural acoustics and to introduce a new profession. Still, the skill that required three or four months to attain by Sabine's method may be replaced by a few minutes' work with the phonometer.

In order to avoid the influence of disturbing objects, the observer should take the phonometer to an infinite distance, which is manifestly impossible. The method employed was to get rid of all objects except a reflecting plane covered with a surface the coefficient of reflection of which could be measured. For this purpose the teeing ground of a suitable golf course was used. With the present instrument it can be determined in a few minutes, if there is no wind.

[1] From a Friday evening discourse delivered at the Royal Institution on June 10, 1921.

In 1890 I proposed to use a diaphragm made of paper, which should be placed, shielded on one side, at the point where the sound was to be measured. In order that the effect of the sound should not be distorted, the membrane, instead of having to do any work, as in the case of the diaphragm of the phonograph in digging up the wax, or in that of the microphone in compressing the carbon, was to be perfectly free, but was to carry a small plane mirror cemented on at its centre. In close juxtaposition and parallel with this was the plane side of a lens which, viewed in the light from a sodium flame, was to give Newton's rings, or interference fringes. Of course, when the sound falls upon the diaphragm the fringes vibrate rapidly and disappear from sight.

By the introduction of a Michelson optical interferometer, two of the difficulties of this instrument were overcome, namely, (1) that of adjusting the lens so that it would not strike the vibrating mirror, since the mirrors in the interferometer could be as far apart as one pleased; and (2), more important still, it permitted the use of fringes in white light, so that it was possible to use gas, incandescent, or arc light with excellent effect. A further improvement was introduced by the use of a thin plate of mica for the diaphragm.

To obtain the sensitiveness necessary to measure sounds of ordinary intensity, the property of resonance is employed twice—*i.e.* a system of two degrees of freedom is used. First, the plate resounds to a sound more strongly as it is tuned more nearly to it; and second, a resonator that can also be tuned is put behind the plate. The sound entering by the hole in the resonator is magnified by the tuning, and acts upon the plate, which is also tuned. A graph can be plotted in which one co-ordinate represents the stiffness of the plate, or rather what may be called the mistuning, which is the stiffness lessened by the product of the mass by the square of the frequency. The other co-ordinate represents the corresponding quantity for the resonator, the stiffness of which depends simply on the volume into which the air is compressed, while the

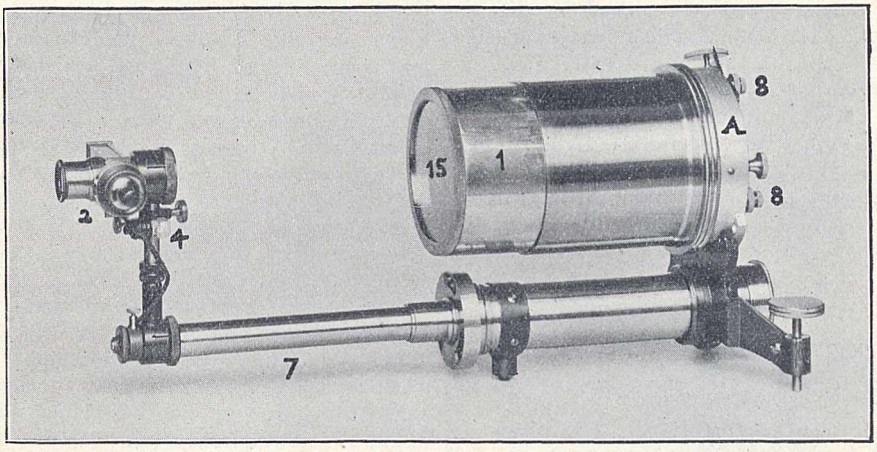


FIG. 1.—Phonometer. (Interferometer not shown.)

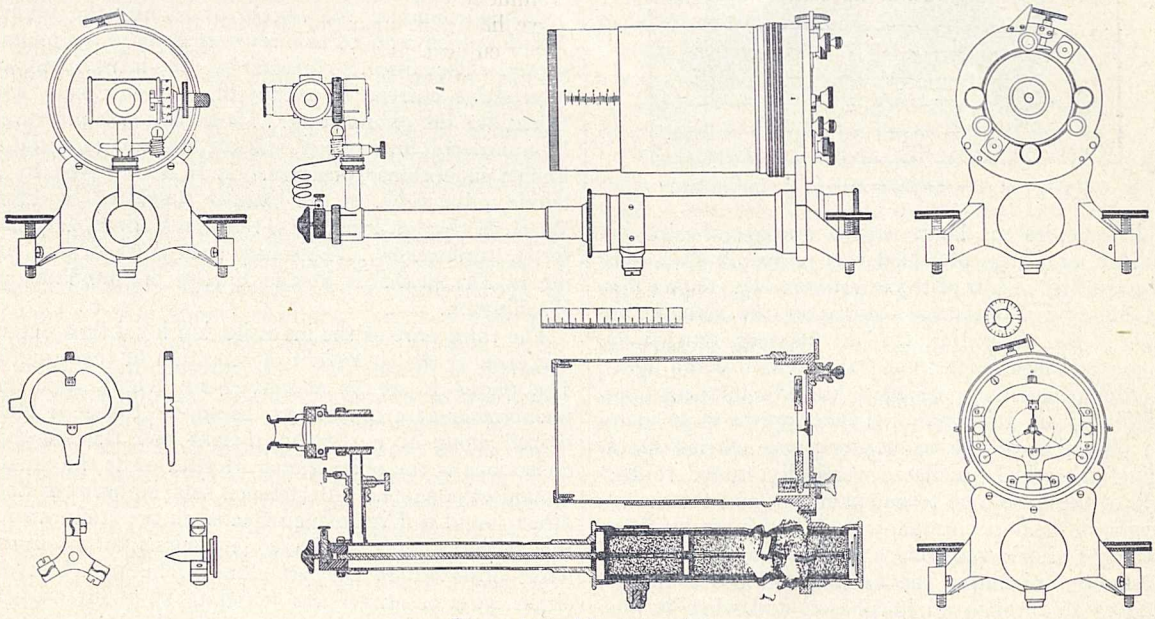


FIG. 2.—Parts of the phonometer.

effective mass depends on the dimensions of the whole, and its damping on the sound radiated from the mouth. It is then found that the tuning should not be such as to make the representative point occur at the middle of the figure, making both mistunings zero, but that both mistunings should be of the same sign and a certain magnitude, depending on the coefficients of damping of the two degrees of freedom of the coupled system. The mathematical theory is precisely that of a wireless receiver. The ultimate sensitiveness depends on the smallness of the damping of the plate.

The apparatus as it was built several years ago was mounted upon a heavy bronze stand, covered at the back by a heavy bronze cover to keep out the sound, while the three shafts turning the screws of the interferometer adjustment protruded through sound-tight fittings. Upon the front of the instrument a properly tuned resonator was attached, and at the side was a

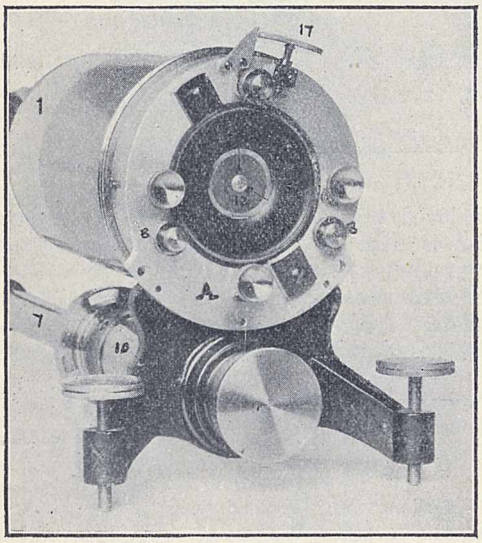


FIG. 3.—Front view of phonometer with annular opening.

small incandescent lamp with a straight, horizontal filament, an image of which was projected by a lens upon the first mirror of the interferometer. Upon this was focussed a telescope, giving in the reticule an image of the horizontal, straight filament, crossed by the vertical interference fringes seen with white light. In order to get these the plate must be in the proper position within a few hundred thousandths of an inch. The objective of the tuning-fork was carried by a tuning-fork which oscillated vertically, tuned to the pitch of the pure tone to be examined, and this, combined with the horizontal motion of the fringes, resulted in a figure of coloured fringes in the form of an ellipse. On slightly mistuning the fork, the ellipse could be made to go through all its phases, and when it was reduced to an inclined straight line its inclination was read off on a tangent scale. The amplitude of the compression of the air in the sound was then directly proportional to the scale-reading.

While the interferometer is still used for calibration, the movement of the diaphragm is recorded for actual measurements by a thin steel torsion strip carrying a concave mirror. A lamp with a vertical, straight filament is viewed through a telescope into which the small mirror focusses the image of the filament on the reticule, and a magnification of from 1200 to 1500 is used, so that the sensitiveness is about the same as with the interferometer.

At first the only method of tuning was the clumsy one of changing the mass of the diaphragm by adding small pieces of wax. This was not capable of continuous variation. Now the diaphragm has been discarded and replaced by a rigid disc supported by three steel wires in tension. The disc is made of mica or aluminium, and is carried by a little steel spider containing three clamps to hold the wire. The tension is regulated by three steel pegs, one of which is controlled by a micrometer screw. The disc is placed in the circular hole through which the sound enters the resonator. This has the advantage of reducing damping very largely, and thus of increasing the sensitiveness enormously. The instrument now competes with the human ear, and can be tuned over two octaves or more.

This sensitiveness can be demonstrated by projecting the coloured interference fringes on a screen and singing faintly in a remote part of the room, when the fringes will disappear. Using the telescope end of the apparatus, the instrument will indicate the sound of a tuning-fork when one can scarcely hear it. It is obvious that the disc may be made the diaphragm of a telephone and thus increase its sensitiveness. In fact, Prof. King has used with great success such a telephone to record wireless messages. He has also invented another sort of tunable diaphragm composed of a stretched steel membrane with compressed air behind it, which enables it to be tuned continuously, but over a smaller range.

I now come to the source of sound—the phone. This has been reduced to a reversed form of the phonometer. The disc is driven by an interrupted or alternating current by means of electromagnets, and tuned like the phonometer. Its excursion is measured by a powerful microscope, and the emission of sound is known in absolute measure. It is now driven by a triode valve tube, in the manner suggested by Prof. W. H. Eccles, of Finsbury Technical College, London, for a tuning-fork. This has been worked out for me by Dr. Eckhardt at the Bureau of Standards in Washington.

The third part of the investigation involves a determination of the coefficient of reflection of the ground. The phone is set at a convenient height, and the phonometer at a convenient distance. Either is then moved along at a constant height and the varying deflections of the phonometer are read while the sound remains the same. Interference sets in between the direct sound and its image reflected in the ground, and the existence of a minimum is obvious to the most naive observer by the ear alone. The reflection of either grass or gravel was found to be about 95 per cent., while, with a most carefully deadened room, the walls of which were covered with thick felt, there was perhaps 20 per cent. reflection. The whole measurement at both ends and the transmission checks up with an accuracy of about 2 per cent.

With this apparatus all sorts of acoustical experiments may be performed. By attaching to the phonometer a long glass tube or antenna, it has been possible to explore all sorts of places, such as the

field within a horn or tube lined with an absorbent substance. The transmission of sound through fabrics, walls, and telephone booths may also be quickly examined. The instrument is used by psychologists and by telephone and acoustic engineers, and is of interest to navigators. An interesting by-product is an instrument for showing the direction of an acoustic signal in the fog. It has been called a phonotrope, on the analogy of heliotrope, which turns to the sun. It consists of two equal horns which bring the sound to the opposite sides of the disc. When the whistle blows, the band of light spreads out, and on turning the instrument it closes to zero when the sound is directly ahead. Thus at several miles the direction is given to within two or three degrees.

Finally, let us consider that mystery of sound, the violin, which has been studied by Prof. Barton of Nottingham, and by Prof. Raman at Calcutta. This may be described by the engineer as a box of curious shape, made of a curious substance, wood, of variable thickness, with two holes of strange figure to let the sound out of the resonating box. The latter is actuated by a curious substance, catgut, made of the intestines of a sheep, and set in vibration by another curious substance, the tail of a horse. Yet from this wonderful box we get the most ravishing sounds, which affect profoundly the emotions of the most civilised. Yet the physicist reduces all musical instruments to combinations of resonators with strings, membranes, bars, plates, and horns. The mathematical theory of strings was given by Euler two hundred years ago, of bars and plates less than a hundred years, of resonators by Helmholtz and Rayleigh, and I have recently added a theory of horns which, while only approximate, works well in practice, and investigations are now being carried out by such methods on vowels and the violin.

Biological Studies in Madeira.

By Dr. MICHAEL GRABHAM.

THE component islands and rocks on the Madeira Archipelago are separate foci of volcanic ejecta in the abysmal oceanic depths, and the level of the Atlantic waters might be lowered 100 fathoms without merging them in a common connexion. Of the 170 forms of Testacea existing in the region, only five species are distributed throughout the Island group, and such evidence is adversely copious and conclusive as to the theory that the Madeiras are a surviving relic of a former continent.

The fossil shells now lifted 1500 ft. above the sea level show an upper Miocene association, but the massive piling up of volcanic matter in countless reiteration of eruption and age-long intermission began long before the fossil shells were living creatures on a Miocene shore.

Examination of a fossil leaf-bed, containing examples of the specific insular flora buried 120 ft. beneath a variety of strata and capped by a thick deposit of white trachyte, shows that the trachyte rock has almost disappeared under the slowly working forces of erosion and disintegration. From this is adduced the enduring quality of the trachyte steps and gateways of Funchal, which have been exposed for two centuries, with little evidence of decay, to the same influences under which the thick leaf-bed cap has vanished. Thus we need set no niggardly limit to the time requirement for the establishment of the specialised forms of life developed and buried ages before the trachyte capped the successive strata in a flowing stream of lava.

The Archipelago came to us 500 years ago, in the dawn of navigation, ready made, already well worn into characteristic scenery, with the local flora stabilised, the discovery being due to the erratic drifting from its course to the West African coast of a crazy vessel of Prince Henry the Navigator. An ancient building is regarded locally as the traditional home of Christopher Columbus, who married the Admiral Peristrello's daughter, and was, no doubt, inspired for his western enterprise by watching the sea currents and the evidence they brought of land and life beyond the horizon.

The agencies of transport and distribution we know; the sea currents are the same; the same winds prevail; the same birds come and go, though it may be difficult to believe that the presence of the Testacea in 170 forms and the Coleoptera in 700 species has been due to fitful and accidental influences. It is difficult, though the rain falls now as formerly, to point to a single rock or ravine as having appreciably lessened or deepened, though the storms of every winter carry thousands of tons of material to the ocean bed.

The completeness with which the natural orders exist in Madeira and the prevalence of specific forms make it less bewildering to believe that these forms of life were brought to us in pots from the Garden of Eden than to trace their descent from primeval forms which no longer survive. The shells can be compared with fossilised ancient types, but the flora has no such satisfactory appeal.

The name "Madeira" is derived from the hard wood known as Materia; Coniferæ are not prominent in the native flora. I have introduced *Pinus Insignis*, *Cupressus Macrocarpa*, and other species, while the seeds of *Persea Indica* have been sent abroad with the view of enlarging the range of the alligator pear-tree by grafting.

In conformity with other oceanic centres, Madeira has numerous examples of orders with a single genus and of genera with a single species. The striking fruticose echiums illustrate stabilised specific forms, and show how a new bee has effected an important hybridisation by which perennial characters were conferred on a plant of biennial life-limit, the helicoid flowering cymes, normally 2½ inches long, being prolonged into growths 7 or 8 feet high.

The Carniolan bee concerned in this hybridisation at first abstained from fruit eating, but it speedily blended with the local black bee and became a vine-

yard pest. Similarly many attractive flowers have become in Madeira pernicious pests; such are Oxalis, Eupatorium, Scenecio, and *Freezia refracta*.

Madeira could, however, be made a focus for the dissemination of plants of economic value. The gourd, *Sechium Edule*, has remarkable food value, and is very potent in fat utilisation. The plant shows a singular development of the seed-surrounding flesh into the permanent stem growth of the climbing plant. During the stress of war, when German U-boats wantonly destroyed everything and the Island food was restricted to local resources, the potency of the Sechium was realised, and on several occasions the sullen apathy of incipient starvation was awakened into reviving animation under its influence. The gourd was also utilised during the time of construction of the Panama Canal, when the Italian labourers had to be coerced to use a sufficient fat ration in their food in order that they might equal the output of their Canadian fellow-labourers.

Another valuable plant is *Lycopersicum cerasiforme*, which provides an agreeable tomato food with important antiscorbutic qualities. In the Salvage Islets there is also *Monizaa Edulis*, the carrot fern of Madeira, with a species of the apterous Deucalion, otherwise known only on the Madeira rocks, side by side with the Canarian *Samphire astadamya*; this seems to establish a balancing correlation or agreement between the botanic and entomological features of the two island groups.

An interesting illustration of sterility yielding to the introduction of a new pollen is afforded by a species of the Bignoniaceous jacaranda, while the sterility of the banana and the complete loss of fertility in the fruiting *Solanum guatemalense* show, on the other hand, how we are constantly curbing the superabundant seed growth of valued sub-tropical fruits, such as the custard apple and the loquat, which in the fruit-vacant months of Northern Europe should flood British markets both in perfection and profusion.

Many introduced plant pests, such as Peronospera and Oidium, have been brought under control, and even the *Phylloxera vastatrix*, which destroyed the Madeira vineyards before its life-history was made out, has become almost negligible in its depredations; thus the wine of Madeira has returned in adequate and superabundant supply. The Argentine ant may be credited to some extent with restraining the activity of the Phylloxera aphis. In view of the almost certain invasion of the British Islands by this pest, the Board of Agriculture should issue and circulate the American official booklet on the subject, together with a reprint of a paper read by me before the British Association two years ago. No less than 47,000 of these ants have been found engaged in draining a single lemon tree of its vitality; but various agencies of restraint are now employed in the orange and coffee plantations. The common flea and the house-fly do not seem to have abated under the domination of the Iridomyrmex.

The winged ant-queens suffer deälation after mating, and, discarding the cares of motherhood, they issue forth with the workers and found new colonies wherever conditions invite. The intelligent ingenuity of the ant and its tenacity of purpose in the face of obstacles is very remarkable.

As regards oceanic research, organised exploration of the ocean flora and deep-water biology is urgently necessary in the national interest. This investigation is a part of our responsibility in Imperial expansion; a second *Challenger* expedition is long overdue, and could be accomplished at a comparatively small cost.

The fisheries of Madeira provide several novel specimens. The Sherny, *Polyprion Cernier*, freshly brought from the deep sub-tropical water of the Madeira district, is typical of the warmer seas, though occasionally seen farther north. This is the wreck fish of British nomenclature, so known from its association with floating timber logs. The early life of the fish is passed in the sunlit surface waters, but the proper habitat of the full-sized creature, 100 lbs. in weight or more, is in the open sea at the enormous depth of 2000 or 3000 ft.

The fish, when brought to the surface from that profound depth, so distends at the removal from the vast pressure below that it emerges from the water like a cork or bladder, with its stomach forced through the capacious mouth and the eyes protruding in front of their sockets. No explanation is known of the conditions which prompt the fish to descend from the surface warmth into the cold darkness of the abysmal region, where only the larger examples are to be found. That the sea is nowhere azoic is shown by the plump and well-fed condition in which the Sherny comes to the surface. Its dull colouring, which is shared by the Aplurus and *Promethus Atlanticus*, contrasts surprisingly with the brilliant hues of Sebastes, Scorpœna, and Lampris, which also live in the depths, though rarely in close association with their sober-tinted brethren. The Sherny has a large air-bladder firmly attached to the spine, but knowledge of the function of this organ is very imperfect. The regulation of submersibility by a voluntary act of filling, emptying, or compressing is probably only a subordinate physiological function, for the structure of the bladder is suggestive of pulmonary functions, and its firm attachment to the spine and its prolongation upwards to a cerebral connexion with the organ of hearing, seem a sure indication of the use of the organ as a resonator in the interpretation of weak sonorous vibrations. The air-bladder, nevertheless, is totally absent from the Aplurus and many other fishes.

Some of the fishes swimming near the surface are believed to have their air-bladders charged with nitrogen, but extensive observation does not confirm the current idea that in deep water oxygen is the inflating gas. The consumption of oxygen by fish is small, and the standard of respiration in oceanic fish of deep water is low; the heart-beat in the Polyprion will continue many hours after every other sign of life has ceased. Stationary traps are necessary for the investigation of the abysmal forms of life.

The surface plankton is abundant, but the contracted empty stomachs of some of the deep-sea fish is evidence against the idea that much food is dissolved in deep-sea water. The *Aphanopus Carbo* is a voracious monster which abounds in the lesser depths, and ranges freely among the inexhaustible invertebrates of those regions.

During a series of observations on earth-currents in deep-sea cables, strange effects were noted which were

found to be due to a submarine earthquake which broke up many miles of the ocean floor. The occurrence may be compared with a similar commotion which destroyed an important fishery in the sub-tropical waters of the United States.

A full and comprehensive appreciation of sub-tropical ichthyology is necessary to indicate the vast and interesting variety of the fauna and the intrinsic charm of scientific research. It is the duty and interest of the community to discover the potential genius and place him where he can accomplish that for which he is fitted, unfettered by the suppressing restrictions of a false communistic socialism or cramping of individual effort.

Magna opera Domini exquisitae omnes
voluntates ejus.

Ten Years of X-ray Crystal Analysis.

By Dr. A. E. H. TUTTON, F.R.S.

A SPECIAL number of *Die Naturwissenschaften*, entitled "Zehn Jahre Laue-Diagramm," was issued on April 21, forming Heft 16, 1922, which contains eight articles by authors who have contributed to the subject of X-ray analysis on the continent since its first inception by Dr. M. von Laue, among whom may be mentioned Drs. Friedrich and Knipping, who collaborated with Dr. von Laue in the first discovery, Prof. Debye, and Prof. Niggli. Probably the article of deepest interest to the general reader will prove to be that of Dr. Friedrich, who gives an account of the circumstances in the year 1912 in Munich when the first discovery was made. To the present writer, who was himself in Munich in the summer of that same remarkable year, this memoir is of fascinating interest. It has to be remembered that the scientific coterie at that time forming the professorial staff of the University, Museum, and Institute, included Prof. Röntgen, the generally recognised discoverer of X-rays (although their production had for some time previously been almost a daily occurrence in the private laboratory of the late Sir William Crookes); Prof. von Groth, the founder and editor of the *Zeitschrift für Krystallographie* and the doyen of crystallographers, whose brilliant lectures on crystal structure and optics attracted students from all over the world; Prof. Sommerfeld, who had carried on the tradition of X-ray physics bequeathed to him by his predecessor Boltzmann, and also extended the work of Haga and Wind, and of Walther and Pohl on X-radiograms and the general physics of X-rays; Prof. Ewald, who had studied the behaviour of long electromagnetic waves with space-lattices; and Dr. von Laue, who had specialised largely on the interference phenomena of ordinary optics. It was among this strong combination of crystallographers, X-ray specialists, and diffraction (grating) opticians that the inception of the attack on crystals by X-rays had its birth.

During a conversation between Laue and Ewald, the former raised the question as to how electromagnetic waves would behave which were small compared with the grating constants, and from his optical experience, he suggested that diffraction spectra should be produced. The order of the space-lattice cell dimensions of crystals was already known to be about an Ångström unit (10^{-8} cm.), from the density and molecular weight of the crystal and the mass of a hydrogen atom. The work of Sommerfeld and of Walther and Pohl had led us to expect that the order of dimensions of the wavelength of X-rays would be about one-tenth of this (10^{-9} cm.). Consequently Laue suggested that the conditions should be particularly favourable for the origination of interference phenomena on the passage of X-rays through crystals.

The discussion was continued in the common room, and taken up by the whole, deeply interested coterie, and Friedrich, who was at the time acting as Sommerfeld's assistant, declared himself, with youthful enthusiasm, ready to test the idea practically. He secured the assistance of Knipping, who had more spare time at his disposal, and together they set up the now famous arrangement of X-ray bulb, leaden screens with slits for ensuring the exit of a definite beam of X-rays, simple goniometer carrying the crystal, and photographic plates to receive the expected radiations. At the first attempt the sensitive plates were only arranged parallel to the primary beam of X-rays, as any effect expected appeared likely to be of the character of secondary rays from the crystal, and it was only on repeating the exposure with a photographic plate arranged behind the crystal, perpendicular to the direct beam, that the first Laue radiogram with a crystal of zinc blende was obtained, after several hours of exposure.

Friedrich describes how excited and delighted he was when, alone in his working room at the Institute late that night, he saw the spots appear on the plate under the influence of the developer, due to the deflected X-rays, now known to be reflected from the planes of atoms within the crystal, the planes of the atomic space-lattice. Next morning he went early to show the negative to Knipping, and together they hastened to Laue and Sommerfeld, who were both naturally equally interested and delighted. Prof. Sommerfeld at once excused his assistant from his ordinary duties, so that he might go ahead with further experiments. Both Profs. von Groth and Röntgen, to whom the result of the experiment was at once communicated, supplied materials and gave valuable advice. A much better and more accurate apparatus was erected, including a good goniometer for the exact adjustment of the crystal (which is particularly necessary), and the excellent X-radiograms of zinc blende, quartz, rock-salt, and other crystallised substances, now so well known were obtained as the immediate results.

Dr. Knipping directs special attention in his article to the remarkable work of Siegbahn, who worked with an evacuated apparatus, so as to exclude air absorption of the X-rays, and measured the wave-lengths of the "softer" long wave-length portion of the radiation, eventually discovering and measuring rays as long as ten Ångström units. Compton, it will be remembered, at the other extreme, has measured X-rays (γ-rays

from radium) on the short wave-length side as short as 0·02 Ångström units. Hence, the X-ray spectrum now known comprises waves of all this great range of wave-lengths. It will also be remembered that other researches, such as those of Lyman and Kurth, Mohler and Foote, and Richardson and Bazzoni, have introduced us to rays, termed the K, L, M, and N series, derived by radiations from carbon, oxygen, iron, copper, potassium, sodium, magnesium, and molybdenum, which have wave-lengths ranging to 375 Ångström units, thus bridging over the gap between the shortest ultra-violet rays and X-rays.

Prof. Niggli's contribution offers a survey of the substances the crystal structure of which has now been ascertained by the various X-ray methods of Laue, the Braggs, Debye and Scherrer, and Hull, including a table of the absolute dimensions of the space-lattice cells resulting from the Bragg spectrometric measurements. His concluding remarks are well worth quoting (so far as is possible in a translation from the German), especially when it is remembered that Prof. Niggli has now taken over from Prof. von Groth the editorship of the *Zeitschrift für Krystallographie*. "By Laue's discovery crystallography not only obtains a new method of investigation, but experiences a new 'liveliness' in almost every one of its branches. Most especially are we mineralogists glad that our colleagues of the sister sciences now bring to the crystal an entirely new attitude of mind and interest than formerly, for only by the combined and simultaneous labours of all can further research move along right lines."

With these words of Prof. Niggli we must all agree, and it would appear that the sentiment is now so universally accepted and recognised that the future is bright with hope for a progress during the next decade as glorious as that which is now recorded at the termination of ten years of X-ray crystal analysis.

Obituary.

Prof. J. C. Kapteyn, For. Mem., R.S.

JACOBUS CORNELIUS KAPTEYN was born at Barneveld, Holland, on January 19, 1851. He studied at Utrecht from 1869 to 1875, and was then appointed an observer at Leiden Observatory, where he remained for two years. In 1878 he was appointed professor of astronomy and theoretical mechanics at the University of Groningen. He was in the unusual position of an astronomical professor without an observatory, and he immediately applied to the Dutch Government for the means to equip a students' observatory; he mentioned in particular a 6-inch heliometer as desirable. The application, however, was unsuccessful, and for a few years his lectures monopolised his attention. Then, finding that he had time to spare and no instruments, he began to look about for some useful astronomical work of a computational kind that he could carry out. Circumstances soon brought a task well fitted to his tastes.

Photography had been revolutionised by the introduction of the gelatine dry plate about 1880, and its astronomical possibilities were soon exemplified by the successful photographs obtained of the comets of 1881 and 1882. In the latter case Sir David Gill assisted the local photographers by letting them strap their camera to an equatorial, with very successful results; he was impressed by the number of faint stars that were visible on the plates, and the idea of a southern photographic *Durchmusterung* quickly matured in his mind. He found a willing collaborator in Kapteyn, who volunteered to conduct the measurements and reductions at Groningen. Funds were collected from various sources; the Government Grant Committee of the Royal Society voted 300*l.* in each of the years 1885 and 1886; this was, however, stopped in 1887, it is believed from the notion that the Astrographic Catalogue, which was then inaugurated, would obviate the need for the *Durchmusterung*. If that was the idea, subsequent events have proved it to be incorrect. The Astrographic Catalogue is still far from completion, while the *Durchmusterung* has been available as a standard work for a quarter of a century. It might have been made more perfect but for shortage of funds: the plates admitted measurement to seconds of arc, but in practice this was limited to tenths of minutes. Moreover, it was only carried to declination 18° S., instead of to the equator. With a view of shortening the reductions, Kapteyn devised an ingenious measuring instrument, which was practically a small equatorial placed in the position, relatively to the plate, occupied by the centre of the camera lens, the principle being that, since the rays through this point suffered no bending, the star-images, viewed from here, have the same configuration as the stars themselves. Hence right ascension and declination could be read from the circles.

The whole work occupied thirteen years, nearly double the original estimate, but the time was spent ungrudgingly by Kapteyn, and the close examination and discussion of the results brought to light many interesting facts, such as the change of colour-index with galactic latitude, the galactic stars being bluer than the non-galactic ones. It was also found by careful counts that there was no sensible difference in the number of stars recorded at the centres of the plates and near their edges. Several cases of light variation and of rapid proper motion were also found. The question of photographic stellar magnitudes was still in its infancy, but a simple formula was found, mag. = B/(C + diam.), B and C being constants for the plate; as these are printed, it is possible to recover the diameter of each star.

Kapteyn was elected an associate of the Royal Astronomical Society in 1892, and received its Gold Medal in 1902 in appreciation of his work on the *Durchmusterung*. This was, however, only one of the numerous researches that he undertook to investigate the structure of the sidereal universe. He saw the need for increased knowledge of stellar parallaxes. In 1886 he investigated the parallaxes of forty-five stars by the method of meridian transits (since found to be less accurate than the photographic method), and endeavoured to secure that the astrographic plates should each have three exposures at dates of maximum parallactic displacement. This was not

carried out, but Prof. Donner tested the method at Helsingfors, sending the plates to Kapteyn for measurement; he deduced parallaxes for 246 stars, but realised that direct parallax measures were insufficient to gauge more than a small fraction of the universe. He then set to work to deduce distances from the proper motions, incidentally giving a new method of deducing the solar apex by making the sum of the resolved proper motions in the direction of the antapex a maximum, that in the perpendicular direction zero. From this work he deduced formulæ connecting parallax with magnitude and proper motion, which, with some modifications, have been found very serviceable. To the end of his life he entertained a certain distrust for spectroscopic parallaxes, though this scarcely seems to be justified.

In the course of his studies on proper motion Kapteyn made the notable discovery of the two star-drifts, which has played a great part in all subsequent work on stellar motions. It has been interpreted in various ways—as the separate motions of two interpenetrating star-clouds—as radial motions, respectively inward and outward, of stars oscillating through the centre—as rotational movements in opposite directions about the centre. Kapteyn himself favoured the latter view. He saw the necessity of obtaining more statistics about the faint stars, and planned the "Selected Areas" uniformly distributed over the sky; in these restricted regions all available information should be obtained about all the stars down to the faintest visible; from the results statistics for the whole sky could be formed. One of his last wishes was that astronomers should continue to investigate these regions after his death, and his wish will doubtless be realised.

Of late years Kapteyn spent a good deal of time at the great American observatories, and took the keenest interest in the physical investigations there in progress. His last paper on the configuration and motion of the stellar system was published in the *Astrophysical Journal* a few days before his death.

A. C. D. CROMMELIN.

JOHN WARD.

THE National Museum of Wales and the cause of archæology in the Principality have sustained a serious loss by the death, on June 18, of Mr. John Ward. Born in 1856 at Derby, he started in life as a pharmacist, but all his leisure time was devoted to the examination of old buildings and other objects of antiquarian interest. It was this work which in 1893 led to his appointment as curator of the Cardiff Municipal Museum in succession to the late Mr. John Storrie. Here he carried on the same lines of research, which resulted in the publication of several papers in the Transactions of the Cardiff Naturalists' Society and the *Archæologia Cambrensis*, of which probably those on the Roman fort at Gellygaer and the St. Nicholas chambered tumulus were the most important. In addition he wrote for Methuen's series of "Antiquaries' Books" two volumes on "The Roman Era in Britain," and "Romano-British Buildings and Earthworks."

He naturally took a deep interest in the establishment of the National Museum of Wales, and when the Cardiff Museum was absorbed in that Institution he was appointed to the dual post of Keeper of its Archæological Department and Curator of the Cardiff Collections; these duties he discharged with energy and success until failing health necessitated his retirement two years ago.

A conspicuous service which Mr. Ward rendered to the Museum was the accumulation of a large series of obsolete and obsolescent appliances from farms and rural homesteads. These were arranged by him in a temporary "Exhibition of Welsh Byegones," for which he prepared a valuable and interesting handbook. The book found a ready sale and was soon out of print. It was his intention (now, alas, impossible of accomplishment) to prepare an enlarged edition of it, illustrated by drawings from his facile pencil.

One of his striking characteristics was the exquisite finish of every piece of work which left his hands. A conspicuous example of this is the series of models illustrating geological structures, which gained him a silver medal at the Paris Exhibition in 1900.

Mr. Ward had been for many years a Fellow of the Society of Antiquaries, and in 1918 the University of Wales conferred upon him the honorary degree of Master of Arts. Unfortunately the state of his health prevented him from attending the graduation ceremony. He was a keen and enthusiastic student, a man of enlightened views on Museum policy, a loyal colleague, and a warm friend.

W. E. H.

SIR GEORGE R. PARKIN, K.C.M.G.

BORN in New Brunswick in 1846, George Robert Parkin was one of many notable men whom the Maritime Provinces have given to the Empire; but few have had so clear a vision of what Empire means, or have devoted their lives with such ardour to its service. Life in Lower Canada in his early days was strenuous. Farm work, study when body and brain were tired, a meagre living earned by teaching in the common schools, a B.A. degree secured by the practice of severe economy, the Douglas gold medal for proficiency in science. In after days Parkin attributed his intellectual awakening to the influence of a teacher who had been a pupil of Agassiz, although his own bent, after he left the University of New Brunswick, was for the humanities. In 1874–75 he was so fortunate as to spend a year as an unattached student at Oxford, where his eloquence gained for him the office of secretary to the Union at a time when Asquith, Milner, and Thomas Raleigh were its leading speakers. But most notable of the friendships consolidated at Oxford, although it originated through correspondence before he left Canada, was that with Edward Thring, the strength of which is evidenced by the request in Thring's will that Parkin would write his biography. In 1875 he returned to Canada as headmaster of the school at Fredericton.

Parkin was a great talker. His ebullient enthusiasm overflowed in speech; and, just as his enthusiasm was the product of fervid conviction, so also was his talk sincere. He had no conscious mission. His advocacy, in consequence, was irresistible. In 1889 the Imperial Federation League induced him to make a tour through Canada and Australasia. That he should be chosen by the Rhodes Trustees, in 1902, as their first organising secretary, was a proof that it was generally recognised

that, for such a position, his qualifications were unique. Before he resigned this office in 1920 he was able to boast that he had visited every State in the Union and spoken in every University of the Empire. Universities will hold his name in remembrance, not the least of the causes for their gratitude being the paper which he read to the Congress of 1912 on "The Establishment of a Central Bureau; its Constitution and Functions." Re-reading this paper with a knowledge of the developments which have taken place since it was written, one is impressed with the practical character, and even the prescience, of the proposals it contains.

WE note with regret an announcement in the *Chemiker Zeitung* of June 15 that Prof. Wilhelm Wislicenus, director of the Chemical Institute of the University of Tübingen, died on May 8, aged sixty-one years. Prof. Wislicenus was one of the foremost chemists in Germany, and his researches on organic chemistry and stereochemistry are well known.

Current Topics and Events.

AT a meeting of the Council of the Royal Society of Arts on June 29, the president, H.R.H. the Duke of Connaught and Strathearn, presented the Albert Medal of the Society for the present year to Sir Dugald Clerk, "in recognition of his important contributions, both theoretical and practical, to the development of the Internal Combustion Engine."

THE James Scott Prize of the Royal Society of Edinburgh, established in 1918 for a lecture or essay on the fundamental concepts of natural philosophy, was presented on June 5 to Prof. A. N. Whitehead for his lecture entitled "The Relatedness of Nature."

PROF. L. BAIRSTOW has been elected chairman of the Royal Aeronautical Society for the year 1922–23 in succession to Lieut.-Col. M. O'Gorman, whose period of office terminates on September 30 next.

AT the annual meeting on June 27 of the Research Defence Society, Sir Walter Fletcher, secretary of the Medical Research Council, gave an address on the work that is being done, by medical research, for the advantage of the life of the nation. He took two instances: the study of the vitamins in food, and the action of pituitary extract. Both are good examples of work already fruitful, but not yet complete. But they are only two examples, taken almost at random, from a great wealth of material. It would need a big book to describe all that has been done of late years, under the Medical Research Council, for our health and welfare, and it is strange that there should be members of the House of Commons opposed to the spending of public money on this work. The opposition, of course, is to the necessary use of experiments on animals. The spirit which goes by the name of anti-vivisection was described as one of the enemies of the people. Happily, in this matter, we have all the help which the Government can give to us.

IT is reported in the *Times* that Mr. T. W. Bagshawe and Mr. M. C. Lester have returned to England after an adventurous wintering in the Antarctic. Landed at Andvord Bay on the west of Graham Land (lat. 64° 45′ S.) by a Norwegian whaler in December 1920, Messrs. Bagshawe and Lester hoped to be able to undertake some exploration in the interior of Graham Land; but the site of their base was ill-chosen for this purpose, and they were unable to do any survey beyond the immediate locality. Their work amplified the rough surveys of the *Belgica* on this coast in 1898. Meteorological observations were taken throughout the winter. From Mr. Bagshawe's account of the adventure it would appear that he and his companion were most inadequately supplied with stores and equipment for an Antarctic winter, having to improvise a hut from their boat with the help of canvas and packing-cases. For food they wisely relied largely on seals and penguins. Fortunately the west side of Graham Land has a relatively open winter climate. The men were rescued by a Norwegian whaler from Deception Island in December 1921.

AN exhibition of Egyptian ornaments, tools, and carvings belonging to the First Dynasty, and of numerous papyri of different ages, the fruits of a season's work by the British School of Archæology in Egypt, under the direction of Prof. W. M. Flinders Petrie, will be open at University College, Gower Street, until July 29. Admission is free and without ticket.

THE twentieth session of the International Congress of Americanists will be held in Rio de Janeiro on August 20-30 next, under the presidency of Dr. Joao Teixeiro Soares. The arrangements are in the hands of a strong local committee. As the celebration of the centenary of Brazil's independence begins on September 7, it is anticipated that there will be a large attendance. The subjects which are to be discussed at the congress are the origin, history, languages, customs, and religions of the native races of America; the ancient monuments and archæology of America; and the history of the discovery and European occupation of America. At the close of the congress arrangements will be made for excursions to the States of Minas Geraes, St. Catherina, Espiritu Santo, and São Paolo. Members of the congress will be afforded an opportunity to return by way of Para, where there is, in the museum, the collection of ancient pottery from the island of Marajo, which is of great interest to students of American archæology. Arrangements have been made by the Royal Mail Steam Packet and Nelson lines for members of the congress to travel at reduced rates. Information

respecting the congress may be obtained from the Secretario Geral, XX Congreso de Americanistas, Sociedade de Geographia, Praça 15 de Novembre, No. 101, Rio de Janeiro.

SOME interesting points in the work of officials connected with scientific and technical bodies, especially in relation to the scientific and technical press, were raised in an address on the duties of secretaries, delivered by Mr. P. L. Marks at a meeting of the Circle of Scientific, Technical, and Trade Journalists on May 30. There are few men gifted with the power of presenting scientific knowledge in an easily assimilated form, and it is here that a really competent secretary reveals itself. Editors are busy men, often with a wide but not a detailed knowledge of scientific subjects, who require information conveyed within a small compass; and if a secretary, in issuing matter to the press, can select certain journals for individual treatment, providing them with matter closely allied or linked to their respective fields of operations, his efforts will not be vain. This applies particularly to bodies the aim of which is the popularisation of science. The ideal secretary must be able to take a wide view and sanction some departure from the limits of absolute scientific truth, if essential to simplicity and popular appeal. While rejecting fallacious statements—involving inaccuracy arising from ignorance rather than an effort after simplicity—such as are apt to creep into daily non-technical papers, it is not necessary to adhere to the standard rightly demanded in scientific transactions. With regard to secretaries who exercise editorial functions in connexion with their societies, Mr. Marks inclines to the view that no radical alteration in contributions or discussion should be permitted. Nevertheless we think it advisable in the interests of a society that its transactions should not contain statements that are manifestly incorrect or absurd, or in conflict with its policy. In general the authors of such remarks are open to correction, if tactfully conveyed. A secretary of a scientific body may not receive high remuneration, may not even enjoy the esteem and appreciation he deserves, but he has the knowledge that by his work he is shaping the scientific destiny of the nation.

WITHIN recent years most of the leading industries have founded Research Associations, and in 1919 the Council of the Institute of Brewing decided to make provision for investigating problems of a general character in the brewing and allied industries. To obtain the necessary funds for carrying out the scheme a new class of members, known as Research Fund Members, has been created. These members consist of firms who are invited to join the Institute at a minimum annual subscription of 10 guineas. At the end of 1921, the total subscriptions amounted to nearly 6000*l.* per annum, so that the scheme is now well in being. Two reports have already been issued, and particulars are given of the investigations so far carried out in connexion with hops, barley, and timber. An account is given of the experiments on breeding new varieties of hops at the South Eastern Agricultural College, Wye, and their testing on a commercial scale at the East Malling Research Station, under the direction of Mr. E. S. Salmon. Photographs and a detailed description of the kilns erected by the Institute at Beltring, Kent, for investigating the various factors involved in the drying of hops are also given in Report II. Manurial experiments on hops are being carried out at Chilham and Horsmonden by Mr. F. Ivo Neame and Mr. T. I. Nicolson respectively, while the chemical investigations are being conducted, under the direction of Dr. F. L. Pyman, at the College of Technology, Manchester. With regard to barley it is intended to make a systematic study of barley and malt from the agricultural, botanical, chemical, and physiological standpoints, and arrangements have been made for field trials, under the direction of Sir John Russell, of the Rothamsted Experimental Station, on farming conditions in East Suffolk, Lincolnshire, Somerset, Essex, Yorkshire, Norfolk, Shropshire, Wiltshire, and the East Lothians. Trials are also being made at the Rothamsted and Woburn Experimental Stations. Mr. H. F. E. Hulton has drawn up a report on the relation of the nitrogenous matters in barley to brewing value, while botanical and chemical investigations on timber for casks, with special reference to American oak, are being carried out at the Imperial College of Science and Technology, under the direction of Prof. P. Groom and Prof. S. B. Schryver, respectively.

AT the meeting of the Royal Statistical Society on June 20, a paper was read by Mr. J. W. Verdier dealing with the statistics of shipping casualties and loss of life at sea. Discussing the occupational risks run by seamen, the author gave comparative estimates, based on the recorded deaths by accidents in the five years ended 1913. The yearly death-rate among seamen was 4·05 per thousand employed, compared with 1·56 for underground workers in coal mines, and 0·59 for railway servants. It is estimated that the number of deaths per million man-hours of employment was 0·97 for seamen, 0·68 among underground workers in coal mines, and 0·20 among railway servants. Mr. Verdier also compared the accidents involving deaths of passengers on steam vessels with those on railways. Assuming that, in the foreign trade, sea passengers are at sea for twenty days on the average, and that railway passengers (excluding season ticket holders) are on the train for about an hour, then, in the period about 1900, the railway passengers' deaths were 0·12 per million passenger-hours, while the sea passengers' were 1·5, or more than twelve times as great. In the period about 1910, the railway passengers' deaths were about 0·1 per million passenger-hours, and the sea passengers' 0·3, or three times as great, showing that there has been a general progress towards safety.

THE address prepared by Sir Robert Hadfield for the Sheffield Association of Metallurgists and Metallurgical Chemists last October has been published under the title of "The Work and Position of the

Metallurgical Chemist," and is illustrated by a number of plates. The address covers a very wide field, the history of metallurgical research being surveyed, with special reference to the part played by Sheffield workers. This is brought into relation with the general history of science, and with the early work of the Royal Society in establishing the experimental method of investigation. The international character of metallurgical research is exemplified by a description of the new Japanese Institute for Steel Research, just opened at Sendai under the direction of Prof. Honda. The speaker's own work is dealt with, particularly in the application of manganese steel to the purposes of the war. This aspect of metallurgy was illustrated by the exhibition of a very fine series of specimens of this alloy as employed in the arts of peace and war. The exhibition also included specimens of the author's other technical work, and books and other objects of historic interest. The plates are finely produced, and are of great interest.

ACCORDING to the June issue of the *Decimal Educator*, the official organ of the Decimal Association, the Association proposes to concentrate its efforts for the time being on securing an alteration of the value of the pound weight from 454 to 500 grams, that is, half a kilogram. The ounce of 16 to the pound would in the first instance be retained, so that 4 ounces would be 125 grams. The new ton would be 2000 new pounds, equal to the metric ton and a little more than 1·5 per cent. greater than the present ton. All denominations between the pound and ton, such as hundredweights, quarters, and stones of all kinds, would be eliminated and intermediate weights expressed in pounds. This decision will not interfere in any way with the movement, which has the support of bankers and chambers of commerce, for the change of the value of the penny to one-tenth of a shilling.

THE Review of the work of the Rockefeller Foundation for 1921, compiled by the president, George E. Vincent, has just been issued. Grants have been made to numerous educational institutions for campaigns against hook-worm disease, malaria, yellow fever, and tuberculosis; for the promotion of the training of nurses; for libraries, fellowships, and other purposes. A sum of more than seven and a half million dollars has been expended on the world-wide activities of the Foundation.

THE Ministry of Agriculture, Industry, and Commerce of Brazil has just published the first number of a new journal, *Revista Mensal de Meteorologia*, which will be devoted to meteorological interests in that country. The review will be divided into (*a*) memoirs, etc.; (*b*) notes, reviews, and critiques; (*c*) bibliography; (*d*) notices; (*e*) papers by the Director of Meteorology. The first number contains an article on the applications of meteorology to everyday life, the report of the Director of Meteorology from June to December 1921, the reorganisation of the meteorological service in the Minas Geraes province of Brazil, notes from foreign sources, and a number of reviews, among other interesting features.

THE firm of Messrs. Pastorelli and Rapkin, Ltd., of 46 Hatton Garden, London, has forwarded to us a list of thermographs and hygrographs. The instruments are of two types, for meteorological observers and a stronger make for factory work, such as fruit preserving and drying, cold storage chambers, dye works, wall paper printing, and other branches of industry. Two patterns are recommended—the Peandar and the Edney. The former is suggested for meteorological observers and has a small, stem-divided thermometer fixed near the thermometric coil, so that the readings shown by the self-recording instrument can be compared and if necessary readjustment can be made. A pattern of the Edney is adapted as a hair hygrometer which records directly the percentage of humidity by the alterations in the length of a string of human hair. The dry and wet bulb thermometers, known as Mason's hygrometer, have long maintained their utility. The instrument maker would improve the hygrometric results if he contrived that a good flow of air should be driven over the wet bulb, a consideration of growing interest on both sides of the Atlantic.

WE have received from the City Sale and Exchange, 81 Aldersgate Street, E.C.1, the catalogue of the Koristka microscopes and accessories, for which they are sole British agents. Several different types of microscope stands are listed, from simple students' models to instruments suitable for research work and photomicrography. A travelling portable folding microscope is also supplied, which, with objectives, etc., weighs less than 7 lb. and folds into a leather case measuring $7\frac{3}{4} \times 5 \times 7$ in. Photomicrographic cameras, warm and detachable mechanical stages, dark-ground illuminators, microtomes, hand lenses, and other accessories are also included in the catalogue. A complete series of apochromatic, semi-apochromatic, and achromatic objectives are manufactured by the firm. The Koristka Co. has a deservedly high reputation both for their mechanical and for their optical work, and the prices charged compare favourably with those of other firms.

MESSRS. W. HEFFER & SONS, Ltd., Cambridge, have in the press "Cements and Artificial Stones: A Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge," by the late J. Watson, edited by Dr. R. H. Rastall, in which will be found a brief history of the origin and development of the cement industry, and notes on the manufacture and uses of the various kinds of cement, concrete, and artificial stone which are exhibited in the economic department of the Sedgwick Museum of Geology, at Cambridge. The same publishers also promise "An Introduction to Forecasting Weather," by P. R. Zealley, which aims at presenting in a clear and simple manner the principles on which weather forecasting is based.

Our Astronomical Column.

EPHEMERIS OF SKJELLERUP'S COMET, 1922 *b*.—This ephemeris is for Greenwich midnight from the elliptical elements given in NATURE of July 1, p. 20, which are approximately true.

	R.A.			N. Decl.		R.A.			N. Decl.
	H.	M.	S.			H.	M.	S.	
July 6	15	58	43	37° 53′	July 14	16	37	46	31° 47′
8	16	10	1	36 19	16	16	45	45	30 16
10	16	20	14	34 45	18	16	53	4	28 48
12	16	29	30	33 13	20	16	59	32	27 29

During the interval, June 30-July 20, log r increases from 0·0486 to 0·1131; log Δ from 9·5124 to 9·6830. Owing to its short period, it is important to follow it as long as possible in order to facilitate its recovery on its return.

PROF. PLASKETT'S MASSIVE STAR.—Some further particulars about this star (see NATURE, June 17, p. 791) may be of interest. It is in Monoceros, in the middle of the Galaxy, its place for 1900 being R.A. 6^h $32{\cdot}0^m$, N. Decl. 6° 13′, visual magnitude 6·06. The spectral type in the Henry Draper Catalogue is Bop, but Plaskett prefers Oe5; the orbital velocities of the two components are 206·38, and 246·7 km./sec., the period 14·414 days, the eccentricity 0·0349, the minimum masses of the components 75·6 sun and 63·3 sun. From the non-occurrence of eclipses it is inferred that the orbit is at least 17° from the edgeways position, and the masses 14 per cent. greater than the minimum values. The centre of gravity is receding at 23·94 km./sec. The H and K lines of calcium show no orbital motion, but a steady recession of 15·9 km./sec., which is exactly the amount of the sun's resolved motion, so that the calcium is at rest with respect to the star-system, a result obtained in other spectroscopic binaries. The following estimates are given of the star's size and distance: density 0·01 of sun's, surface brightness 4 magnitudes in excess of sun's, diameters 20 and 18 times sun's, distance between centres 65 sun-diameters, distance from the earth 10,000 light-years, absolute magnitude of brighter component −5·65. It is noted that the recession of the centre of gravity, corrected for solar motion, is 8 km./sec.; with the estimated dimensions and masses, the Einstein spectral shift would account for 2·8 km./sec. of this quantity.

Since this star, the most massive known, lies so near the mean galactic circle, it may be suggested as a suitable zero of galactic longitude; it seems wrong to use the terrestrial equator as the zero point, for it reintroduces precession, which it is the object of galactic co-ordinates to avoid.

ORIGIN OF THE ASTEROIDS.—Dr. K. Hirayama discusses this old problem once more in the June number of *Scientia*. He recalls the early suggestion of an exploded planet, and its abandonment when the wide range of the orbits became known. He then mentions the rival hypotheses, one by one, showing that they too have difficulties. Thus many have suggested that it was the disturbing action of Jupiter that prevented the nebulous ring, assumed to have existed in this region, from forming into a single planet; but he notes that the four great satellites of Jupiter are quite near it, and yet much larger than any of the asteroids. He also notes objections to the theory that the asteroids came from a distance, and had been captured by Jupiter, like the short-period comets. The orbits of many of them do not approach near enough to Jupiter for this, and their major axes are almost free from perturbation.

Dr. Hirayama himself favours a theory, put forward by Young, which invokes not one but several explosions. Each "family" of asteroids, of which many have been traced, is explained as the result of an explosion of a single body. In support of this view he refers to the rapid and irregular light-variation of many asteroids, notably Eros. He supposes that they are irregular, angular fragments, their own gravitation being too weak to compel them to take a spherical form; if they were rotating about an axis that was not a principal axis, both the position of the axis in the body and the period of rotation would vary; this agrees with observed facts. It would be possible, by assuming a sufficient number of explosions, to trace the whole system of asteroids to a single primitive planet. As the whole mass of the known asteroids is only some 1/2000 of that of the earth, he thinks it possible that many fragments may have been absorbed by the sun and Jupiter, and in conclusion suggests a similar origin for the ring of Saturn, noting the many resemblances between it and the asteroid system.

NORMAN LOCKYER OBSERVATORY (1921–1922).—In his report for the year 1921, April 1, to 1922, March 31, Dr. W. J. S. Lockyer, the director of the Observatory, directs attention to several advances which will be of interest to observers who have followed the progress of this new institution.

At present the greater part of the work is confined to stellar investigations, and observations were made on 137 of the 149 nights which were sufficiently clear. The McClean telescope, with the 12-inch prismatic camera, has been used for obtaining stellar spectra for classification and parallax determinations. During the year 654 negatives have been secured.

With the 9-inch Kensington prismatic camera 79 negatives have been obtained in the progress of a scheme to photograph the spectra of all stars down to about the fourth magnitude. Special attention is being paid to large-scale spectra of standard giant and dwarf stars of types F to M. These are being examined by Adams' method for the determination of stellar parallax. At the present time 1200 negatives are available, and 370 have been measured, giving preliminary curves showing correlations between absolute magnitude and line-intensity differences. A wedge method of determining the line intensities has been devised, and details of the procedure have been published.

The routine classification of stellar spectra by means of the Kensington nomenclature of generic class names has been discontinued, and the Harvard system, based on numerical measures of line-intensities in the spectra, combined with the separation of stars into groups of increasing (giant) and decreasing (dwarf) temperatures, has been adopted in its place. For laboratory investigations a 10-feet Littrow spectrograph, by Hilger, has been presented to the Observatory by Lady Lockyer.

It is evident that an observatory of this character, with extensive instrumental equipment, is well suited to further the prosecution of investigations beyond those covered by the immediate routine, and it is pleasant to note that during the past year two student observers have been encouraged to spend short periods at the Observatory.

Research Items.

THE PEOPLING OF ASIA.—Dr. Aleš Hrdlička, the distinguished American ethnologist, contributes to the Proceedings of the American Philosophical Society (vol. lx. No. 4) an important paper on the peopling of Asia, which "constitutes one of the greatest problems of anthropology." He concludes that the cradle of humanity was essentially south-western Europe, with, later, the Mediterranean basin, Western Asia, and Africa. It is primarily from Europe and secondarily from these regions that the earth was peopled, and this peopling was comparatively recent. Early man was unable to people the globe owing to his insufficient effectiveness, and until the end of glacial times and his old stone culture he had evidently all he could do to preserve mere existence. Only an advance in culture could enable him to control his environment and secure a steady surplus of births over deaths. The cause of man's peopling of the world was not a mere wish to do so, but the necessity arising from growing numbers and correspondingly decreasing supply of food. It was this which eventually led to agriculture. This spreading over the globe was conditioned by three great laws—movement in the direction of least resistance; movement in the direction of the greatest prospects; movement due to a force from behind, or compulsion.

COINS OF CROESUS.—A party of American archaeologists working in Anatolia, among the ruins of Sardis, has discovered thirty gold staters of Croesus, dating from the period between 561 B.C., when Croesus ascended the throne, and 546 B.C., when his capital was taken by Cyrus, king of Persia. They are in excellent condition, although some are a little worn. The only five staters hitherto known to exist are in the British Museum, but only one is in good condition. Dr. Leslie Shear, the archaeologist of Columbia University, who has brought the news of this discovery, states that the coins were found in a small earthen vessel in the ruins of a tomb, where they may have been hidden by a Lydian merchant during the siege of the city by Cyrus. The coins, which are in charge of the discoverers, cannot be brought to America until the right of ownership is decided, but according to the treaty of Sèvres, such articles discovered in territory assigned to Greece should be divided, half to the Constantinople Museum, and half to the finders. The coins of Croesus are made of electrum, or mixed gold and silver, and are of two types, weighing respectively 8·40 grams and 11·20 grams. Those hitherto discovered are oblong in shape, bearing the heads of a lion and a bull.

AN UPPER PALAEOLITHIC STATION, AVELINE'S HOLE.—The report of the Spelaeological Society, University of Bristol, for 1920–21, describes the excavation of Aveline's Hole, a rift cavern in the mountain limestone forming the east wall of Burrington Combe. It was first discovered in 1797, and Rutter, writing in 1829, states that nearly 50 skeletons were found lying with their heads under the north side of the rock and feet extended towards the centre of the cave. The Society commenced work in 1919, and it has continued regularly ever since. Associated with numerous animal remains characteristic of the late Pleistocene were found artifacts of the early Tardenoisian or late Magdalenian periods, agreeing with the determination of the fauna. The human remains belong to the same horizon, since no trace of polished stone or metal weapons, or of any culture other than late Palaeolithic, has been found in the cave, which seems to have been closed with a block of stone very shortly after the bodies were deposited. The people whose remains were found were contemporaries with the late Magdalenians of southern France, and their culture was Tardenoisian, possibly a transitional stage between the Magdalenian and Aurignacian, an industrial evolution which may have taken place in England.

THE RED CRAG FLINTS OF FOXHALL.—In the June issue of *Man* Mr. S. Hazeldene Warren discusses the question of the signs of human handiwork on flints from the Red Crag, Foxhall. He sums up his conclusions as follows: "The Foxhall flints give us another instance of the association of striated surfaces with exclusively mechanical characters in the flakes themselves and in their trimmed edges. And that this association and limitation to the mechanical group of forms does not constitute an unsatisfactory, or doubtful case of not proven, but (from the point of view of a human industry) a definite, complete, and conclusive case of 'proven not'."

PARASITIC COPEPODS.—Mr. C. B. Wilson contributes to the Proceedings U.S. Nat. Mus. (vol. 60, art. 5, 1922, 100 pp., 13 plates) his sixteenth paper on the parasitic copepods in the museum collection. The present paper is devoted to the Dichelesthiidæ, which are parasites on the gills of fishes, but do not burrow into the tissues of their host after the manner of the Lernæidæ, though one genus, Cætrodes, produces irritation of the gill tissue, causing the latter to grow up as a flap or fold entirely surrounding the body of the copepod and holding it securely in place. Other genera provoke irritation by their prehensile claws sufficient to cause the gill tissue to grow up around the claws. The transformations common in the Lernæidæ are not met with in the Dichelesthiidæ. No material change in the bodily form or structure of these copepods takes place subsequent to their attachment. The author gives a history of the family, a short account of the ecology, external features, and internal organs, systematic descriptions of and keys to the 20 genera and 107 species. The only stage of development known for any of the members of this family is the nauplius, and a description of the known nauplii is given. In the account of the internal structure is included a short note on the closed vascular system of the genus Lernanthropus, which consists of two ventral longitudinal trunks below the intestine, and a single dorsal trunk above the intestine, from all three of which branches pass to the appendages, and there is a network of capillaries over the dorsal surface and in the laminate swimming legs. No part of this system is connected with the body cavity (hæmocœl). The trunks and capillaries contain a yellowish red fluid which streams backwards and forwards under the influence of the peristaltic movements of the alimentary canal. Neither blood corpuscles "nor any other definite constituents" were found in this fluid.

INTERSEXUALITY.—Dr. R. de la Vaulx has given (*Révue générale des Sciences*, March 30, 1922) a short review of recent work on intersexuality — the occurrence of examples intermediate between the normal male and female of the species. Some of these are intersexes, others are more correctly termed gynandromorphs. The former are intermediate in structure between male and female, and are the same on both sides, whereas gynandromorphs consist typically of a mosaic of male and female structures—often one side is male and the other female—and these cases are comparatively rare. The author cites examples of intersexuality from invertebrates—the

butterfly *Lymantria dispar*, the lice *Pediculus humanus* vars. *capitis* and *corporis*, Gammarus and Drosophila, and describes some examples from his own cultures of Daphnia. In Daphnia the intersexes appear not among hybrid examples as in the other cases cited above, but arise during parthenogenetic reproduction, and, on the whole, they seem to have been biassed originally towards the male sex and then to have been secondarily feminised. Dr. Vaulx proceeds to discuss whether the intersexual condition is due to the action of two determining factors acting simultaneously or to two forces, *e.g.* hormones, working successively, and remarks that sex appears to depend on numerous factors or elements, and it has hitherto been found possible to investigate only some of these. He considers that the facts examined lead to two inferences: (*a*) That sex does not depend on discontinuous factors, or the absence or presence of something as chromosome formulæ suggest, but on complex causes resulting in continuous variation; (*b*) every unisexual individual possesses potentially the attributes of the other sex, and these may be revealed under certain conditions; it does not seem that one sex can be really homozygous.

ARCTIC ROTIFERA.—In a short account of the Rotifera of the Canadian Arctic Expedition (Report, vol. viii.) Mr. H. K. Harring records 64 species, four of which are new, among which is a pelagic Synchæta—an addition to the extremely small number of rotifers known to exist in the open ocean in waters of normal salinity. The total absence of the genus Brachionus so abundant elsewhere is noteworthy.

CARBONACEOUS MATERIAL IN OILSHALE.—Mr. E. H. Cunningham Craig's recent paper on kukkersite, the oilshale of Esthonia (read before the Institute of Petroleum Technologists on May 9), reopens—among other controversial matters—the question of the origin of the carbonaceous material present in oilshale, a problem upon which the study of this particular deposit may be destined to shed considerable light. The shale is of Ordovician age, and forms part of a Lower Palæozoic sequence remarkable alike for its sedimentary characters and its simplicity of geological structure. Palæontologically the shale has received recent attention from Mr. H. Bekker, who has not only described the Kukkers stage (C_2), but has given some account of the lithology and mode of deposition of the deposit, together with his views on the origin of the bitumenous matter present. His conclusions differ in many respects from those of Mr. Cunningham Craig, the latter regarding the deposit as a relic oilfield, the former stressing the importance of the part played by diatomaceous algæ and bacteria under a changing environment. Mr. Cunningham Craig regards the shale as being formed by impregnation with inspissated petroleum, derived from the underlying Cambrian beds, a theory presenting many difficulties, some at least as formidable as those possibly occasioned by the phytoplanctonic theory. Apart from this, the commercial possibilities of the shale are extremely favourable, though one gathers from Mr. Cunningham Craig's remarks that the type of retort used in the past has not been the success anticipated. He estimates the available reserves as 1000 million tons. The yield of oil, at present varying from 40 to 50 gallons per ton, could easily be raised to 70 or even 80 gallons per ton, the oil having a specific gravity not higher than 0·93 and containing very little sulphur. Labour is cheap, and the cost of working and refining the shale should not be great. Altogether Esthonia possesses a deposit valuable alike from scientific and economic standpoints, and the progress of development of this shale will be watched with wide interest.

THE DROUGHT OF 1921.—A communication is given in the Quarterly Journal of the Royal Meteorological Society for April by Mr. C. E. P. Brooks and Mr. J. Glasspoole, of the Meteorological Office, on the drought of 1921, dealt with under the headings of the rainfall of the British Isles and the causes of drought in the British Isles. The year 1921 was in certain areas a year of unprecedentedly small rainfall. The only years since 1850 at all comparable with 1921 were 1854, 1864, 1870, and 1887. In 1854 the deficiency of rain reached its maximum in the south-east, where it was more than 30 per cent., to the east of a line roughly from Bournemouth to Lincoln. In 1864 the maximum deficiency exceeded 30 per cent., over large areas along the east coast and in Devon and Herefordshire. In 1870 the greatest deficiency, exceeding 30 per cent., occurred in the central plain of Scotland and locally in the south and centre of England. In 1887 deficiencies of more than 30 per cent. were widespread in the centre of the British Isles, especially in the south-west of Ireland and in a broad band across England from Southport to Hull. For England and Wales, 1921 was the driest year since 1850, while for the British Isles as a whole, only one year, 1887, was slightly drier. Indeed, 1921 was probably the driest year since 1788 for England and Wales. A comparison is also made between the general rainfall in 1921 with that of other dry periods of three to nine months' duration, and maps are given showing the several percentages. In the second part of the communication the drought is considered as related to abnormalities in the circulation of the atmosphere. Droughts in the British Isles are closely related to the establishment and the persistence of local anticyclonic conditions, and an attempt is made to find how these abnormalities are related to others in different parts of the world. Maps of the world showing deviations of pressure from normal during the chief periods of drought in the British Isles are given for the occurrences since 1864. Generally speaking, low pressure over the polar regions appears to be an essential feature of drought in the British Isles, and in consequence is considered to be an important factor in forecasting droughts.

FOCAL DEPTHS OF EARTHQUAKES.—The first number of the Geophysical Supplement to the Monthly Notices of the Royal Astronomical Society (for March 1922) consists of a valuable paper by Prof. H. H. Turner on the arrival of earthquake waves at the antipodes and on the measurement of the focal depth of an earthquake. To a distance $\Delta = 90°$, the usual tables give good results for the arrival of the primary waves of an earthquake. Beyond this distance there is some uncertainty, but near the antipodes of the epicentre the records again become clear and regular. From 130° to 180° the time of traverse in seconds is given approximately by the expression

$$1217 - (180 - \Delta)^2 \times 0{\cdot}0235.$$

For a single earthquake, the mean error of the expression is about $\pm 3{\cdot}5$ secs., but for the great earthquakes from 1913 to 1916 it is about ± 14 secs. There is thus a systematic error for each particular earthquake ascribable to a particular depth of focus, which must be greater than 0·021, and may have a value such as 0·04, of the earth's radius. Prof. Turner suggests that the antipodes of the epicentre should be called the hypocentre, a term which has been used for the last thirty years to denote the seismic focus. In Italy its use for this purpose is practically universal. Outside that country, it has been adopted by M. de Montessus de Ballore and Prince Galitzin.

Coral Reefs of the Louisiade Archipelago.[1]

By Prof. W. M. DAVIS, Harvard University.

THE Louisiade archipelago, consisting of four medium-sized and many small islands east of New Guinea, is well represented on British Admiralty chart 2124 on a scale of about 1 : 280,000 ; chart 1477 shows part of the archipelago in greater detail on a scale of about 1 : 140,000. According to brief accounts by Macgillivray,[2] Thomson,[3] and Maitland,[4] the chief islands are composed of steeply inclined and deeply eroded schists and slates, traversed by quartz veins ; they are evidently parts of the mountain range that extends for hundreds of miles along the northern coast of New Guinea, from which they have been separated by strong subsidence after having been eroded to about their present form. The largest island is Tagula, 30 miles in length east-west along the trend of its schists, and 8 or 9 miles in width ; it has an embayed shore line and rises in ten summits to heights of from 1330 to 2645 feet. Near by is the Calvados chain of satellite islands, which begins about 7 miles north of the middle of Tagula and extends 70 miles westward ; it includes more than a score of members, the largest having a length of 11 miles and a height of 1110 feet. Tagula and its chain of satellites are enclosed by a superb barrier reef, the irregularly oval circuit of which measures 112 miles in east-west diameter by about 30 miles north-south ; it is unquestionably one of the finest reefs of its kind in the whole Pacific.

The smaller islands of Rossel to the east and Deboyne to the north-west of Tagula are also surrounded by sea-level reefs, partly as fringes but mostly barriers. Misima, north of Deboyne, measuring 22 by 10 miles and reaching 3500 feet in height, is peculiar in having no sea-level reefs and in descending rapidly into deep water, although it is terraced by unconformable reefs at various altitudes. It has therefore suffered a recent uplift after having previously taken part in the subsidence which characterises the other islands ; but its subsidence must have been more rapid than theirs as it has no widely developed barrier-reef lagoon floor, either near present sea-level or above or below it.

The Tagula barrier reef and its great lagoon merit special attention from the evidence that they give regarding the verity of certain coral-reef theories. The reef is best developed around the south-eastern or windward half of its great oval circuit, where it is interrupted by only four passes in a curved distance of 110 miles, and where the reef flat has a width of 2 or 3 miles. The north-western or leeward half of the barrier is strikingly discontinuous and consists in part of small patches, but more commonly of atoll-like loops and rings, thirty-six in number, from 1 to 5 miles in diameter, enclosing little lagoons from 10 to 17 fathoms in depth. The loops and rings of this half of the circuit are separated by as many passages, from ¼ to 3 miles wide and from 15 to 35 fathoms deep. But the most remarkable features of this part of the barrier are the small or minute but high islands, here to be referred to as outposts, which rise in twenty-two of the reef loops. The largest of them is only 4 miles in diameter ; their heights vary from 40 to 530 feet. Some of them appear to consist of schist, judging by their trends ; but according to Maitland some of the others are volcanic and a few are made of limestone. As elements of a barrier reef, these small but high outpost islands are so exceptional as to be almost unique.

The great Tagula lagoon is divided by the Calvados chain of satellite islands into a smaller northern and a larger southern compartment ; the northern compartment is of triangular outline, with its base along the dividing chain and its vertex about 10 miles away at the most northern point of the reef ; it occupies about one-sixth of the entire reef-enclosed space, which is about 2000 square miles in total area. The southern compartment measures 20 miles across, and extends east-west along the whole 112 miles of the lagoon length ; it occupies about four-sixths of the enclosed area ; the remaining sixth is taken by Tagula and the satellite islands. The greater part of the lagoon floor in both compartments is a gently undulating plain usually from 25 to 35 fathoms in depth. The depth of the southern compartment increases gradually for a moderate distance from the broad enclosing reef, and more rapidly from the islands of the Calvados chain. The greatest depths, 46 fathoms in the southern or windward compartment and 49 fathoms in the northern or leeward compartment, are in both cases found much nearer the dividing island chain than the outer barrier reef. The exterior slopes of the reef fall off rapidly into deep water ; a few soundings show depths of more than 600 fathoms two miles from the reef on the west and north-west.

A correct theory of the Louisiade reefs must take account of the great subsidence that the islands have suffered. It would therefore appear that the present sea-level reefs should be regarded as the successors of a long-lived series of upgrowing reefs which have been formed, essentially according to Darwin's theory, by more or less intermittent upgrowth from earlier shore lines of the subsiding mountainous islands. It is probable that where the island slopes were very steep, the reefs, presumably inclining inwards as they grew up, remained attached to the shore as fringes ; conversely, where the island slopes were gentler or where low slopes have been broadly submerged, the reefs now form offshore barriers. During the upgrowth of the reefs, some of their detritus must have been swept seaward, to form the submarine talus that descends into deep water ; the rest must have been swept into the lagoons, where, reinforced by local organic detritus and probably in smaller measure by detritus from the islands, it appears to have aggraded the "moats" between the reefs and the islands.

It thus seems that the formation of the great undermass of the Louisiade reefs, and especially of the Tagula reef, may well have been consistent with the conditions and processes of Darwin's theory. It should be added that the evidence for the strong subsidence of the Louisiade islands is, in view of their constitution, much more direct than that furnished for the similar subsidence of most reef-encircled volcanic islands in the central Pacific ; and that this well-certified subsidence of the foundations on which the Louisiade reef-masses have been built up gives immensely greater support for Darwin's theory than is afforded by the atolls of the open Pacific, where the occurrence of subsidence is indicated only by indirect evidence. It remains to inquire whether the Louisiade sea-level reefs, which surmount the great undermass, accord with or contradict other coral-reef theories, especially the newly framed Glacial-control theory of sea-level reefs. This theory was proposed

[1] Reprinted from the Proceedings of the National Academy of Sciences, Washington, D.C., U.S.A. (vol. 8, No. 1, Jan. 1922).

[2] J. Macgillivray, "Narrative of the Voyage of H.M.S. *Rattlesnake*," London, 1852, 2 vols. See i. 182 ; ii. 72.

[3] B. H. Thomson, "New Guinea : Narrative of an Exploring Expedition to the Louisiade and D'Entrecasteaux Islands," Proc. Roy. Geogr. Soc., 11, 1889 (525-542).

[4] A. G. Maitland, "Geological Observations in British New Guinea," Queensland, Geol. Surv. Pub., 85, 1892. "Salient Geological Features of New Guinea," Journ. W. Austral. N. H. Soc., 2, 1905 (32-56).

more particularly to account for the atolls and barrier reefs of the supposedly quiescent central Pacific than for the barrier reefs of much disturbed regions like the Louisiade archipelago: nevertheless the Tagula reef in particular affords critical evidence against that theory, as will be made clear by the following considerations.

The Glacial-control theory appears to be based on the conviction that it is the smooth lagoon floors rather than their enclosing reefs which are most in need of explanation, and that the bathymetric relation of the lagoon floors to the level of the ocean reached by the enclosing reefs is normally so nearly constant in all the coral seas that their explanation by Darwin's theory in terms of reef upgrowth and lagoon aggradation on subsiding foundations of irregular form is impossible. A long period of nearly perfect stability of the mid-ocean floor is therefore assumed, although instability is admitted for islands in the south-western Pacific; and instead of postulating that lagoon floors represent "moats" that have been heavily aggraded behind the upgrowing reefs during the subsidence of their foundations, a series of ingenious suppositions is invented, of which the chief are: that during Preglacial time many still-standing islands, more or less reef-surrounded, were either worn down to low relief by subaerial erosion or cut down to shallow platforms by marine abrasion; that during the Glacial epochs of the Glacial period the ocean surface was lowered by about 35 fathoms by the withdrawal of water to form continental ice sheets; that the surface waters of the ocean were then so chilled as to kill or greatly to weaken reef-building organisms; that islands were then attacked by the waves, which cut low-level benches around them if they were high, or if they were low completely truncated them in platforms at a depth of 35 to 40 fathoms below normal sea level; that as the waters warmed and rose, reefs grew up on the margins of the benches and platforms, whereupon the lagoons behind them were moderately aggraded; and that the thickness of the aggrading deposits is greater, and consequently the lagoon depth is less in small than in large lagoons, because the detritus supplied from a linear front-foot of a reef has a smaller interior sector to aggrade in a small lagoon than in a large one. In brief, the long-continued stability of reef foundations and the abrasion of sub-lagoon platforms upon them are leading factors of the Glacial-control theory.

It should be noted here that neither the stability of reef foundations nor the abrasion of sub-lagoon platforms is proved by any direct evidence; both of these leading factors are, like the subsidence of atoll foundations in Darwin's theory, assumed because they are thought to be necessary for the explanation of observed facts; and both assumptions are believed to be true because of the apparent success of the explanation that they provide. Hence if it be shown, even in a single instance, that a lagoon floor of typical form and depth has been produced around an island which provides independent evidence contradictory to stability and abrasion and, indeed, requires strong subsidence, the fundamental assumptions of the Glacial-control theory will be seriously invalidated.

The bearing of Tagula reef and lagoon on the Glacial-control theory may now be apprehended. Tagula is, as has already been shown, not in a region of long-continued and nearly perfect stability, but in one of marked instability; and as will next be shown, it has not suffered abrasion by the lowered ocean; yet its lagoon floor is smooth and of a depth accordant with that of other large lagoons in various parts of the Pacific. Hence long-continued stability and extensive low-level abrasion are not essential factors in the production of this fine example of a barrier-reef lagoon floor. But if these factors are not essential in Tagula, they should not be regarded as essential anywhere else; and their adoption as the leading postulates of the Glacial-control theory is therefore unnecessary; flatness of lagoon floors and their accordant depths may be explained elsewhere as well as in Tagula as the result of long-continued aggradation on subsiding foundations of uneven surface.

The evidence that Tagula has not suffered abrasion by the low Glacial ocean, and hence that the reef-building organisms around Tagula were not seriously weakened by the lowered temperatures of the lowered ocean in the Glacial epochs, is found partly in the absence of chartered cliffs on the shores of the main island where the barrier reef becomes a fringe, partly in the absence of similar cliffs on the exposed sides of the satellite islands at either end of the Calvados chain where it approaches the barrier reef, and partly in the presence of the outpost islands in the barrier-reef loops around the northern lagoon compartment.

As to the first line of evidence based on the absence of cliffs on Tagula: If abrasion by the lowered ocean had operated long enough to cut a platform 10 or 20 miles wide beneath the present floor of the southern compartment, it ought at the same time to have cut spur-end cliffs on the north shore of the main island, where the defending reef is a fringe only half a mile wide; and these cliffs ought still to show the upper part of their faces as plunging cliffs, now that the ocean has resumed its normal level; but the charts show no such cliffs.

The second line of evidence based on the absence of cliffs on the Calvados islands is similarly argued. It may be added that the absence of cliffs at these significant points on the charts of the Louisiade islands does not appear to be due to poor charting; for on the coast of Misima, where Maitland observed the white limestone scarps of elevated reefs, the charts clearly show a shore cliff, and a legend is printed along it: "Cliffs 100 feet high."

As to the third line of evidence: The little outpost islands are so numerous in the Tagula barrier-reef loops around the northern lagoon compartment and around the western part of the southern compartment that it seems unreasonable to believe the waves of the lowered Glacial ocean could have cut their way behind the outposts efficiently enough to abrade a platform 10 miles in width. Not only so, the outpost islands show no sign of having cliffs on their outer sides. One of them, Utian, a mile across and 480 feet high, is reported by Maitland to consist of volcanic rocks; but it is not a young volcanic cone built up in Postglacial time, for the chart shows it to have well-dissected form, with three slender points enclosing two small bays turned toward the outer ocean; yet the points are not cut back in plunging cliffs. Another outpost not far away is said by the same observer to consist of limestone; this island cannot have been made and elevated since an assumed platform was abraded, for the height of the island, 530 feet, is so great that in such case the platform thereabouts ought to be more or less emerged; and it cannot have been made and raised before the platform was cut, for in such case the limestone ought to have been consumed by the waves that cut the platform.

The small outpost islands of the Tagula barrier reef therefore give strong confirmation of the evidence against abrasion derived from the absence of plunging cliffs on the north side of the main islands and on the terminal members of the Calvados chain. But if the northern compartment of the Tagula lagoon,

which alone is as large as many an atoll, is thus shown not to be underlaid by an abraded platform, there is no sufficient reason for thinking that the southern compartment, or indeed any other barrier reef or atoll lagoon in the whole Pacific, has any such smoothly prepared foundation. Surely if the flatness of the floor and its normal depth in both compartments of the Tagula lagoon have been brought about in a region of instability, and without the aid of abrasion in furnishing a smooth sub-lagoon platform, there is no sufficient reason for assuming that other flat lagoon floors of ordinary depth can have been prepared only on smooth platforms abraded at a standard depth across still-standing islands. It is possible that the Glacial lowering of the ocean surface by a moderate amount may have contributed, in a manner that I have suggested elsewhere,[5] to the production of many lagoon floors 30 or 40 fathoms in depth; but Glacial changes of ocean level do not seem otherwise to have left recognisable marks of their occurrence in the Louisiade archipelago. Crustal deformation has been dominant; and the great changes of shore lines thus determined appear to have been merely played upon by the inferred oscillations of ocean level during the Glacial period.

This discussion is believed to show that, apart from such changes of ocean level as are inherently probable although they are not well-known either in amount or in effects, the assumptions of the Glacial-control theory are not applicable in the production of Tagula reef and lagoon floor; and hence we may fairly conclude that these assumptions are not essential to the production of similar reefs and lagoon floors elsewhere. This argument, in which the evidence furnished by one outspoken witness for Darwin's theory and against the Glacial-control theory is given wide application, would not be valid if other witnesses were equally outspoken elsewhere against Darwin's theory and for the Glacial-control theory; but such is not the case. It must be remembered that the two main postulates of the Glacial-control theory, namely, long-continued stability of reef foundations in the mid-Pacific and the abrasion of sub-lagoon platforms by the lowered Glacial ocean, are not based on direct evidence but are assumed because they are supposed to be necessary for the explanation of smooth lagoon floors of standard depths. Not a single example of an abraded platform has been discovered under recently uplifted reefs; and a large number of mid-Pacific islands which have a decipherable recent history are found not to have been long stable but to have suffered various changes of level. In other words, where other outspoken witnesses are found, their testimony is, like that of Tagula, for Darwin's theory of upgrowing reefs on subsiding foundations of whatever shape. A large number of examples of this kind could be adduced if space permitted.

But although the inhibition of reef growth and the resulting abrasion of low-level platforms by the Glacial ocean thus appear to be excluded from the greater part of the coral seas, it is highly probable that reef-building organisms may have been weakened or killed and that abrasion of platforms may have taken place around islands near the margin of the coral seas; and at least some of those islands ought now to show plunging cliffs in evidence of their possession of submerged platforms; but even there the islands need not have been stable. This aspect of the coral-reef problem is examined in an essay submitted to the Geological Society of America for publication in its Bulletin.

[5] "Problems associated with the Study of Coral Reef," *Sci. Monthly*, 2, 1916 (565).

Root Respiration.[1]

ALTHOUGH so much work has been done on the question of root respiration, it is only within the last few years that the importance of the air content of the soil in this connexion has been clearly demonstrated. With the growth of ecological work has come the indication that this air content is a primary factor in many habitats and a controlling one in wet soil and water, but even yet this is not generally recognised.

Mr. F. E. Clements has endeavoured to clear the ground for further research in this direction by summarising the available information in all its aspects. From the time of Mayou (1668) the necessity of oxygen for root activity has been recognised, and numerous investigations have since added to the bulk of evidence with studies of germination, anaerobic respiration, and the respiratory behaviour of underground parts other than roots. The excretion of carbon-dioxide by the roots was first noted by Hales (1727), but the possible excretion of other substances is still a matter of controversy at the present day. Molisch first showed that roots exhibit the phenomenon of aerotropism or response to different concentrations of various gases. This is of great significance in plants inhabiting bogs and swampy land, as in order to obtain the oxygen necessary for respiration they develop aerotropic roots which run horizontally above the oxygen-free swamp soil, as in Alnus, or rise vertically in the air, as in Avicennia.

The composition of the soil air varies considerably with the nature of the soil, time of year, and seasonal changes, and is also affected by cultivation and plant growth, which increase the carbon-dioxide and diminish the oxygen in proportion. It has been suggested by Bristol that the presence of algæ may also affect the soil gases.

Anaerobic respiration is of much significance in connexion with reduced oxygen supply. The general effect of the reduction or absence of oxygen on respiration is to reduce its intensity, but respiration under anaerobic conditions differs with the species. Carbon-dioxide and alcohol are the regular products of such respiration, which is consequently regarded by most investigators as essentially identical with alcoholic fermentation when carbohydrates are present. Under certain conditions acetic, formic, and lactic acids are excreted from the roots and other parts of flowering plants. After considering the relation of photosynthesis, transpiration, and germination to oxygen supply, Mr. Clements enunciates the general rule that growth is decreased or prevented by the absence of oxygen. The movement of protoplasm in plant cells is stopped, and practically all tropistic responses are suppressed.

Field studies of aeration, approached from the agricultural, pathological, and ecological standpoints, corroborate the results of physiological investigation as to the basic importance of oxygen for root activity and the injury wrought by the accumulation of carbon-dioxide. The practical importance of this appears most strikingly in irrigated regions where the common practice involves the use of too much water, with consequent economic loss, due to the production of an oxygen deficit in the soil.

[1] "Aeration and Air Content: the Rôle of Oxygen in Root Activity," by Frederic E. Clements. Pp. 183. (Publication 315.) (Washington: Carnegie Institution, 1921.) 2 dollars.

The problem of soil aeration and the way in which it works injury to plants is much under discussion, but it appears certain that in some soils the lack of oxygen and the accumulation of carbon-dioxide are primary factors, while the organic acids and salts arising from anærobiosis may play some part. In other cases acidity brings salts of aluminium, iron, or manganese into solution, which then exert a toxic effect.

Finally, after putting forward the present position of affairs with regard to toxic exudates and soil toxins, the author concludes his valuable survey with a comprehensive bibliography which contains more than seven hundred references. W. E. B.

Radio Direction Finding in Flying Machines.

THERE is little doubt that radio direction finders and other radio devices will soon be in regular use to enable aeroplanes to land at night, during fogs or at other times of poor visibility. The usual method is to transmit signals from an antenna in the landing field to the direction-finder on the aeroplane. This, however, gives merely the direction of the landing-field and provides no indication to the navigator of his distance from his destination.

Some years ago the Bureau of Standards in America experimented with induction signalling. A large horizontal single turn coil, 600 by 800 feet, was erected at the landing-stage. It was tuned to resonance at a frequency of 500 so that it produced a very powerful alternating magnetic field over a wide area in the neighbourhood. It was found that induction effects could be detected at considerable distances when the aeroplane was at a low altitude, but at the height of a mile they could be detected only throughout a small area directly over the coil. The tests showed that what was wanted was a hollow conical beam of radiation, the vertex of the beam being on the landing ground. At low altitudes it was very important that the signal should be audible over only a very limited range.

This has been effected by means of two equal coaxial coils with their planes horizontal and at different altitudes. The current, which has a radio-frequency of 300,000, flows in opposite directions in the two coils. Under these conditions the signals are received at the aeroplane only when the machine is in the immediate neighbourhood and approaching or receding from the station.

Gregory Breit, a physicist of the Bureau of Standards, has worked out mathematically the nature of the field from the two horizontal coils. It is proved that the maximum intensity of the signals occurs when the angle which the line joining the aeroplane with the landing-stage makes with the vertical is approximately 30°. The region of space within which the signal can be detected is nearly the space between two inverted coaxial cones with their axes vertical and their common apex at the transmitting station. The signals are inaudible directly overhead and rapidly die away when the aeroplane passes through the conical surface where the sound is a maximum. The lower the aeroplane also the louder the noise. The theoretical results have proved of great value in designing stations for emitting landing signals, and should be of considerable practical importance.

Industrial Research in India.

ONE of the bye-products of the new constitution legalised by the Government of India Act of 1919 was the transfer of certain "heads of business," previously administered by the bureaucratic regime, to the control of popularly elected Ministers in each province. The subjects so transferred included agriculture, forests, and the development of industries, with, therefore, the scientific and technical services attached to these departments. Realising that "decentralisation of authority and responsibility must necessarily tend to give rise to local variations in policy, apart altogether from those variations that follow local diversity in natural resources," Sir Thomas Holland, when designing the new Department of Industries and Labour in 1920, elaborated a system which would facilitate concerted action among the provinces while leaving them free to develop in any way that seemed to their respective legislatures best suited to their special needs. The new Ministers were, in the first instance, provided with a monthly circular summarising the information, often of a semi-confidential nature, collected by the Intelligence Branch of the Munitions Board. Out of these circulars grew the agenda of half-yearly conferences, followed by a quarterly Journal and a series of Bulletins suitable for publication.

During 1921 four parts of the first volume of the Journal, amounting to 568 pages, well illustrated and fully indexed, were issued, and we have now received the first part of the new volume for 1922, together with twenty-three Bulletins on special subjects. The first part of the Journal published in 1921 was noticed last year in NATURE of April 7 (vol. 107, p. 179), and it is satisfactory to observe that the quality of the papers and the fundamental object of the publication have both been faithfully maintained. Some of the articles, like those by Dr. E. R. Watson and Mr. Mukerji on the alkaline "bad lands" of the United Provinces, by Mr. B. M. Das on the tan-stuffs of the mangrove swamps on the Gangetic delta, by Mr. Appleyard on the manufacture of acetone and butyl alcohol, and by Messrs. Gadre and Mukerji on rose otto, include the results of original research; but generally the articles and notes have an industrial rather than a scientific bias, avoiding the ground covered by those scientific and technical departments that have established journals of their own. Problems of factory welfare, which are beginning to assume embarrassing importance in India, occupy a conspicuous place among papers describing local ventures in glass manufacture, paper-making, tanning, pottery, oil-extraction, perfume distillation, wire-drawing, textile manufacture, and mineral enterprises.

The progress reports provided quarterly by the provincial Directors of Industries show the efforts being made to carry out the recommendations of the Industrial Commission which delivered its report towards the end of 1918. The reports generally give some justification for the claim made by Lord Chelmsford in his article in the *United Empire* for December last (vol. xii. p. 778) that "never has effect been given more expeditiously" to a Commission's report. Differences of provincial outlook, however, still retard the adoption of the excellent scheme of chemical research drawn up by Prof. Thorpe's Committee in 1920; and without some such organisation to this end, by co-operation among the provinces, the industries of India must always retain their primitive "configuration" and remain distinctly behind, for example, those of a country like Japan.

Rainfall in Southern Italy and Tripoli.

PROF. FILIPPO EREDIA, of the Italian Meteorological Service, has recently contributed some further climatological studies to the many which he has already published. One of these (Nuovi Annali del Ministero per l' Agricoltura) deals with the seasonal conditions of rainfall in the province of Apulia and the relation of the quantity of precipitation to the number of days of incidence. The matter is important in connexion with the somewhat precarious water supply in that southern Italian province, which during the summer months is affected by the Saharan regimen of drought.

In another publication, on the rainfall of Tripoli ("L' Agricoltura Coloniale," Anno xv., No. 8, 1921), Prof. Eredia shows that there is no foundation for the supposition that the rainfall of the region is steadily diminishing because the country shows signs of progressive desiccation. One might remark that progressive desiccation is considered to be the fact in many parts of Africa other than Tripoli, and that it has been explained by Schwarz and others as due, not to diminishing rainfall, but to a continental configuration which is slowly inducing baneful hydrological changes.

Two other papers on the climates of Gharian and Cussabat on the interior plateau of Tripoli (Bollettino di Informazioni, Nos. 3-4, 7-8, 1921) give an interesting glimpse of general climatic conditions based on a few years' records for meteorological observations since the Italian occupation. The mean annual temperature at Gharian, high up on the plateau and more than 2000 feet above sea-level, is about 65° F., ranging between 83° in July and 48° in January, and the mean daily range varies from 30° F. at midsummer to less than half that value at midwinter. The absolute extremes of temperature recorded at this station were 121·1° F. in June and 32·1° F. in December, whilst extreme fluctuations of relative humidity characterise this dry region. The general rainfall of Tripoli is less than 20 inches a year, chiefly confined to winter. In this region we have another instance of the fact that occasional snowfalls at sea-level make a much closer approach to the tropics than is commonly supposed.

University and Educational Intelligence.

BANGOR.—Prof. D. Thoday of the University of Cape Town has been appointed to the chair of botany, in succession to Prof. R. W. Phillips, who retires after thirty-eight years' service.

BIRMINGHAM.—At the Degree Congregation held on July 1, in the great hall of the University at Edgbaston, the number of degrees conferred was the largest hitherto recorded for the University. Many of the new graduates are ex-service men, and the Principal (Mr. C. Grant Robertson) paid a tribute to the work of these men and their valuable help in creating afresh traditions of the University after the war: "They have given us invaluable service in that necessary work. They brought to the University a breadth and a variety of experience, a maturity of judgment, and an energy and enthusiasm which those who know the University from the inside recognise has been invaluable, and which will leave a permanent imprint on our University life and a permanent addition to our University traditions." The institution by the Government of grants to ex-service men was a unique educational experiment and, judging by the experience of Birmingham University, it had proved an unqualified success.

The following degrees were conferred: *Doctor of Science*: Mr. R. H. Whitehouse; *Doctor of Medicine*: Mr. O. J. Kauffmann, Mr. J. Robertson, and Mr. J. W. Russell; *Philosophiæ Doctor*: Mr. F. Adcock, Mr. C. B. Childs, Mr. V. A. Collins, Mr. E. A. F. Reeve, Mr. J. D. M. Smith, Mr. R. E. Stradling, Mr. E. H. Wells; *Master of Surgery*: Mr. L. P. Gamgee. For the degree of Master of Science, 45 candidates were presented; for the degree of B.Sc. with Honours, there were 74 candidates, and for the ordinary B.Sc. degree, 157.

The Vice-Chancellor, Sir Gilbert Barling, announced that a war memorial was to be erected on the east wall of the entrance hall, in the form of three marble panels bearing the names of the members of the University of all ranks who fell in the war. It is expected that the memorial will be unveiled in October next.

Mr. C. G. Payton has been appointed demonstrator in anatomy.

The Ingleby Lecturer for 1924 will be Mr. A. W. Nuthall.

CAMBRIDGE.—In connexion with the meeting of the Royal Agricultural Society (the "Royal Show"), honorary degrees are being conferred on H.R.H. The Duke of York, the Honourable W. H. Taft, Mr. C. R. W. Adeane, Sir G. Greenall, Sir Daniel Hall, Mr. E. S. Beaven, Mr. A. E. Humphries, Mr. E. Mathews, and Mr. G. P. Hawkins. Mr. L. C. G. Clarke, Trinity College, has been appointed curator of the Museum of Archæology and of Ethnology.

LONDON.—Prof. H. S. Birkett (Dean of the Faculty of Medicine, McGill University) will deliver the Semon Lecture at the Royal Society of Medicine, 1 Wimpole Street, W.1, on Wednesday, July 12, at 5 o'clock. The subject will be "The development of Trans-Atlantic Rhino-laryngology." Admission will be free and no tickets will be required.

OXFORD.—At the Encaenia, held on June 28, the honorary degree of D.Sc. was conferred on Prof. J. Perrin of Paris and Prof. F. Gowland Hopkins of Cambridge. In introducing Prof. Perrin, the Public Orator (Dr. Godley) referred particularly to his experimental researches in the character and constitution of the atom, and to his determination of the velocity of the component electrons. His scientific investigations had been used in the service of his country, and had contributed largely to its victory in the war. Of the work in biochemistry of Prof. Gowland Hopkins, the Orator found it difficult to speak "in hac patrii sermonis egestate." He was able, however, to pay tribute in general terms to Prof. Hopkins's abstruse researches into the nutrition and metabolism of living bodies. His discovery of the importance of vitamins was not only of high scientific value, but had also a practical bearing of the greatest interest in the study of disease. Prof. Perrin was greeted by the Vice-Chancellor (Dr. L. R. Farnell, Rector of Exeter College) as "Vir doctissime; maxime physicae scientiae auctor"; and Prof. Hopkins as "Vir eruditissime; chemiae explorator insignis; Universitatis Cantabrigiensis decus."

SHEFFIELD.—Honorary degrees have been conferred on Sir Charles Parsons for his work on the turbine engine, and on Mr. T. W. Hall for researches in palæography and archæology.

DR. R. H. CHITTENDEN, the well-known authority on dietetics, is retiring from the post of director of the Sheffield Scientific School, Yale University, which he has held since 1898. He is to be succeeded by Dr. C. H. Warren, now professor of mineralogy at the Massachusetts Institute of Technology and a former assistant at the Sheffield Scientific School, of which he is himself a graduate.

Calendar of Industrial Pioneers.

July 1, 1860. Charles Goodyear died.—The father of the American rubber industry, Goodyear was born at New Haven, Connecticut, on December 12, 1800, his father, Amasa Goodyear, being known as an inventor of agricultural implements and a manufacturer of hardware. The failure of his father's business about 1830 led Goodyear to study the problem of "curing" rubber, which at that time became soft and sticky in summer and brittle in winter. Always in debt, sometimes in prison, and often regarded as a crank, Goodyear persevered until, in 1839, he accidentally discovered that by partly melting rubber and sulphur the rubber could be given varying degrees of hardness and elasticity. His first patent was taken out in 1844, and though he reaped no fortune he continued to improve the manufacture and extend the use of rubber until his death.

July 2, 1798. John Fitch died.—One of the pioneers of steam navigation, Fitch was the son of a farmer of Windsor, Connecticut, and was born on January 21, 1743. After a few sea voyages he engaged in clockmaking and brassfounding, and as a gunsmith to the American troops during the War of Independence made a considerable fortune. His project of driving boats by steam was launched in 1785, and the following year he formed a company and secured exclusive rights in New Jersey and other States. A boat built by him and placed upon the Delaware in 1790 was the first steam vessel to convey passengers for hire. The undertaking, however, proved financially unsuccessful, and three years later Fitch met with no more success in France. Reaping nothing but disappointment and poverty, his mind gave way, and he died by his own hand at Bardstown, Kentucky.

July 5, 1826. Joseph Louis Proust died.—Trained as a chemist by his father, Proust made one of the earliest balloon ascents, was for some years employed by the King of Spain, and discovered a process of making grape sugar. He was also known for the enunciation of the law of constant proportion and for his controversies with Berthollet.

July 5, 1883. Robert Spence died.—Beginning life as a grocer, Spence afterwards found employment in the Dundee Gas-works and became the proprietor of chemical works in London, Manchester, and elsewhere. In 1845 he discovered the process of making alum from the refuse shale of collieries and the waste ammoniacal liquor of gas-works, and became the chief alum manufacturer in the world. He also took out many patents in connexion with industrial chemistry and metallurgy.

July 7, 1850. Timothy Hackworth died.—Born at Wylam, near Newcastle, in 1786, Hackworth became a foreman smith and assisted in some of the pioneering work on the locomotive. Appointed in 1825 resident engineer and manager of the Stockton and Darlington Railway, he built the *Royal George*, which definitely asserted the superiority of steam over horse traction, and in 1829 produced the *Sans Pareil*, a worthy competitor with Stephenson's *Rocket*, at Rainhill.

July 7, 1896. Sir John Pender died.—A successful merchant in textile fabrics in Manchester and Glasgow, Pender was an enthusiastic supporter of submarine telegraphy, and was one of the 345 subscribers who each risked a thousand pounds in the Atlantic Cable of 1857. He personally guaranteed 250,000*l.* to the Telegraph Construction and Maintenance Company in 1865, and at his death was the head of various concerns owning 73,640 nautical miles of submarine cable and having a capital of fifteen millions.

July 10, 1867. Thomas Richardson died.—Trained as a chemist under Thomas Thomson, Liebig, and Pelouze, Richardson became a chemical manufacturer at Newcastle, introduced improvements in the production of lead, and began the manufacture of superphosphates. He lectured on chemistry in Durham University, published information about the industries of the north, and with Ronalds translated Knapp's "Technological Chemistry."

July 10, 1874. John Grantham died.—The author of a standard work on iron shipbuilding, Grantham designed many sailing-ships and steamships, patented a screw-propeller, and devised a method of sheathing iron ships with copper. He was also joint engineer with his brother to the northern railway of Buenos Aires and planned the first tramway in Copenhagen. He was one of the founders of the Institution of Naval Architects.

July 12, 1892. Cyrus West Field died.—Born in Stockbridge, Massachusetts, November 30, 1819, Field built up a large paper-manufacturing business, and then in 1854 turned his attention to submarine telegraphy, ultimately becoming the chief promoter of the Atlantic Telegraph. It has been said, "Let who will claim the merit of having said the Atlantic cable was possible, to Mr. Field is due the inalienable credit of having made it possible, and of giving to an abortive conception all the attributes of healthy existence." His share in the great enterprise was recognised by the award to him by Congress of a gold medal, and he received the thanks of the American nation.

July 12, 1910. Charles Stewart Rolls died.—A pioneer of the motor-car in England, an expert aeronaut, and the first English victim of aviation, Rolls was the son of Baron Llangattock and was born August 28, 1877. Educated at Eton and Trinity College, Cambridge, he studied practical engineering, and in 1895 purchased his first motor car. Nine years later he founded the well-known firm of Rolls-Royce, Ltd. To study Wilbur Wright's experiments he visited France in 1908, acquired a Wright aeroplane, and became an expert flyer. In June 1910 he crossed and recrossed the Channel without stopping. His death was due to an accident to the machine he was flying at Bournemouth.

July 14, 1806. Emiland Marie Gauthey died.—A student at the École des Ponts et Chaussees, under the celebrated Perronet, Gauthey rose to eminence in the French service, and was especially known for the construction of the Canal du Centre in Burgundy. His "Traité complet sur la construction des ponts et des canaux navigables" was published in 1809 by his nephew Navier.

July 14, 1808. John Wilkinson died.—The father of the iron trade in Staffordshire, Wilkinson was born in 1728, and learned the art of smelting from his father. In 1748 he built a blast furnace at Bilston, Staffordshire, using coke for fuel, and afterwards had works at Bersham and Broseley. He introduced the boring of cannon, in 1787 he constructed an iron barge, and he also patented a method of making lead pipes.

July 14, 1887. Alfred Krupp died.—The son of Friedrich Krupp (1787–1826), who opened a small iron forge at Essen in 1810, Alfred Krupp was born April 26, 1812, and at an early age succeeded to the management of the business which, in his hands, became of world-wide importance. He made the first steel gun, established the first Bessemer works in Germany, and manufactured large quantities of ordnance and railway material. The works at Essen cover an area of about five square miles, while the firm, in its various establishments, employs some 80,000 men.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 22.—Sir Charles Sherrington, president, in the chair.—G. I. **Taylor**: The motion of a sphere in a rotating liquid. There are an infinite number of solutions to the equations of motion of a rotating fluid, when a sphere is moved uniformly along the axis of rotation, which satisfy the boundary conditions and the conditions at infinity. They are characterised by spherical rotational waves which accompany the sphere. The radius of the sphere may be reduced to zero without reducing the disturbance in the fluid to zero. The equations then represent a motion which is finite and continuous at the centre, and consists of a central core of fluid which rotates more slowly than the surrounding fluid and travels along the axis with a constant speed.—T. R. **Merton** and D. N. **Harrison**: On errors arising in the measurement of unsymmetrical spectrum lines. The instrumental displacements occurring while spectra are being photographed can be rendered innocuous, for wave-length determinations, only when the spectrum lines are symmetrical. With uniform displacement of a line during exposure, the maximum on the photographic plate occurs where the intensity distribution curves at the beginning and end of the exposure intersect. When the ratio of the widths on either side of the maximum of the curve remains constant for all values of the intensity, the displacement of the maximum is simply related to the "index of asymmetry" of the line.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. Pt. VIII. The action of sodium carbonate in promoting the hydrogenation of phenol. Small amounts of mild alkali, especially anhydrous sodium carbonate, stimulate the hydrogenation of liquid phenol in presence of nickel. The amount of sodium carbonate has a specific influence, the optimum being about 25 per cent. of the weight of metallic nickel present. The hydrogen-absorption time curves for phenol in presence of nickel and in absence of sodium carbonate are of logarithmic type; with the optimum concentration of carbonate they are approximately linear. The sodium carbonate suppresses a retarding or poisoning influence, leaving the nickel free to exercise its normal function. The toxic agent appears to be some stable association between the nickel and phenol, or a product from the latter, possibly nickel phenate. Pt. IX. The action of copper in promoting the activity of nickel catalyst. Copper-nickel catalysts prepared at 180° C. are not so active as the plain nickel catalyst, distributed to give the maximum surface area, reduced at a higher temperature. For maximum activity, the proportions of the mixed carbonates must be such that nickel α-cupri-carbonate is present in the precipitate. The preparations yielding active catalysts respond to Pickering's tests for complex cupri-carbonates. The production of a little reduced nickel at this low temperature is conditioned, perhaps, by the heat liberated in the reduction of the copper.—E. A. **Milne**: Radiative equilibrium: the relation between the spectral energy curve of a star and the law of darkening of the disc towards the limb, with special reference to the effects of scattering and the solar spectrum. For stars in radiative equilibrium the darkening of the disc towards the limb in wave-length λ depends only on the product λT, T being the effective temperature. The ratio of the intensity at the limb to that at the centre increases as λT increases, but never exceeds 0·8; it approaches zero for small values of λT. For stars not in radiative equilibrium the coefficient of darkening in the integrated radiation must lie between $\frac{3}{5}$ and $\frac{1}{2}$, and the temperature distribution near the surface can be deduced. Selective absorption in the continuous spectrum alters the law of darkening. A scattering atmosphere round a star should make the coefficients of darkening in all wave-lengths tend to the same value, about $\frac{3}{5}$. The observed darkening of the continuous solar spectrum differs very little from the theoretical darkening for radiative equilibrium; it is not possible to correlate the spectrum with the darkening, either on the hypothesis of selective absorption or on that of a scattering atmosphere. Probably there is no scattering atmosphere of appreciable optical thickness round the sun, and the bulk of the emergent radiation is not scattered light.—C. N. **Hinshelwood**: On the structure and chemical activity of copper films and the colour changes accompanying their oxidation. The gradual activation of a copper surface in a series of oxidations and reductions has been studied at pressures of a few millimetres. A limiting state appears to be reached in which the copper film has an open structure consisting of granules of radius a small fraction of 1μ. During oxidation, brilliant diffraction colours are observed, depending upon the composition of the separate granules. The mechanism by which the film becomes granular is discussed.—R. C. **Ray**: Heat of crystallisation of quartz. The difference between the heats of solution of quartz and silica glass in aqueous hydrofluoric acid, and the specific heats of aqueous hydrofluoric acid represents the heat of crystallisation of quartz at the ordinary temperature, and is 6·95 kilogram calories. Grinding converts the crystalline material partly into the vitreous state. Near the melting-point the heat of crystallisation is probably nearly equal to that at air temperature.—C. G. **Schoneboom**: Diffusion and intertraction. With fluid-mixing, in addition to diffusion, another specific operating factor called "Intertraction" has been found experimentally. Clerk Maxwell, in discussing interfacial tension, concluded that an interpenetrating movement of this kind was *a priori* to be expected. The phenomenon has been described by Sir Almroth Wright in the special case of the admixture of serum and salt solutions, but it can be obtained with practically any substance in any solvent.

Geological Society, June 14.—Dr. G. T. Prior, vice-president, in the chair.—P. G. H. **Boswell**: The petrography of the Cretaceous and Tertiary outliers of the west of England. The outliers of Upper Greensand on the Haldon Hills, the Eocene (?) of Marazion, Buckland Brewer, and the Haldon Hills, and the Oligocene of Bovey Tracey and Petrockstow are discussed. Andalusite, topaz, and tourmaline are the typical minerals. Minerals foreign to the West Country, such as kyanite and staurolite, are also abundant in the Cretaceous and Pliocene. The mineralogical constitution yields evidence of a progressive restriction of drainage-area, commencing with the marine and glauconitic Greensand and continuing through the fluviatile (?) Eocene to the lacustrine Bovey deposits, and of a reversion to marine conditons with a polygenetic mineral assemblage in the Pliocene.—W. N. **Benson** and S. **Smith**: On some rugose corals from the Burindi Series (Lower Carboniferous) of New South Wales. The corals were obtained from the western foothills of the New England Plateau, in the north-eastern portion of the

country. The region consists mainly of Upper Palæozoic rocks, Devonian to Permian. The Burindi Series is made up of olive-green mudstones and tuffs, with occasional lenticular masses of oolitic and crinoidal limestone. From these intercalations the corals, which are related to Cyathophyllum and Lithostrotion, were obtained. Both forms have abnormally large columellæ. The species of Lithostrotion have small peculiarities of structure, which distinguish them as a group from British species.

EDINBURGH.

Royal Society, June 5.—Prof. F. O. Bower, president, in the chair.—A. N. **Whitehead**: The relatedness of Nature. Hume disposed of the theory of the relatedness of Nature as it existed in the current philosophy of his time. We can discern in Nature a ground of uniformity of which the more far-reaching example is the uniformity of space-time, and the more limited example is what is usually known under the title of "The Uniformity of Nature." Our arguments must be based upon considerations of the utmost generality, untouched by the peculiar features of any particular natural science. Every entity is an abstraction from the concrete, which in its fullest sense means totality. The important point of that doctrine is that any factor of Nature, by virtue of its status as a limitation within totality, naturally refers to factors of totality other than itself. Equality of limitude is the significance of factors. The uniform significance of events becomes the uniform spatio-temporal structure. In that respect it is necessary to dissent from Einstein, who assumes for that structure casual heterogeneity arising from contingent relations. The structure is uniform because of the necessity for knowledge that there should be a system of uniform relatedness, in terms of which the contingent relations of natural factors can be expressed. Otherwise we can know nothing until we know everything. It is evident that a scientific object such as an electron must qualify future events, for otherwise the future contingency is unaffected by it. In that, a scientific object differs decisively from a sense-object. A sense-object qualifies events in the present. Thus, the seemingly contingent play of the senses is controlled by the conditions brought about by its dependence upon the qualification of events introduced by the scientific object.

SHEFFIELD.

Society of Glass Technology, June 21.—Prof. W. E. S. Turner in the chair.—Y. **Amenomiya**: The devitrification caused upon the surface of sheet glass by heat. Heat causes devitrification, or crystallisation of window glass. This alteration takes place between 700° and 800° C.—K. **Kamita**: The influence of alumina in preventing the devitrification of sheet glass during the drawing process. As the amount of alumina in the glass increased in the samples used, so the temperature at which devitrification occurred was raised; 5 per cent. of alumina caused a rise of approximately 100° C. in the temperature at which devitrification commences.—L. E. **Norton**: The apparent swelling of sand on the addition of water. With three typical sands the addition of water caused difficulty in packing equivalent to swelling which might be 12-15 per cent. of the total dry sand. The maximum effect occurred when 5-6 per cent. of water was mixed with the sand.—W. E. S. **Turner**: The mixing of batch. Taking three works samples from batch mixed by hand, the maximum variations were 44-77 per cent. sand and 4·8-8·3 per cent. lime, while a similar batch mixed by different machines showed variations of 69-73 per cent. sand and 4·2-6·6 per cent. lime. Machine mixing, by giving a much more regular batch, assisted the melting, and materially reduced the time necessary for the production of good glass.

PARIS.

Academy of Sciences, June 12.—M. Emile Bertin in the chair.—Henry le **Chatelier**: The geometric representation of saline equilibria. Remarks on a question of priority raised by Prof. Jaenecke.—Charles **Depéret**: An attempt at the general chronological co-ordination of quaternary time.—Maurice **Leblanc**: The use of air as a cooling agent. A theoretical and practical comparison of the use of liquid ammonia and compressed air as cooling agents, with a study of the best conditions for using the latter.—A. **Rateau**: General theory of the turbo-compressor for aviation motors. The compressor is worked by the exhaust gases from the engine and delivers the air to the cylinder at about double the atmospheric pressure. It is especially designed for use at high altitudes.—M. **Riquier**: Singular integral figures of passive systems of the first order involving only a single unknown function.—Jules **Andrade**: Three classes of non-maintained isochronal vibrations and three types of timepieces. New instruments for the experimental study of viscosities.—G. **Friedel** and L. **Royer**: Liquids with Grandjean's equidistant planes.—Torsten **Carleman**: Asymptotic series.—G. **Valiron**: Hermite's method of approximation.—Georges **Rémoundos**: The general problem of the thrust of earth.—M. **Sudria**: The elastic deformation of an isotropic body.—E. **Merlin**: The calculation of heliographic co-ordinates.—M. **Dufour**: The refraction of a luminous pencil in the general case.—A. **Andant**: The variations of critical opalescence with the filling of the tubes and the nature of the liquids studied. The effects of the variation of critical opalescence with the temperature and with the wave-length of the incident light have been described in an earlier paper. The ratio of liquid to vapour in the tube (D) also affects the phenomenon, and the temperature of reappearance of the meniscus is now shown to be a parabolic function of D. A study of the acetates of methyl, ethyl, butyl, and isobutyl shows that the opalescence increases in intensity and extent, passing from the first to the fourth of these acetates.—A. **Dauvillier**: The exact measurement of the energy levels of the barium atom and the appearance of the L ionisation spectrum.—M. de **Broglie** and A. **Dauvillier**: A new absorption phenomenon observed in the field of the X-rays.—A. **Damiens**: The crystallisation of amorphous tellurium. According to Berthelot and Fabre, the crystallisation of tellurium is an endothermic phenomenon, thus forming an exception to the general rule. A repetition of the experiments of Berthelot and Fabre has shown that the reaction used by them (bromination of tellurium) is not complete in the case of crystallised tellurium, and by substituting bromine in hydrochloric acid for bromine and water it is proved that the change from amorphous to crystallised tellurium is accompanied by an evolution of heat. Tellurium thus falls into line with other amorphous substances.—R. **Locquin** and Sung **Wouseng**: The preparation of the dialkylvinryl-carbinols. A general method for preparing the unsaturated alcohols of the type $RR'-C(OH)-C\equiv CH$ has been given in an earlier communication. By a suitable catalyst (reduced nickel) these can be reduced by hydrogen to the corresponding tertiary ethylene alcohols

$RR'-C(OH)-CH=CH_2$; the preparation and properties of three of these are described.—E. E. **Blaise** and Mlle. **Montagne**: The action of thionyl chloride on the α-acid alcohols. With lactic and α-oxyisobutyric acids, thionyl chloride forms anhydro-compounds of a new type.—MM. **Pastureau** and Henri **Bernard**: The chlorhydrin of mesityl oxide and its transformation into the chlorhydrin of tetramethyl glycerol.—Edmond **Gain**: The comparative resistance to heat of the growing points of the embryo of the sunflower. If the seeds have been submitted before germination to temperatures just below those capable of destroying life (110° to 155° C.) the various points capable of growth are shown to be unequally sensitive, that of the root being most easily destroyed.—Maurice **Lenoir**: Somatic kinesis in the aerial stem of *Equisetum arvense*. From the facts described it would appear that the fundamental substance of the chromosome is the nucleolin; the chromatin is derived from it.—Mlle. Marguerite **Larbaud**: The anatomy of flowers of the same species at different altitudes. A detailed comparison of plants of *Silene inflata* grown at about sea-level and at 2000 metres altitude.—Gabriel **Bidou**: An artificial musculometer.—Clément **Vaney** and Jean **Pelosse**: Origin of the natural coloration of the silk of *Bombyx mori*. The colouring matter from the silk and that derived from the leaves of the mulberry tree give identical absorption spectra in alcoholic solution. This confirms the view of Conte and Levrat that the silk cocoons derive their colour from the pigments of the leaf serving as food for the silkworms.—M. **Aron**: The development of the primary sexual characters in *Triton cristatus*. Hypothesis on its determinism.—P. **Bouin**: Dipyrenid of the sperm in certain double spermatogeneses is obtained by a heterotypical mitosis produced in the course of development.—A. **Pézard**: The idea of the "*seuil différentiel*" and humoral interpretation of the gynandromorphism of the bipartite birds. In these birds the plumage is divided into two parts following the plane of symmetry of the body, one half having a male appearance, the other female. The reproductive organs show corresponding peculiarities.—A. **Desgrez**, H. **Bierry**, and F. **Rathery**: A balanced food regime and diabetic acidosis.—Pierre **Goy**: Microbial physiology and the accessory growth factor. It appears to be impossible to determine Vitamine B by studying its action on the growth of yeast.—Charles **Lebailly**: The duration of the contagious period in aphthous fever.

CAPE TOWN.

Royal Society of South Africa, May 17.—Dr. J. D. F. Gilchrist, president, in the chair.—J. R. **Sutton**: The control of evaporation by the temperature of the air. The rate of evaporation from the surface of the water in a metal gauge sheltered by a louvred screen increases as the air temperature rises above that of the water. In the space just above the water the relative humidity is much higher than, while the temperature there is about the same as, that of the free air. The results illustrate the general law that water vapour diffuses along the relative humidity gradient.—Sir Thomas **Muir**: Note on a determinant with factors like those of the difference-product.—J. **Moir**: Colour and chemical constitution, Pt. XVII. The azo dyes and other monocyclic colours. By spectrophotographic means, and replacing N by CH and eliminating N or CH, the azo dyes are calculable from oxy- and amino-benzaldehyde, previously calculated in Pt. XIII. Quinone and its imines all have six bands, one pair for neutral, another pair for acid, and a third pair for alkaline solution.

Official Publications Received.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 16: Education in the Maritime Provinces of Canada. By Wm. S. Learned and Kenneth C. M. Sills. Pp. iv+50. (New York.)

Department of the Interior: United States Geological Survey. Bulletin 726-E: Geologic Structure of Parts of New Mexico. By N. H. Darton. Pp. vii+173-275. (Washington: Government Printing Office.)

Classified List of Smithsonian Publications available for Distribution, April 15, 1922. Compiled by Helen Munroe. (Publication 2670.) Pp. vi+30. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Professional Paper 129-G: The Flora of the Woodbine Sand at Arthurs Bluff, Texas. By Edw. W. Berry. Pp. 153-181. Professional Paper 129-H: Geology of the Lower Gila Region, Arizona. By Clyde P. Ross. Pp. 183-197. Professional Paper 129-I: The Flora of the Cheyenne Sandstone of Kansas. By Edw. W. Berry. Pp. 199-225. (Washington: Government Printing Office.)

Smithsonian Institution: United States National Museum. Contributions from the U.S. National Herbarium. Vol. 22, Part 6: Grasses of British Guiana. By A. S. Hitchcock. Pp. x+439-515. (Washington: Government Printing Office.)

Cornell University Agricultural Experiment Station. Memoir 46: A Classification of the Cultivated Varieties of Barley. By R. G. Wiggans. Pp. 363-456. Memoir 49: The Biology of Ephydra Subopaca Loew. By Chih Ping. Pp. 555-616. Memoir 50: The Relative Growth-promoting Value of the Protein of Coconut Oil Meal, and of Combinations of it with Protein from various other Feeding Stuffs. By L. A. Maynard and F. M. Fronda. Pp. 617-633. Memoir 51: The Hog Louse, Hæmatopinus Suis Linné: Its Biology, Anatomy, and Histology. By Laura Florence. Pp. 635-743. Memoir 52: Studies in Pollen, with Special Reference to Longevity. By H. E. Knowlton. Pp. 745-793. (Ithaca, N.Y.: Cornell University.)

Diary of Societies.

FRIDAY, JULY 7.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. A. F. Hess: The Effect of Light in the Prevention and Cure of Rickets.

TUESDAY, JULY 11.

INTERNATIONAL NEO-MALTHUSIAN AND BIRTH CONTROL CONFERENCE (at Kingsway Hall, Kingsway, W.C.2), at 10.—Dr. C. V. Drysdale: Presidential Address.—At 2.30.—Dr. Jane L. Hawthorne: Birth Control as it affects the Poor.—E. Cecil: C3 Motherhood.—Mrs. B. I. Drysdale: The Individual and the State.—Miss F. W. Stella Browne: The Feminine Aspect of Birth Control.—Dr. Frances M. Huxley: Birth Control from the Point of View of a Woman Gynæcologist.

SOCIETY FOR THE STUDY OF INEBRIETY (at 11 Chandos Street, W.1), at 4.—C. J. Bond: The Influence of Hospitals on Temperance Reform (Presidential Address).

WEDNESDAY, JULY 12.

INTERNATIONAL NEO-MALTHUSIAN AND BIRTH CONTROL CONFERENCE (at Kingsway Hall, Kingsway, W.C.2), at 10.—Dr. C. V. Drysdale: The Criterion of Overpopulation.—Dr. B. Dunlop: A Malthusian View of Death Rates and of the Average Duration of Life.—Prof. K. Wicksell: The Crux of Malthusianism.—Prof. R. Michels: Emigration and the Birth Rate.—Baron Keikichi Ishimoto: The Population Problem in Japan.—A. M. Carr Saunders: The Historical Aspect of Birth Control.—Prof. E. Punke: Birth Control and Organised Labour.—At 2.30.—Moral and Religious Section.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—Prof. A. H. Todd: Surgery in Rheumatoid Arthritis.

THURSDAY, JULY 13.

INTERNATIONAL NEO-MALTHUSIAN AND BIRTH CONTROL CONFERENCE (at Kingsway Hall, Kingsway, W.C.2), at 10.—Prof. E. W. MacBride: Birth Control and Biological Law.—M. Pollock: The Problem of the Unfit.—Prof. W. F. Willcox: Economic Competition between American Races, Negro and White.—Miss Mary Winsor: The Cost to the State of the Socially Handicapped and the Socially Unfit.—Prof. P. W. Whiting: Relation of Recent Advances in Genetics to the British Control Programme.—Dr. H. Hart: Differential Fertility in Iowa.—Prof. K. Dunlap: Psychological Factors in Birth Control.—At 2.—H. Cox: International Aspects of Birth Control.—Dr. A. Nystrom: Overpopulation of the Earth and its Dangers.—J. O. P. Bland: The Far Eastern Population Question.—Mrs. Anne Kennedy: Birth Control in the United States.—Prof. Isoo Abe: The Birth Control Movement in Japan.—Dr. F. Goldstein: Birth Control the Saving of Civilisation.

FRIDAY, JULY 14.

INTERNATIONAL NEO-MALTHUSIAN AND BIRTH CONTROL CONFERENCE (at Kingsway Hall, Kingsway, W.C.2), at 10.—Dr. C. K. Millard: Birth Control and the Fertility Question.—Dr. A. Nystrom: The Necessity for abolishing Laws against Preventive Measures.—Dr. H. Rohleder: Neo-Malthusianism from the Medical Standpoint.—Dr. D. R. Hooker: Effect of X-rays upon Reproduction in the Rat.

PUBLIC LECTURE.

WEDNESDAY, JULY 12.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. S. Birkett: The Development of Trans-Atlantic Rhino-Laryngology (Semon Lecture).