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British Water Power and its Administration.

FOLLOWING almost immediately upon the publication of the Third and Final Report of the Water Power Committee of the Conjoint Board of Scientific Societies, there has recently appeared the Final Report of the Water Power Resources Committee of the Board of Trade. To a certain extent it may be said that the two Reports cover common ground, but there is this important distinction, that, whereas the Water Power Committee of the Conjoint Board addressed itself to the widest possible survey of the resources of the British Empire, the Board of Trade Committee has been limited by its terms of reference to the resources of the United Kingdom. The investigations, therefore, of the latter body within this restricted area have naturally been more searching and more detailed, and to that extent more complete.

The Report of the Board of Trade Committee confirms, in general, the views which were expressed in a leading article in NATURE of December 8 last in reviewing the earlier Report, particularly as regards the necessity of conserving the national resources of water power, of taking steps without delay to ascertain accurately their full extent and availability, and of providing effectively for their economic and judicious development in the interests of industrial enterprise. The Committee states, as a result of its researches, that it is estimated by the development of certain specified water-power schemes in Great Britain (a by no means exhaustive list) that a continuous output of 210,000 kilowatts could be obtained at an economic rate, and that this would result in a saving in coal consumption for steam-raising purposes of nearly three million tons per annum.

The statement is impressive as an instance of the prodigality with which the country's power resources are allowed to run to waste. But while the desirability of effecting so appreciable a reduction in the national coal bill must be clear and unmistakable to all who give a thought to the matter and realise the limitations of our stores of solid fuel, yet the suggestion put forward in the present Report as to the primary step to be taken towards this end will perhaps not receive such unquestioning assent. The Committee, with two dissentients, recommends the establishment by Act of Parliament of a Water Commission with controlling powers over the water resources of England and Wales, and authority to compile proper records, to allocate supplies, to adjust conflicting interests, and to recommend suitable development schemes. The public, restive after a long and irksome imposition of bureaucratic control, will, we feel, be inclined to express sympathy with the minority view of Mr. Sandford Fawcett and Mr. W. A. Tait that the appointment of such a Commission is unnecessary, and that it must necessarily prove a source of further expense to the taxpayer. Mr. Tait, in his separate memorandum on the proposal, utters a justifiable warning on the inherent defects of a permanent official body vested with statutory powers. "Such a Commission," he says, "however well constituted and however open-minded its members at first may be, will inevitably in course of time become bureaucratic in its outlook, and will in this respect be less fitted to adapt itself to circumstances, as these vary from time to time, than independent Committees of Parliament, who, from the nature of things, approach any subject with fresh minds and unbiased views."

We confess that, to a considerable extent, we share Mr. Tait's apprehensions. There is undoubtedly a tendency on the part of all official bodies to become stereotyped and perfunctory. Imbued with a sense of immunity from criticism, they not infrequently adopt autocratic methods, and this does not endear them to the public mind. For our own part, while cordially agreeing as to the urgent desirability of carrying out each and all of the functions and duties enumerated for the proposed Commission, we are inclined to suggest that the collection and col-

lation of data could be assigned at less expense to some existing department, such as the Ordnance Survey, as is the case in the United States, where the work is carried out by the Geological Survey, and that as regards jurisdiction and oversight of sources of supply these could be exercised without undue strain by County Councils or similar provincial bodies, while sanction for new schemes in the public interest should be obtained by application to Parliament in the customary way by private Bill as at present. We see no occasion for departmental initiative in industrial enterprise. Such a policy leads to the preparation of grandiose and untimely projects like that recently put forward for the River Severn by the Ministry of Transport. British commercial enterprise is not dead, and if a scheme be reasonably practicable and remunerative it is sure to receive support. We therefore range ourselves alongside Mr. Fawcett and Mr. Tait in deprecating the creation of an additional Government department with a retinue of salaried officials. There is a significant suggestion in the Report that the expenses of the proposed Commission should be defrayed *in part* by a levy on water undertakings in England and Wales. We imagine that this will give rise to some demur.

Into the more detailed recommendations of the Committee we do not feel it necessary to enter at the moment. The Report is a lengthy one, running to 165 foolscap pages, with maps and diagrams. In addition to the primary and principal recommendation, upon which we have commented above, there are subsidiary recommendations, such as that all hydrometric data collected in the United Kingdom should be compiled on a uniform basis (a schema is exhibited in an appendix), and that the widest publicity should be given to the information obtained in these surveys. With both these suggestions we are in complete accord. There is also the interesting statement that, "leaving out of account the question of availability, the schemes in our possession relate to potential water-power of a total capacity in excess of 250,000 kw. (continuous). The aggregate power involved in the various parts of Great Britain is as follows: Scotland, 194,965 kw.; Wales, 35,900 kw.; England, 20,440 kw. The Irish Sub-Committee estimates that the total available potential water-power resources of Ireland amount to 280,000 kw. (continuous)."

The purview of the Report is comprehensive and includes a consideration of tidal power, canals, salmon fisheries, pollution of underground water, and land drainage. We do not propose to discuss these features. Our immediate object will be achieved if we succeed in focusing attention on the urgent necessity for a systematic compilation of the water resources of the country and of the Empire, to be followed by some means of ensuring a judicious application of the available power in the most economical manner so as to reduce the present excessive demands on our reserves of solid fuel.

American Organic Chemicals.

THE production of synthetic organic chemicals for use in research is being developed in America on the same lines as in this country. Laboratories have been specially equipped for the purpose by the Eastman Kodak Company, which makes a number of compounds and purifies others yielded by the chemical industry of the country. In that way some eleven hundred different chemicals are at present available. Although this is only half the number of substances offered by one of the English manufacturers, the effort is meeting with enthusiastic support from men of science in America, and those concerned feel thereby greatly helped and encouraged. In that country, at least, the war-time resolution of independence in the matter of scientific supplies is not forgotten.

Much complaint is made in this country concerning the prices of such chemicals. It is therefore of interest to compare Kahlbaum's pre-war prices and the present prices of a well-known English manufacturer with those of the Eastman Kodak Company. A comparison extending to four pages of the Eastman list gives the ratio: Kahlbaum, 100; B.D.H., 135; Eastman, 171—not so great an increase on pre-war prices as the increase in cost of labour would lead one to expect.

In a paper read before the Society of Chemical Industry last August, C. E. K. Mees and H. T. Clarke gave some account of the chemical work of the Eastman Company. They said it had been conducted hitherto at a very considerable loss, the first year's working showing a deficit of about 3000*l.*, although no rent or overhead charges were debited. This loss was generously borne by the company.

If American users and producers continue to work in the same spirit, not only will they gain the immense advantage of national independence in the matter of organic chemicals, but also the business will become self-supporting and in the end remunerative. At the same time, laboratories in which such organic compounds are made should provide a useful training-ground for young technical chemists.

Elie Metchnikoff.

Life of Elie Metchnikoff, 1845–1916. By Olga Metchnikoff. Authorised translation from the French. Pp. xxiii+297. (London: Constable and Co., Ltd., 1921.) 21*s*. net.

IN an introductory chapter Madame Metchnikoff relates how, some years ago, one who scarcely knew her husband had asked permission to write his biography. Metchnikoff wanted his biography written, for he held that the story of the evolution of a mind and character in relation with its environment, if faithfully set down by one knowing and comprehending, is always an interesting psychological document. The idea of the story of his life being related by one who neither knew nor understood was, however, repugnant to him. So it came about that Madame Metchnikoff undertook the biography of her husband with his co-operation and on the understanding that the whole was to be told without reservation. The result, as Sir Ray Lankester observes in an appreciative preface to the English edition, is "a remarkable and beautiful record of the development and activities of a great discoverer."

Metchnikoff was born in 1845 in the province of Kharkoff, where he was educated first at the lycée and then at the university. The lycée is represented as a progressive school, and the sketch of the youthful Metchnikoff and his companions affords an interesting glimpse of the intellectual awakening of young Russia at this period. Among the books he read at fourteen years of age was Buckle's "History of Civilisation," and we gather from the biography that the idea of the dependence of human progress upon science originated from reading that work. This belief became strengthened as he grew older, and ultimately it reached the intensity of a religious faith. At fifteen years of age Metchnikoff abandoned the religion in which he had been brought up, and so ardently preached atheism to his fellow-pupils that he received the nickname "God is not." Although he appears to have devoted most of his time at school to reading books on science, religion, and philosophy, he nevertheless passed out from the lycée with the highest honours and entered the university. This is described as a stagnant and reactionary institution. His teachers were uninspiring, and exerted little influence upon him.

While at the university, however, he read "The Origin of Species," which he had brought back with him from a visit to Germany. Metchnikoff was fascinated by the splendour of the horizon it opened, and considered it had more influence upon his later career than any other book he read. He seems to have planned to devote himself to searching for further support of Darwin's great generalisation. With this object he decided to undertake the study of intermediate types with a view to disclosing the genetic relationships between different orders of animals.

This programme could not be carried out at his own university, so as soon as his undergraduate career was completed he went to Germany. Afterwards he removed to Naples, where he met Kowalevsky. Both young men became engaged in a comparative study of the embryology of invertebrates. Metchnikoff discovered embryonic layers similar to those of vertebrates in Arthropoda and Cephalopoda, thus helping to bridge the gap between the higher and lower animals.

It was at Giessen in 1865 that intracellular digestion by the cells of the alimentary canal of a land-planarian (*Geodesmus bilineatus*) was observed. It is explained that this was the first time that he had encountered this phenomenon except in protozoa and very simple metazoa. He was much impressed, and afterwards regarded the observation as the basis of his phagocytic theory, although at the time its full significance was not appreciated.

Returning to Russia full of enthusiasm for science, Metchnikoff was appointed a *docent* at Odessa, but, finding the university backward and reactionary, he removed to St. Petersburg, where he hoped to find conditions for work more congenial. He was, however, disappointed. There was no laboratory for him to work in, his time was consumed by teaching for a subsistence, his eyes became troublesome and his health bad. He was lonely, and during an illness he was nursed by a young lady in the house of a mutual friend. Craving for affection and sympathy, he not unnaturally became engaged to be married.

Unfortunately, the lady was phthisical and developed alarming symptoms immediately after marriage. The next few years are described as a tragic struggle against disease and poverty. The serious affection of his eyes prevented the use of the microscope, and his young wife's health became so precarious that he was obliged to resign his appointment and take her to Madeira, where she died.

After his wife's death Metchnikoff started on the return journey to Russia in blank despair, and, seeing no issue to his situation, attempted suicide at Geneva. Fortunately, he took too large a dose of morphia, was violently sick, and recovered.

On his return to Russia Metchnikoff was appointed to the chair of zoology at Odessa, which he occupied for nine years. He threw himself with enthusiasm into the duties of his post. At Odessa

he met Madame Metchnikoff, who was then a schoolgirl. Finding that she was interested in zoology, he undertook to teach her, and shortly after they married. His second marriage was a happy one; his wife, although more directly interested in art than in science, became a willing disciple. Madame Metchnikoff thus describes their work together:—

"It was both delightful and profitable to work with him, for he opened out his ideas unreservedly and made one share his enthusiasm and his interest in investigations; he could create an atmosphere of intimate union in the search for truth which allowed the humblest worker to feel himself a collaborator in an exalted task."

Metchnikoff appears to have exerted a great influence in the university, especially upon the young men, but was regarded with some suspicion by the authorities, owing to the independence of his ideas and the directness with which they were expressed. After the assassination of Alexander II. in 1881 the government of the university became more and more reactionary, and the independence of the university was threatened. Though not greatly interested in politics, Metchnikoff seems to have become unavoidably involved in these quarrels, and ultimately, finding the conditions intolerable, resigned.

His resignation of the Odessa chair and the circumstances which led to it preyed upon his mind. Another period of ill-health ensued associated with intense depression, during which suicide was again attempted. In order not to harrow his family by a suicide that was too obvious, and at the same time to put the occasion to the use of ascertaining whether relapsing fever could be transmitted by inoculation, he injected into himself some blood from a patient suffering from that disease. He had a prolonged attack of the fever, but this shock treatment cured his pessimism, and after his recovery he had a renascence of vital energy such as he had not enjoyed for years. Moreover, thanks to the inheritance of landed property, the Metchnikoffs were now in a position of modest independence and able to live where they liked. Accordingly in 1882 they repaired to Messina to take advantage of the opportunities for study afforded by the sea fauna of the Mediterranean.

It was at Messina, at Christmas of that year, that what Metchnikoff regarded as the great event of his scientific life occurred. It is described by him in his own words as follows:—

"One day, when the whole family had gone to a circus, I remained alone with my microscope, observing the life in the mobile cells of a transparent starfish larva, when a new thought suddenly flashed across my brain. It struck me that similar cells might serve in the defence of the organism against intruders. I felt so excited that I began striding up and down the room, and even went to the seashore to collect my thoughts.

"I said to myself that, if my supposition was true, a splinter introduced into the body of a starfish larva, devoid of blood-vessels or of a nervous system, should soon be surrounded by mobile cells, as is to be observed in a man who runs a splinter into his finger. This was no sooner said than done.

. . . . . .

"I fetched some rose-thorns and introduced them under the skin of some beautiful starfish larvæ as transparent as water.

"I was too excited to sleep that night in the expectation of the result of my experiment, and very early the next morning I ascertained that it had fully succeeded.

"That experiment formed the basis of the phagocyte theory, to the development of which I devoted the next twenty-five years of my life.

. . . . .

"A zoologist until then, I suddenly became a pathologist."

It appears that the discovery of phagocytosis first disclosed to him the possibility of utilising his talents to intervene advantageously in human affairs. A moral purpose in life was found, and thenceforth Metchnikoff became an optimist and a scientific philanthropist. His future researches, although conducted in the laboratory, were essentially directed towards the improvement of the health and happiness of mankind. Possibly his scientific work suffered occasionally from his impatience to apply results to the benefit of his fellow-creatures, for, like most philanthropists, he exhibited some intolerance of criticism of his efforts.

In 1882 phagocytosis as a curative force was still only an hypothesis, but an opportunity for putting it to the test of experiment soon occurred. Water fleas (Daphniæ) were observed to be subject to infection by a fungus (*Monospora bicuspidata*) the spores of which, sharp like needles, traversed the gut of the insect when introduced with food. Watching the process in these transparent creatures, Metchnikoff saw that, immediately after the entrance of a spore into the body cavity, it was attacked by mobile phagocytes and englobed. If the phagocytes succeeded in digesting all the spores, the daphnia recovered, otherwise the spores germinated, and the fungus, spreading throughout the body, killed the insect. Recovery or death depended upon the issue of the battle.

The next question to be decided was whether this method of defence was common to all animals. That some diseases of higher animals were attributable to invasion by microbes had recently been established, and it is explained how Metchnikoff's previous training and experience as a zoologist had led to the conviction of the essential unity of structural plan and physiological behaviour throughout

the animal kingdom. Metchnikoff was convinced that in the case of such a fundamental mechanism as that he had discovered in invertebrates this would prove to be true, and shortly afterwards he succeeded in establishing the generality of the phenomenon by experiments upon higher animals infected with the anthrax bacillus. In this case the bacilli were attacked and eaten by the white blood corpuscles which wander everywhere. Two other observations recorded deserve special mention because they opened up new country, the exploration of which occupied Metchnikoff and his pupils and many others for the next twenty years.

The first of these was that active phagocytosis occurred only in animals refractory to anthrax, thus providing a possible interpretation of the natural immunity of some species of animals to a disease. The second was that animals naturally sensitive to anthrax could be induced to respond like naturally refractory ones by vaccination, an indication of the nature of acquired immunity.

Such entirely new conceptions were not readily acquiesced in, and even encountered hostility. Two great men, Virchow and Pasteur, however, were immediately impressed by them, and in 1888 the latter invited Metchnikoff to come to the Pasteur Institute. The invitation was accepted, and there he remained until the end of his life, occupied under ideal conditions in developing the consequences of his discovery at Messina.

At the Pasteur Institute he found every facility for his researches, and was undisturbed by administrative or academic work. He enjoyed the companionship of wise colleagues, themselves actively engaged in inquiries in bacteriology and pathology, and soon became surrounded by willing pupils ready to undertake investigations dictated by his fertile imagination.

This was a time of immense activity, mainly devoted to exploring the whole subject of immunity which he had illuminated by the discovery of phagocytosis. This prolific period of his career is skilfully dealt with in broad outline, and details which, being of a highly technical character, would be tiresome to the general reader are omitted. The theories current regarding immunity when Metchnikoff approached the subject from a naturalist's point of view are briefly sketched, and the influence of his work and that of others in the development of our present views is indicated.

In 1900 Metchnikoff presented an account of his researches to the International Congress of Medicine at Paris, and fought his critics for the last time. Then, convinced that his deductions were sound, he proceeded to expound his views at length under the title, "Immunity in Infectious Diseases," which appeared a few years later.

Metchnikoff's greatest scientific achievement was undoubtedly the discovery of phagocytosis and its manifold significance in biology and pathology, and it is clearly brought out in his biography that he would not have made these discoveries had it not been for his previous training and research in zoology. Perhaps the best way to appraise this, his contribution to science, is to try to think what our present knowledge of inflammation and immunity would be without it.

At the age of fifty-three Metchnikoff turned his attention to the subject of senility. Regarded from a long biological view, man's imperious instinct for life in the later years of existence, notwithstanding obvious breakdowns, must, he considered, be a pathological coincidence. How, otherwise, was the fear of death, a general and inevitable occurrence, to be explained? Metchnikoff imagined that this lack of harmony exists because senility is premature and partial and arrives before the natural instinct for death has had time to develop.

If this supposition were correct, the greatest of life's disharmonies might be remedied, for he believed that it was within the power of science not only to preserve the body from the depredations of disease, but also to maintain the equilibrium of the tissues. In such a case happiness and contentment should be the lot of man for a period far exceeding the usually allotted span. Upon such ideal physiological existence or "orthobiosis" a quiet satiety with living should, he supposed, ultimately supervene and death be welcomed as sleep at the end of a long day.

The consideration of the changes in the tissues in old age led Metchnikoff to the conclusion that, apart from the damage done by diseases such as syphilis, tuberculosis, and other chronic infections, the principal cause of premature degeneration of the important cell elements was a prolonged intoxication by the products of the activities of the innumerable bacteria which inhabit the large intestine. For this hypothesis he obtained anatomical and experimental support.

The former he tersely summarised by the phrase, "the longer the large intestine, the shorter the life," an aphorism which is to some extent responsible for the depredations of some of our famous surgeons.

Having arrived at the conviction that unlicensed bacterial activity in the colon was harmful, Metchnikoff essayed to control it by implanting into the alimentary canal a special microbe which produced much lactic acid from carbohydrates, and was itself

capable of surviving in high concentration of this acid. To this end he recommended, and himself practised, the imbibition of large quantities of soured milk.

Metchnikoff's preoccupation with the disadvantages of senility have been misunderstood and misinterpreted. Although his attention was becoming unpleasantly directed in his own person to the effects of a life of intense activity and mental excitement, coupled with serious cardiac mischief, it is not to be ascribed to the morbid introspection of an invalid. Old age is a legitimate subject for scientific inquiry. It is not unnatural, but unfortunate, that nobody becomes sufficiently interested in the problems of senility until their own age well-nigh precludes the possibility of a successful enterprise. It was approached by Metchnikoff with ideas based on broad biological principles, and most of his late work was really concerned to find justification for them.

Elie Metchnikoff's enthusiasm for his theory of orthobiosis was maintained actually until the end of his life, and the last chapter of the biography contains many records of his mental attitude on contemplating death at short range. He was anxious that these should be recorded as so few with the capacity to analyse their mental processes retain their intellectual powers until the end of life.

His wishes have been piously complied with, and his observations, when confronted with impending dissolution, are faithfully recorded as his final contribution to his theory of the development of the death instinct.

The book is more than an account of the interesting discoveries of Elie Metchnikoff and their far-reaching importance in natural history; it is a human document, an account of the mental adventure of a striking personality, with contemporary science as a setting, told with a *naïveté* reminiscent of Marie Bashkirtseff.

The translation is excellent, and little if any of the charm of the original French is lost. The biography contains as frontispiece a characteristic picture of Metchnikoff in his laboratory, and concludes with a useful bibliography of all his published writings.

Electrical Measurements.

Absolute Measurements in Electricity and Magnetism. By Prof. A. Gray. Second edition, rewritten and enlarged. Pp. xix+837. (London: Macmillan and Co., Ltd., 1921.) 42*s.* net.

ALL physicists are familiar with the first edition of this important work, which, completed in 1893, has long been regarded and used as a standard treatise on electrical measurements. In introducing the second edition Prof. Gray refers at the outset to a certain lack of interest shown by physicists at the present time in the theory and practice of absolute measurements, and it is undoubtedly the case that, in our universities at any rate, the subject receives less attention than was formerly devoted to it. The principal reason for this change may be traced to the nature of such work as the experimental determination of absolute electrical units, and the accurate comparison of secondary standards with them, and also to the great importance which work of this kind possesses. Few, if any, of our university laboratories are sufficiently well equipped for the prosecution of researches in which the construction of apparatus and the carrying out of measurements of the highest precision are involved; and so necessary is this work recognised to be that special laboratories, such as the National Physical Laboratory in this country, and the Bureau of Standards at Washington, have been established, at which it can be more effectively organised and carried out, and at which the research worker in any of the universities may have his measuring instruments accurately standardised. Thus the apparent decline of general interest among physicists in methods of absolute measurement is not due to any diminution in the importance of the subject, but to the fact that the practice of these methods is now more concentrated in institutions specially equipped for the purpose.

A second reason for the change may be found, as suggested by Prof. Gray, in the fact that new and fascinating subjects of study, mainly consequent upon the discovery of the X-rays and radio-activity, have arisen which have been taken up with enthusiasm in our universities, and have to some extent diverted attention from absolute measurements of the classical kind. While it is of the greatest importance that research into the problems of modern physics should be pursued as vigorously as possible, it is no less important to the future of the science that the endeavour to attain greater accuracy in our standards and methods of measurement should not be relaxed. It may well be that the future trend of physical theories will be largely influenced by the degree of accuracy with which some of the important constants can be determined.

The new edition of Prof. Gray's book will be welcomed as a full and clear statement of the present position regarding accurate electrical measurements. There is probably no other book which contains so full an account of the classical experiments for the determination of electrical units and constants, and the many detailed abstracts of original memoirs give the book a special value as a work of reference.

The principal changes found in the new edition

relate to the calculation of the constants of coils, and the theory of absolute electro-dynamometers and current balances, a domain of the subject to which Prof. Gray has himself so largely contributed. His well-known calculation of the mutual inductance of two single layer coils the axes of which intersect at any angle has led to the realisation of an absolute electro-dynamometer, constructed at the Bureau of Standards, the constant of which can be calculated to a high degree of accuracy. It was shown by Prof. Gray that if the coils of the instrument are concentric and have lengths $\sqrt{3}$ times their radii, all the terms between the first and the seventh vanish in the zonal harmonic series for the mutual inductance and the couple between them, and the remaining terms amount to only a very small correction if the dimensions of the inner coil are small in comparison with those of the outer. Consequently the couple is given very accurately by the first term alone of the series—that is, it can be calculated on the assumption that the inner coil is suspended in a perfectly uniform field equal to the field at the centre of the fixed coil.

It is shown how the values of the mutual inductance of two coaxial single-layer coils (including the important case of a helix and a coaxial circle), the self-inductance of a single-layer coil, and the mutual attraction of two coaxial coils, such as those of a current balance, can also be deduced from the general formula. Many other cases are worked out in the chapter on the calculation of inductances, which is much extended in the new edition, and the description and illustrations of the current balances of the National Physical Laboratory and the Bureau of Standards, and the electro-dynamometer of the latter institution, form a valuable feature of the book.

Other portions of the book which are much expanded are those dealing with magnetometry, measurements in alternating current circuits, the distribution of alternating currents in cylindrical conductors, the comparison of resistances, and the absolute measurement of resistance. The recommendations of the International Conference on Electrical Units held in London in 1908, embodying the definitions of the international ohm, ampere, and volt, and the specification of the Weston normal cell, are given in appendices.

Much that was in the old edition has of necessity been omitted from the new; the omitted portions, however, mainly of a theoretical nature, are not directly connected with methods of measurement, and have been fully treated in Prof. Gray's "Treatise on Magnetism and Electricity." The result is a more complete and a better arranged account of methods of electrical measurement and the calculations connected therewith.

In its new form the book is in one volume, and the larger page, the absence of small type, and the numbered sections will make the book more acceptable to the reader. Typographical errors are remarkably few for a work of this size, and in the few cases where results are stated erroneously (as, for instance, the expression for the capacity of a condenser on p. 749) the reader will find no difficulty in supplying the correction.

Of the great value of the book there can be no question, and it may be confidently anticipated that the new edition will be appreciated as highly as was its predecessor. E. T. J.

The Art of Prehistoric Man.

Prehistory: A Study of Early Cultures in Europe and the Mediterranean Basin. By M. C. Burkitt. Pp. xx+438. (Cambridge: At the University Press, 1921.) 35*s*. net.

DURING the last two decades great progress has been made in our knowledge of prehistoric man, especially by discoveries in the caves of France and Spain. Most of the results are published in technical memoirs in serials not easily accessible, and it is difficult to follow them without much previous study and extensive reading. Mr. Burkitt has therefore done good service by the preparation of his volume on "Prehistory," which summarises the whole subject and enables both the student and the general reader to appreciate its present position. He himself has taken an active part in much of the research, in association with the Abbés H. Breuil and H. Obermaier; he thus writes from personal knowledge, and adds sufficient details of some of the most interesting localities to make his text-book a useful guide for those who wish to visit them.

Other English books, especially those of Lyell and Boyd Dawkins, have already given a good general account of the discoveries of early man in the caves of this country, so that Mr. Burkitt has done well in devoting attention chiefly to France and Spain. His "outline of the history of the subject," however, fails to give due credit to the English pioneers, whose systematic work in Brixham Cave, Kent's Hole, and Wookey Hole is not even mentioned. MacEnery and Pengelly are overlooked, and Mello's discovery of the drawing of a horse's head on a piece of bone from the Cresswell caves is wrongly described, thus throwing doubt on its authenticity. On p. 76 bone is said to have been "first utilised in Upper Mousterian times," and when this statement, based on French and Spanish experience, is contradicted on p. 89 by a casual reference to the English discovery of a large bone

implement with early Palæolithic flint implements at Piltdown, the latter is briefly dismissed as "possibly the only exception." England has indeed played a prominent pioneer part in unravelling the problems of prehistoric man, and deserves full acknowledgment.

Mr. Burkitt begins with an excellent concise account of man's relation to the glacial period in western Europe, and shows how far the successive races may be correlated with the mild intervals in this period which are marked by the retreat of the glaciers in the Alps and Pyrenees. He also refers to Baron de Geer's counting of the annual layers of sediment which the ice of the last glacial episode in Scandinavia deposited in the sea during its retreat northwards. From this it is inferred that man cannot have reached southern Scandinavia until it was uncovered twelve thousand years ago. The latest phases farther south in Europe must therefore have been somewhat earlier. How long before the glacial period man first appeared here remains uncertain, but both the Abbé Breuil and Mr. Burkitt are agreed that Mr. Reid Moir's discoveries of worked flints in the Red Crag prove his presence in the Upper Pliocene.

Most of the volume is devoted to flint and bone implements and art, and Mr. Burkitt traces the successive developments in a more exhaustive manner than has hitherto been attempted. He classifies the flints, and not only records the order of their succession, but also describes exactly several places of discovery which prove their relative age. He shows how bone harpoons may be treated as fossils, and points out the minute differences which mark the successive periods to which they belong. He also describes palimpsests among the cave-pictures which exhibit the superposition of different styles of art. He is thus prepared to determine the relative age of almost any discovery of prehistoric human handiwork. On the whole the school of "prehistorians" to which he belongs is probably right, but it makes no allowance for sporadic outbursts of genius.

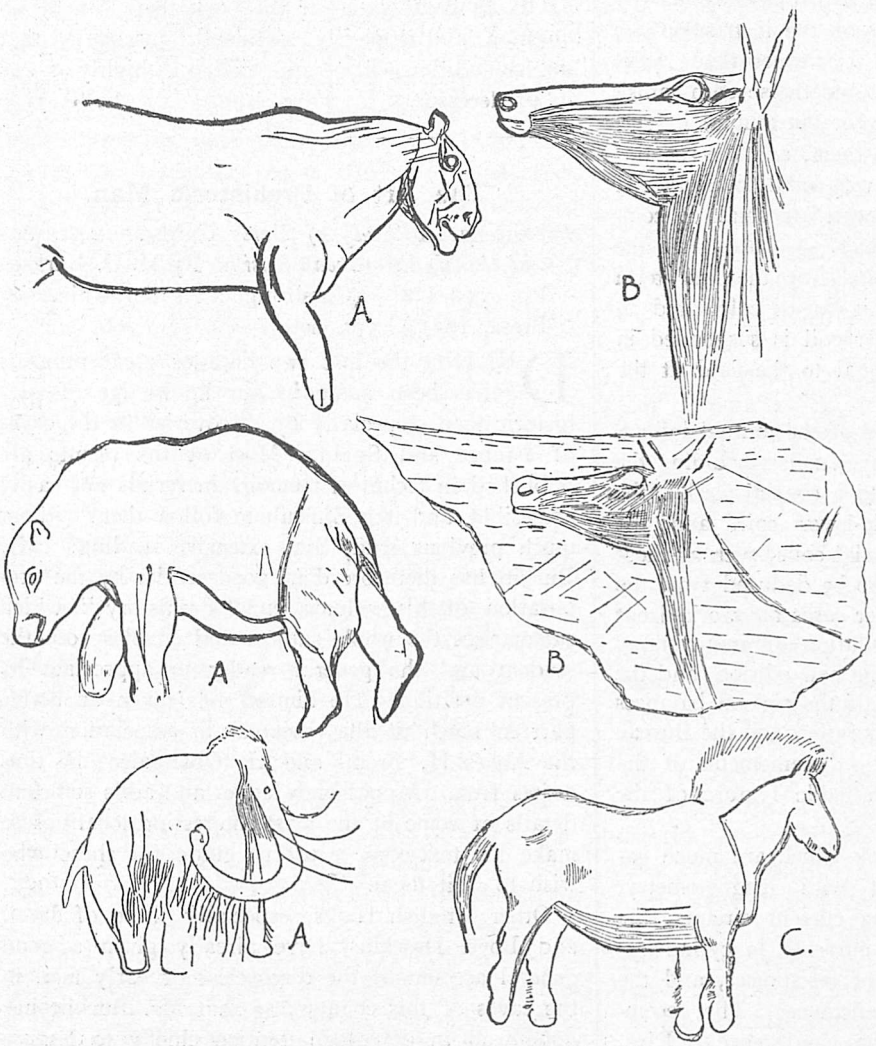

FIG. 1.—Incised drawings rom caves in Dordogne and Cantabria. A. A feline, a bear, and a mammoth engraved on the wall of the cave of Combarelles, Dordogne. B. Head of a deer engraved on the wall of the cave of Castillo, Cantabria, with a similar engraving on a piece of bone from the same cave. C. A hog-maned horse engraved on the wall of the cave of La Pasiega Cantabria. From "Prehistory: A Study of Early Cultures in Europe and the Mediterranean Basin."

The study of the cave-pictures is especially fascinating, and Mr. Burkitt treats it in great detail. Besides the incised figures on the rock, there are paintings in ochre, oxide of manganese, carbon, and kaolin, all mixed with fat. Those of Palæolithic age are isolated drawings, not grouped in scenes, and the majority are in comparatively inaccessible parts of the caves rather than in ordinary living chambers. They were therefore probably not designed for ornament, but in connection with some ideas of sympathetic magic. "No doubt the wonderful naturalistic animals, sometimes

portrayed with the arrows of a hunter in their sides, formed part of a ritual, and were meant to ensure a successful hunt." The incised sketches on bones found in the earth of the floor of the caves were probably in some cases the preliminary studies for the work on the walls and roof.

The volume is illustrated by forty-seven plates, of which we reproduce one (Fig. 1) showing a selection of incised drawings from the caves of Dordogne and Cantabria. All these plates are well described, but they would have proved more useful if they had been referred to in the text. In this and other respects, indeed, the editing of the volume leaves much to be desired, but the work is a unique addition to the literature of prehistoric archæology, and cannot fail soon to reach a second edition, which will afford an opportunity for some useful revision. A. S. W.

The Science of Ancient Greece.

The Legacy of Greece. Edited by R. W. Livingstone. Pp. xii+424. (Oxford: Clarendon Press, 1921.) 7*s.* 6*d.* net.

THIS book redresses in a remarkable way the injustice done to Ancient Greece in most popular works on the subject. Reference to any short history now in use, such as Bury's, or even to such a fine work as "Hellenica" of the last generation, will show that the author finds "the legacy of Greece" in the city-founding activities of the Greeks, and, above all, in the internecine conflicts of the cities in their prime, with some short reference to the Periclean ideal and the philosophic differences of Plato and Aristotle. There is little about literature, less about art, and nothing at all about science. Mr. Livingstone, in planning this volume, has deliberately and rightly set himself to correct this and to put the really substantive achievement of the Greeks in the realm of thought in its due place. The result is that a good third of the book is given to science, and if we include Prof. Burnet's article on Philosophy, which shows its connection with science, we get a larger proportion still. It is most welcome evidence of a change of mind in the university which stands more than any other among us for Greek studies.

The effect is amazing to those accustomed to the old and mainly political outlook, and it will be very wholesome. We see that in every branch of science, in biology and medicine as much as in mathematics, the Greeks laid the foundations on which mankind has built ever since. Sir T. L. Heath well brings this out in his article on Mathematics and Astronomy, which is a complete review of the Greek work from Thales to Diophantus; while Dr. Singer is equally full on Biology and Medicine. The reader will probably share one impression which was borne in strongly on the present reviewer. The writers who describe the newly admitted branches of the legacy of Greece are so full of their subjects, and so eager to display their richness and wonders, that their essays suffer somewhat in comparison with those which deal more allusively with the more familiar topics. Hence the most readable papers, which leave the clearest impression, are Prof. Burnet's on Philosophy, Mr. Livingstone's on Literature, and Mr. Percy Gardiner's on "The Lamps of Greek Art." These are altogether admirable; the leading features are emphasised, and no attempt is made to be exhaustive.

But the fault—if it be a fault—in the essays on science is entirely in the right direction. We have here for the first time in a compendious form the main steps of the Greek construction in mathematics, astronomy, biology, and medicine, and the book is well worth buying for this part of it alone. A charming essay by Prof. D'Arcy Thompson on the Science of Aristotle adds to the attractiveness of the volume, but somewhat disturbs the balance of Dr. Singer's excellent articles on biology and medicine as a whole.

The supreme merit of the book is that it puts in unmistakable prominence the intellectual quality of the Greek mind in its prime, its desire to know, and its power of arranging the material it acquired in that connected form which we call scientific. This is equally salient on the mathematical and the biological side. Sir T. L. Heath shows us how the Greek philosophers had quite early hit on the fundamental equations in geometry; within the seven hundred years of their flourishing they had founded trigonometry through the necessities of their astronomy, anticipated the integral calculus by their method of exhaustions, and laid the basis of algebra in the first generalised notation of Diophantus. In the sciences of life Aristotle had given the first rational classification of living things and an incomparable mass of faithful and detailed description; while the sound principles of Hippocrates in the fifth century in tracing health and illness to natural causes were far in advance of medical theory and practice until the revival of science a thousand years later. It is by these achievements, more than by any other, that the Greeks still rule us from their tombs, and we are deeply grateful to Mr. Livingstone and his coadjutors for putting them in such a clear light without ignoring the due proportion of political theory, art, and psychological philosophy. The well-chosen illustrations add greatly to the value of the volume. F. S. MARVIN.

Jute and Silk in India.

Imperial Institute. Indian Trade Inquiry: Reports on Jute and Silk. Pp. ix+90. (London: John Murray, 1921.) 5s. net.

THESE reports embody the results of the work of special committees, formed, in response to the invitation of the Secretary of State for India to the Imperial Institute Committee, to inquire into the possibilities of further commercial usage of the principal Indian raw materials in the United Kingdom and in other parts of the Empire.

The commercial production of jute is confined to Northern India, including Assam. The fibre is obtained from the inner bark of the stems of two annual plants, *Corchorus capsularis* and *C. olitorius*, members of the family Tiliaceæ, and the crop is raised on small holdings by the Indian ryot. More than 60 per cent. of the total crop is consumed in the Indian jute mills, the remainder being exported to the United Kingdom, various Continental countries, and the United States.

In its recommendations the committee has kept in view two main objects, namely, to make use of our practical monopoly of jute to further the interests of the Empire, and to increase the output, and thereby steady and keep at a moderate level the price of the raw product. It recommends an export duty on raw jute leaving India with a rebate in full to consumers within the Empire, the revenue from the duty to be devoted to the establishment of a scheme for the investigation of problems affecting the production in India of jute and allied fibres. As soon as seed-selection experiments are sufficiently advanced the Government should provide each grower with seed sufficient for the season's crop and adopt means to ensure that none but approved seed is sown. Machinery should be set up to deal with the situation arising from a short crop. The production of Bimli jute (the fibre of *Hibiscus cannabinus*) should be encouraged, and means adopted to improve the condition in which it reaches the market.

The position of India among the silk-producing countries is unduly low; natural advantages are not fully utilised, and, at present, the industry is not able to meet local demands. For many years the mulberry silk industry in India has been steadily declining. The committee recommends the establishment by the Government of India of a central Sericultural Institute, the functions of which should include the training of men to develop sericulture in India, the supply of disease-free "seed" of approved native and foreign races of worms, the testing of new races and the production of hybrid races, and the investigation of silkworm and mulberry diseases. Smaller institutions should be established in all important sericultural districts. The committee considers that the enhanced value of Indian silk that would result from a radical improvement in its quality should render it possible for the Indian product to compete successfully with Japanese and Chinese silks.

Valency and Atomic Structure.

Valenzkräfte und Röntgenspektren: Zwei Aufsätze über das Elektronengebäude des Atoms. By Prof W. Kossel. Pp iv+70. (Berlin: Julius Springer, 1921.) 12 marks.

THE literature on atomic structure has received an interesting addition by the publication of this little work, which consists of two essays, the first being entitled "The Physical Nature of Valency Forces," and the second "The Significance of X-rays in the investigation of Atomic Structure." Berzelius first put forward the theory of the electrical nature of valency forces, but the difficulty of explaining homopolar combination by means of it had led to its being discredited. It has now come to the fore again as the result of our knowledge of the relation between atomic number, the charge on the nucleus of the atom, and the place of the atom in the periodic series, and in its recent developments Kossel has played an important part.

In the first paper, after referring to the various atomic models which have been proposed from time to time, Kossel points out that we can explain many of the chemical properties of the elements if we assume a tendency on the part of the atom to lose or gain electrons, so as to revert to more stable electron configuration. In losing or gaining electrons the atom becomes a charged ion, and without knowing anything further of its structure it is possible to explain the formation of a large number of compounds. The valency forces correspond to an electrostatic field surrounding the ion, such as would arise from a charge placed at the centre of the atom. The molecule as a whole must be electrically neutral, but neutral molecules may have oppositely charged atoms at different points in their structure, and so may attract other neutral molecules with the formation of complex compounds. Kossel makes no attempt to explain the way in which homopolar compounds are formed; he merely indicates the lines along which investigation may be possible. He emphasises the point, however, that the study of organic com-

pounds has led to an excessive importance being attached to valency phenomena in homopolar compounds, whereas a complete theory should cover the very large class of inorganic heteropolar compounds formed by the majority of the elements.

The second essay is a short review of the work which has been done on X-ray spectra and the origin of X-rays, with particular reference to the partitioning of electrons into shells surrounding the nucleus.

The author's style is somewhat involved, and for a reader who is not a good German scholar the argument is sometimes difficult to follow.

Our Bookshelf.

(1) *Abridged Callendar Steam Tables, Centigrade Units.* By Prof. H. L. Callendar. Pp. viii. 1*s.* net.

(2) *Abridged Callendar Steam Tables, Fahrenheit Units.* By Prof. H. L. Callendar. Pp. 8. 1*s.* net.

(3) *Callendar Steam Diagram, Centigrade Units.* 6*d.* net.

(4) *Callendar Steam Diagram, Fahrenheit Units.* 6*d.* net. (London: E. Arnold, n.d.)

THE two sets of abridged tables (1) and (2) will be found to contain all that is required for engineering calculations. Table 1 in each set contains the properties of saturated steam for pressures ranging from 28·98 in. of vacuum up to 535·31 lb. per sq. in. gauge pressure. Table 2 gives the total heat of dry steam (superheated or supersaturated), and table 3 contains the entropy values for dry steam at various degrees of superheat and supersaturation. On the first and last pages will be found notes of the symbols and equations employed. The tables are well arranged and clearly printed, and will be of great service to students and engineers in practice.

(3) The Centigrade steam diagram is also well arranged and has convenient scales. (4) The curves on the Fahrenheit steam diagram are copied from those on the Centigrade diagram; the numerals printed on them are the corresponding Fahrenheit numbers. Hence the scales on the Fahrenheit diagram are not so convenient, and we think it would have been better had this diagram been drawn independently of the Centigrade diagram.

Spot and Arc Welding. By H. A. Hornor. (Griffin's Technological Handbooks.) Pp. vii + 296. (London: Charles Griffin and Co., Ltd., 1920.) 15*s.*

THE application of electric welding processes to heavy steel construction, such as obtains in shipbuilding, forms the main topic of this book. The results of extensive tests conducted during the war in the United States with the object of testing the processes are also given. This work was, unfortunately, discontinued at the time of the armistice, but from the results it was shown that trustworthy electrically welded joints can be made of greater strength than corresponding riveted joints, and that consequently some economy in material can be expected. Special designs for all-welded ships are discussed, and a good deal of interesting information is given on other applications of both spot and arc welding and the training of welders. Small all-welded craft have already been constructed in England, and the author shows that the technical knowledge now available is sufficient for a considerable extension of this method of ship construction.

Handbuch der biologischen Arbeitsmethoden. Edited by Prof. Dr. Emil Abderhalden. Abt. 5, *Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus.* Teil 7, Heft 1, Lieferung 12, *Sinnesorgane.* Pp. 195. (Berlin und Wien: Urban und Schwarzenberg, 1920.) 30 marks.

THE "Handbuch der biologischen Arbeitsmethoden," edited by Prof. Emil Abderhalden, will consist of forty-eight parts, in which chemical, physical, biological, psychological, and many other methods are treated at considerable length. The section under notice, by E. Budde, is devoted to the mathematical theory of audition. The first division of this contains a very full discussion of free and forced small vibrations of a point, followed by systems under non-linear forces, including combination tones. The second division deals with strings and membranes, while the third refers to plane-waves in air. Having thus laid the foundation, the author passes to the detailed treatment of human audition, in which he reviews the interpretations of the phenomena put forward by the chief workers on the subject, but dwells especially on the parts played by the basilar membrane and the endolymph.

Turbines. By A. E. Tompkins. Third edition, entirely revised. Pp. viii + 180. (London: S.P.C.K.; New York: The Macmillan Co., 1921.) 8*s.* net.

THE early part of this book is taken up with historical notes and some explanations of the principles involved in the working of turbines. This is followed by three chapters on water-wheels, turbine pumps, and water turbines. The remainder of the book deals with steam turbines. For the most part the book is descriptive, and the simple language employed, together with the many excellent drawings, will render the volume of interest to the general reader. The author has had considerable experience in the working of turbines, and his treatise on "Marine Engineering" is well known. It is therefore rather surprising to find on p. 21, in reference to a rotating wheel, that "every particle of the wheel also tends to fly away from the axis in a radial direction, due to centrifugal action or force." This statement is somewhat misleading. There are one or two misprints, and the accepted notation for British thermal unit is B.Th.U., not b.t.u.

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 Antitrades.

THE long series of pilot-balloon ascents made at and near Batavia (lat. 6° 11′ S., long. 106° 50′ E.) during the years 1909–17 has given a fair knowledge of the system of air-currents over West Java up to great heights. The general outcome of this investigation has been communicated to the Royal Academy of Science of Amsterdam.[1] My endeavour to explain that system led to a controversy between Dr. Braak and myself and Prof. van Everdingen.[2] After renewed consideration of the problem I have come to new results which I propose to set out provisionally here.

In the memoir presented to the Amsterdam Academy is inserted a synoptical table containing the mean directions and velocities of the wind for each month and for height-intervals of 1 km. up to a height of 24 km. In it the principal air-currents have been made conspicuous by letter colouring and framing. They are :—

First, the *west monsoon* prevailing during the southern summer in the bottom layers up to 5–6 km.

Above it, up to 10–13 km., blow easterly winds with southern components, which I would call tradelike winds. In the winter season such winds blow in the bottom layers up to 3 km.

Above these tradelike winds blow antitradelike winds, *i.e.* easterly winds with a northern component. Their upper limit reaches to 18 km. from December until March; it goes down to 12 km. in June, and again rises to the maximum height of 21 km. in October. The velocities show two maxima: in February at a height of 15 km. (12 m./sec.) and in August at 14 km. (22 m./sec.): in April they are very weak. Not only is their velocity a maximum, but also the transport of air-mass.

Over the antitradelike current appear again currents of tradelike character; however, from March until September an eastward moving air-mass is embedded in them, reaching heights of 24 km. *in maximo*.[3] Very high balloon flights in March and September revealed the existence of strong (30–40 m./sec.) easterly winds up to 30 km.

Considering these results, three principal questions arise :—(1) Are the tradelike winds real trades? (2) Is the antitradelike current a true deflux from the equator towards the sub-tropics? (3) Whence do the great velocities of the high antitradelike and upper tradelike winds originate?

The currents mostly possess a stationary character, and consequently their directions will be in close agreement with the trend of the isobars in their level. For Java the latter will be conditioned by the neighbourhood of the Australian continent. As in the southern winter over Australia is settled a circular High, we may expect over Java the trend of the isobars to be E.N.E.–W.S.W. and the gradient to be towards the equator. However, by friction with the earth surface the air blows across the isobars and takes an E.S.E.–W.N.W. direction. This means real outflow to the equator; thus the tradelike wind mentioned above is a trade.

In the southern summer over Australia lies a Low, causing the west monsoon, but above this Low the gradient is reversed and a High prevails. This causes in the same manner as mentioned above a tradelike wind. The friction required for it, I presume, is caused by the streaming one over another of the two currents with contrary directions (the west–east below, the east–west above). Thus, I think, the first of the three questions put forward has been answered in the affirmative: the tradelike winds are trades.

As to the second question, we may consider first the southern winter season. In it the gradient Australia–Java is reversed at the level of ±5 km. But does it change too in the other season at 3 km.? Apparently not, because, going upwards, the easterly winds do not then change to westerly ones; they back only from E.S.E. to E.N.E., while the velocity does not vanish. Now, admitting the absence of friction in these layers, and consequently assuming the current to follow the course of the isobars, we come to the conclusion that this course remains mainly the same when going upwards, or the Australian High subsists in these higher layers, though perhaps shifting somewhat to the eastward.

Accepting this, we may ask: Might it be that the antitradelike current flows around the Australian High, bringing about thus the deflux towards the sub-tropics?

In that case the antitradelike current should be a true antitrade, although of local character. But then we are obliged to admit that a flux towards the equator will also occur at the opposite side of the oval system of the Australian High; only the deflux should surpass it by the mass of air (or part of it) which ascends from the surface in the equatorial belt.

This influx, too, may give us an answer to our third question: What is the cause of the great east-west velocities of antitradelike and upper tradelike winds? Exner[4] points to the fact that ascension of air at the equator is able to increase its east–west velocity only by a fraction, and, therefore, tries to explain the great velocities of high equatorial east winds by shifting of air from higher latitudes towards the equator with preservation of rotational moment. A meridional shift from latitude ±15° causes velocities from 30–40 m./sec.

My result for the antitradelike current over Java is the same as that obtained by Sir Napier Shaw when calculating isobars for the level at 8000 metres.[5] He, too, finds long-stretched Highs, and he speaks of the flowing of air around these Highs, by which the east–west wind velocities of the equator act on the opposite currents of the sub-tropics as by chain-drive pulling.

However, through lack of data Sir Napier Shaw had to calculate his isobars by means of one and the same set of vertical temperature-gradients for the whole hemisphere, which, of course, makes the results somewhat doubtful for the equatorial belt, because there the critical pressure-differences at the 8000-metre level are small only.

For that reason I have sought for another independent way to solve the antitrade problem, and I think I have found it by mapping the average directions of cirrus drift as observed in the equatorial belt.

Cirrus floats there at levels of about 11 km., and

1 Proceedings, April 16, 1918.

2 *Tijdschrift v. h. K. Aardrijkskundig Gen.*, vol. 35, 1918, No. 1, and vol. 36, 1919, No. 4.

3 Owing to a typographical error in the synoptical table the velocities at the levels 18, 19, and 20 km. for June have wrongly been given as 1 m./sec. instead of 10 m./sec.

4 "Dynamische Meteorologie." 1917, p. 182.

5 Rede Lecture. NATURE, July 21, 1921, p. 653. Sir Napier Shaw most kindly provided me recently with a copy of the unpublished *isobaric charts* which he constructed for the northern hemisphere

at that height over Java the antitradelike winds blow from May until October, while during the rest of the year winds with tradelike character prevail.

The mean directions of cirrus drift which were at my disposal (mostly borrowed from H. Hilderbrandsson [6]) I plotted separately for winter and summer, and although they are very sparse I made an endeavour to construct lines of flow. The result is incorporated in the accompanying maps (Fig. 1). They should be regarded as a first trial; *e.g.* no attention was given to the density of the lines of flow, only to their direction. For three stations (Hawaii, Ascension, and Congo) only annual means were given, and they have been used for both summer and winter.

Trying to design the lines of flow, it was apparent this could be done only by assuming oblong systems to exist at both sides of the equator, together with a zonal stream winding about the equator. Of these ovals those lying over Central America, Northern Africa, and Southern Asia correspond fairly well with the isobaric Highs found by Sir Napier Shaw at the 8-km. level.

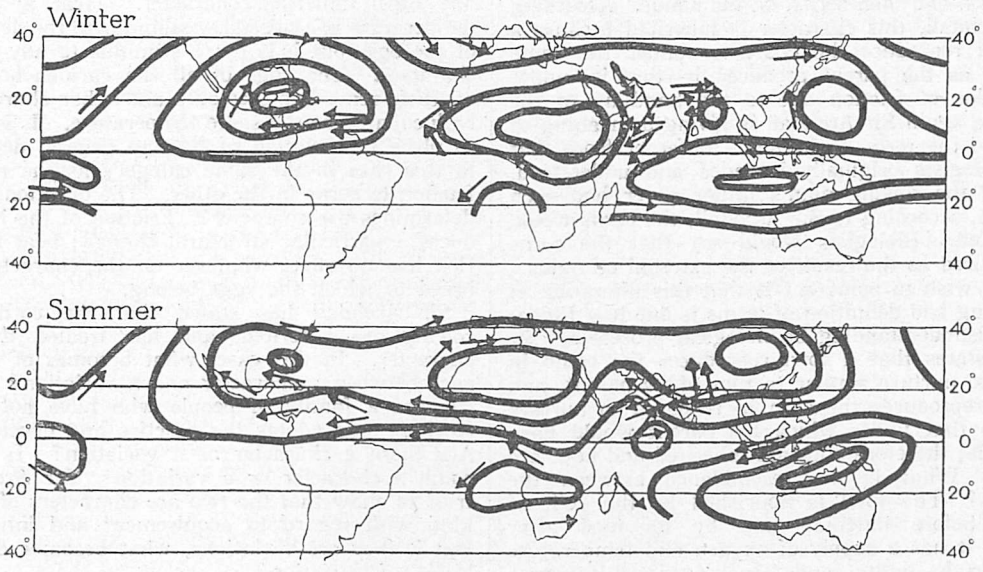

FIG. 1.—Lines of flow of cirrus drift.

Estimating roughly the latitudes of the centres of the current-ovals I find :—

Oval over	Latitude of centre: Winter	Latitude of centre: Summer	Seasonal shift
Central America ...	20° N.	28° N.	8
Northern Africa ...	8° N.	25° N.	17
Southern Africa ...	?	18° S.	—
Arabian Sea	—	0	—
Bengalese Sea	15° N.	—	—
East Asia	17° N.	30° N.	13
Australia	13° S.	10° S.	3
		Mean ...	10

The mean latitude of the northern ovals is about 20°, that of the southern about 15°. At the surface of the earth pressure is highest in latitudes 35° N. and 30° S.; accordingly, when identifying the current-ovals with pressure Highs, the latter are 15° nearer to the equator at the 11-km. level than at sea-level. This shifting is in agreement with the considerations of Teisserenc de Bort and Exner (*loc. cit.*, p. 177), according to which the high-pressure belts with increasing height move towards the equator.

[6] "Les Bases de la Météorologie dynamique," II. Also Nova Acta R. Soc. Sc. Upsaliensis, ser. 4, vol. 5, No. 1.

The mean amount of seasonal shifting found above, *i.e.* 10°, fairly agrees with the corresponding shifting of these high-pressure belts at the surface :—

Northern Belt		Southern Belt.	
January ...	32° N.	January ...	37° S.
July	39° N.	July	28° S.
Shift ...	7°	Shift ...	9°

Resuming, it seems probable that in high levels above the equator and winding about it flows a zonal east–west current of stationary character, which is fed by ascending surface-air and locally by air streaming in from higher latitudes, which, moreover, maintains its east–west motion. Also, that from it flows off in other places air to the sub-tropical belts; these currents of deflux bend from an east–west to a west–east direction.

This communication may prove anew that the knowledge of the direction of the cirrus drift in the equatorial belt is important for the investigation of atmospheric circulation between the tropics, but that the observations at our disposal are few and rather insufficient. For that reason I appeal to those who are in the position to make these observations to supply this need.

To observe in what direction cirrus floats is easy and requires simple means only; moreover, observations are not confined to fixed hours or days. Thus they are particularly adapted to be made by amateurs living in the tropical regions.

W. VAN BEMMELEN.
Emmastraat 28, Haarlem, Holland,
December.

Some Problems in Evolution.

THE controversy between Sir Archdall Reid and the biologists is partly concerned with the meaning of terms and partly with the understanding or misunderstanding of physiological processes. Sir Archdall insists on certain interpretations or definitions of the terms "inherited" and "acquired." These terms were first used by the biologists, and Sir Archdall should not give them meanings of his own different from those which they originally bore. He insists that there are two kinds of variation, but only one kind of character. The word "variation" has been used to mean the small differences always found

between individuals of the same species, and also the larger, more conspicuous departures from the average type or normal character. The former are now called "fluctuations," the latter "mutations." Sir Archdall agrees that a variation may result either (*a*) from germinal or (*b*) from nurtural differences, but he repeats his assertion that all characters are alike with respect to acquiredness and inheritability.

Now I presume that when a variation of germinal origin is inherited it is correctly called a "character." For example, the rose-comb in fowls is a character, and we may suppose that it arose as a variation of germinal origin. We know that it is inherited. But Sir Archdall asserts that when it appears in an individual it is also "acquired" because it was not present in the new-laid egg. Here then he is merely, without any justification, giving a new meaning of his own to the term "acquired," which was applied by biologists to those differences which were not of germinal origin. He insists on substituting in this case the term "acquirement" for the term "development."

On the other hand, if a man rows much he develops first blisters, and then corns, on his hands. According to Sir Archdall, this character is inherited because a son would reproduce the character under the same conditions as the parent produced it—that is, under the stimulus of friction due to the handling of the oar. Here again Sir Archdall is giving a meaning of his own to the term "inherited" different from that which biologists originally intended and understood. Supposing the rowing man's father never had such corns, still, according to Sir Archdall, the corns would be inherited. Biologists would say that the corns were acquired as the result of the external stimulus.

What I wish to point out is that this alteration in the meaning and definition of terms is due to a fundamental misunderstanding of biological processes. Sir Archdall states that a fowl reproduces the comb in response to nurture similar to that of its parent, and the man reproduces the corn in response to nurture similar to that under which his parent would have produced it; therefore both are inherited and both are acquired. What is the resemblance between the two cases? The fowl is nourished by the yolk of the egg before hatching and by its food after hatching; it has a supply of oxygen and temperature within certain limits, and "in response" to these conditions the comb develops. The man is nourished by nutriment before birth, by food after birth, requires oxygen and warmth, *and then his hands are subjected to friction* and the corns develop. It is a manifest absurdity to say that the two cases are of the same kind or analogous. It is easy enough to reduce two different phenomena to the same form of words and then assert that they are of the same kind; it may show ingenuity, but it obscures the truth, and is contrary to the methods of science.

The fallacy of Sir Archdall's argument lies in the words "in response to." After admitting the difference between two kinds of variation, he maintains that the comb, or, taking the more special character, the rose-comb, develops in the offspring in response to similar nurture, *i.e.* the same conditions as in the parent, and that precisely the same may be said of corns produced by rowing. But this is not the truth; it is the exact opposite of the truth. The rose-comb is not a "response" to any of the conditions of the nurture. We may take cocks and hens which are the produce of a cross between rose-comb and single comb, and which all have rose-combs; when we breed from them some of the chicks develop single combs and some develop rose-combs. Which comb-character is the "response" to the similar nurture, parents and offspring having all had the same nurture?

Sir Archdall fails to perceive the difference between a condition or stimulus in the nurture which has a direct relation to a structural feature and conditions which have no such relation. In the case of the corns due to rowing, the increased growth is a definite response to the stimulus of friction. In the nurture of fowls there is no stimulus to which the comb or any comb-character is a response. A character is inherited, not necessarily under the same conditions, but under a great variety of conditions, and vast numbers of different characters are inherited under the same conditions. Consider the various plants in a garden: their characters cannot be said to develop in response to nurture. No stimulus or treatment will produce a purple sweet-pea from a white sweet-pea; apart from variations, the different varieties of plants develop the characters of their parents in the same garden under the same conditions. When a stimulus is found which produces a certain change, then that change is an acquired character.

It is an essential point that the fowl develops in response to nurture, but not the comb-character or any other inherited character. Heat at a certain temperature is a necessary stimulus to the development of the egg, but it is not a stimulus to any particular character. The eggs of all the various breeds with all their remarkable colours and other characters can be incubated at the same temperature. It is a fallacy to place the relation of heat to general development in this case in the same category as the relation of friction to corns in the other. The question is: What determines the character? Friction of the hands produces a particular structural change; heat in incubation has no effect whatever on the characters of the breed to which the eggs belong.

Sir Archdall has stated that the corns due to rowing are inherited, and has treated them as a character. In this case, what becomes of the difference between a character and a variation? We may suppose a family of people who have not practised rowing; one adopts the practice and develops corns. Are these a character or a variation? Is the rose-comb a character or a variation? Sir Archdall has tried to show that the two are characters of the same kind with regard to acquirement and inheritability. But if they are variations, what becomes of the two kinds of variation?

Readers of NATURE are probably as weary of this controversy as I am, but Sir Archdall Reid is doing much harm by leading many who have no special knowledge of heredity and evolution to distrust the work of those who are engaged in research on these subjects. Prof. Bayliss recently stated that it was clear from this correspondence that the actual meaning of the terms used was in dispute. I feel that it is necessary, therefore, to criticise Sir Archdall's statements.

J. T. CUNNINGHAM.
East London College, Mile End, E.,
January 28.

IN his recent letter to NATURE (January 26, p. 104) Sir Archdall Reid restates his belief that "all characters are alike as regards innateness, acquiredness, and inheritability." His difficulties in this matter appear to be largely of his own creation, and they might be dissipated if he paid less attention to words and greater attention to the facts of experimental biology.

Sir Archdall Reid admits that there are "two kinds of variation: (*a*) those which result from germinal, and (*b*) those which result from nurtural, differences." That being the case, it surely follows that there are two kinds of characters; for what is a character but

a difference which has arisen at some time through a variation? We can determine characters only by comparing related organisms and noting their differences. To say that all characters are alike, then, is to say that all variations are alike, which Sir Archdall Reid himself admits is not the case.

Perhaps an experimental instance will make this clearer. Some years ago a fasciated specimen of an Œnothera was sent to me. The plant was in seed; the stem was about 2 in. wide at the widest part and as flat as a ribbon. It was, of course, impossible to say with certainty, from inspection, whether this character would be inherited or not, although the probabilities were somewhat against it. I sowed the seeds, large numbers of them, and they all gave rise to perfectly normal plants with round stems. The character was therefore non-inherited in this particular case. It is, of course, well known that fasciations may be produced by excessive nutrition, and that the peculiarity is then, as a rule at least, not inherited.

But there are other instances in which this character *is* inherited. For example, in the common coxcomb of gardens, *Celosia cristata*, fasciation is one of the specific characters, distinguishing it from such species as *Celosia plumosa*, in which the stems do not fasciate under ordinary conditions of cultivation. I have often grown these two species in quantity side by side in the greenhouse, and compared the extreme fasciation of *C. cristata* with the ordinary branched character of the other species. It should be mentioned, however, that *C. plumosa* does sometimes show slight fasciation at the tips of the branches, and this can be exaggerated by growing the plants under conditions of very high temperature and moisture. But it never approaches the degree of fasciation found constantly as a specific (and therefore inherited) character in *C. cristata*.

The same character, fasciation, is therefore clearly inherited in *C. cristata*, but it was not inherited in the particular instance in Œnothera which I tested. It is also clear that the fasciated Celosia must have originated at some time as a variation from plants with normal stems. Innumerable similar instances will be known to experimental biologists, and it is such cases which they have in mind when they speak of characters as of two kinds, inherited and non-inherited. When a particular new character appears as the result of a variation no one can predict with certainty whether it will be inherited or not until the organism which shows it is tested. But, of course, probabilities may be stated by comparison with similar characters the hereditary behaviour of which is already known. In the face of such experimental facts, which are well known to all geneticists, it is futile to state that all characters are equally acquired and equally inherited.

When Sir Archdall Reid implies that combs and corns are equally inherited he forgets a whole class of experimental facts such as those above cited. One must refuse to consider corns as inherited, because there always remains the possibility that a case may arise where, through a germinal change, they *are* inherited without any special stimulus to produce them. The inherited condition known as keratosis is, indeed, an epidermal thickening of similar character. It seems clear that moles are not usually inherited, but if the writer in NATURE is correct (see NATURE, January 19, p. 78), then there may be instances in which even a mole is inherited in the legitimate sense in which the term "inheritance" is customarily used by biologists.

R. RUGGLES GATES.

King's College, University of London,
January 27.

SIR ARCHDALL REID'S letter in NATURE of January 26 will render considerable service if it induces students of evolutionary phenomena accurately and precisely to define their terms.

If one may, at the beginning, set forth two general statements, the ground will be cleared for a discussion of Sir Archdall Reid's points:—

(1) Genes or factors are inherited, characters are not.

(2) A gene conditions the appearance in the organism of a character or group of characters.

(3) The effect produced by a gene in the organism depends on the environmental conditions which prevail during the life-history of the organism and on the other genes which the organism possesses.

To show that characters are not inherited, the example of "abnormal abdomen" in Drosophila may be cited.

The gene for "abnormal abdomen" causes the condition in moist cultures only. In dry cultures the flies hatch out normal in appearance.

The statement that rose comb and single comb are not more inheritable than corns on oarsmen's hands is obviously correct. Any capacity for reacting to a stimulus may be considered as being represented in the chromosomes by a gene or genes. In this case we may assume that the capacity for responding to the frictional stimulus of the oar by forming a mass of proliferated tissue on the palms of the hands is inherited.

Certain other points raised by Sir Archdall Reid may be dealt with briefly:

(1) The impure dominant does not inherit any trait. It inherits the recessive gene from one parent which may or may not interact with environment and with other genes to produce an effect. The terms "dominant" and "recessive" are purely arbitrary, and used only for convenience.

(2) The pure extracted recessive inherits a recessive gene from one parent and a similar recessive gene from the other. The germ-cells of an impure dominant carry either the dominant or the recessive gene.

(3) The ancestral condition obtained in some pigeon crosses is due to the interaction of the two sets of genes contributed by the two parents.

The interaction of genes may be illustrated by an example from the cow-pea. A red cow-pea crossed with a white may give a black in the first hybrid generation. White possesses a gene for black which is without effect except in the presence of the gene for red present in the red parent. At least eight different genes in the cow-pea are known to depend for their expression on a single colour-conditioning gene.

S. C. HARLAND.

[Sir Archdall Reid began this correspondence with a letter in NATURE of November 25, 1920; and we have now invited him to close it.—EDITOR.]

The Radiant Spectrum.

DR. HARTRIDGE'S objections to my explanation of this phenomenon (NATURE, September 1, p. 12, and December 8, 1921, p. 467) seem to be based on an imperfect appreciation of Brewster's observations on the subject. Brewster brings out two facts clearly in his paper: First, when a very small and intense source of white light is viewed directly by the eye it appears surrounded by a system of radiating streamers which appear to diverge directly from it; secondly, when a prism of small dispersive power is interposed in front of the eye the streamers are deviated and now appear to diverge from a point lying beyond the violet end of the spectrum into

which the source itself is drawn out. It is clearly illogical to suggest, as Dr. Hartridge does, that the prism is responsible for the radiant phenomenon in view of the fact that, in its essential features, the effect is observed even before the introduction of the prism.

Using a sufficiently intense source of light and a prism of small angle with optically good and clean faces, and making the observations in a dark room, it should be easy for anyone to satisfy himself by simple tests of the kind referred to by Dr. Hartridge that he is in error, and that Brewster's phenomenon really arises from the scattering of light in the eye, the prism merely acting as a dispersive apparatus modifying the colour and disposition of the streamers in the halo surrounding the source. Judging from the statements made in his letter, Dr. Hartridge would appear to have been particularly unfortunate in his choice of experimental conditions. Any noticeable imperfection in the optical surfaces of the prism would, of course, give rise to scattering, masking the true phenomenon due to the eye itself. This is indeed clearly suggested in Brewster's own paper.

A further and absolutely crucial test is also available. In my paper on the scattering of light in the refractive media of the eye (*Phil. Mag.*, November, 1919, p. 568), I have described the character of the diffraction-halo arising from this cause in considerable detail. With a source of white light the halo shows a radiating fibrous structure and clearly marked alternations of colour and intensity in its outer parts. A monochromatic source, on the other hand, exhibits a halo with a granular structure and a succession of bright and dark rings. These features are explained in my paper as due to the diffraction of light by corpuscles of more or less uniform size included within the structure of the eye. On this view we should expect one half of the first diffraction ring outside the central portion of the halo to be partially achromatised on the introduction of the prism and to appear as a detached semi-circular arc lying beyond the violet end of the spectrum and the displaced position of the achromatic centre. No mere imperfections or irregularities in optical surfaces could, on the other hand, give rise to such a phenomenon. Actual trial confirms the expectation from theory and puts its correctness on an unassailable basis.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, January 4.

The Naming of the Minor Planet No. 907, Barnardiana.

IN NATURE for September 8 last (vol. 108, p. 69), at the end of "Our Astronomical Column," attention is directed to the naming by Dr. Max Wolf of two of his asteroids in *Astronomische Nachrichten*, No. 5116. They are No. 834, Burnhamia, and No. 907, Barnardiana. In commenting on these asteroids NATURE infers that they were named after two American astronomers. While it is true that Prof. Burnham's memory is thus honoured, Barnardiana was not named after me, but in memory of Mrs. Rhoda Calvert Barnard, who died on May 25, 1921. This is evident from the following quotation from a letter to me by Dr. Wolf on the subject:—

"Wenn ich den Vornamen Ihrer Gemahlin gekannt hätte, und—vorausgesetzt, dass er nicht schon verwendet worden ist—würde ich ihn einem meiner Planeten zur Erinnerung an Ihre liebe Frau beigegeben haben. Da das nicht ging, so taufe ich den Planeten 907 1918 EU, auf den Namen: Barnardiana."

For some reason No. 5116 of the *Astronomische Nachrichten* containing these names has only very recently reached the Yerkes Observatory. I was unaware until then that it did not distinctly state the planet was named after Mrs. Barnard. Though not actively engaged in astronomical work, in her long life in astronomy she had endeared herself to the many astronomical people she had met by her thoughtful and unselfish interest in them and in their work. Hers was a life of love and sympathy. I am grateful to Dr. Wolf for thus perpetuating her memory.

E. E. BARNARD.

Yerkes Observatory, University of Chicago, January 11.

The Resonance Theory of Hearing.

DR. HARTRIDGE imputes to me great absurdities which, either in irony or by an excess of courtesy, he terms "slight errors" (NATURE, January 19, p. 76). Under (1) he takes my plain words, the result "must always be of the same nature," to mean that the result must always be the same! Of course, the harmonic analysis of his oboe and flute combination will not give the same result as in the case of violin and cornet, but in both cases the result will be of the same nature, in that there will be only one fundamental tone. If the data supplied to the sensorium from the cochlea are simply the result of an harmonic analysis, the two notes must appear to the ear inseparably blended in one note. I have not left binaural audition out of consideration. The ability to distinguish two concurrent notes of the same pitch and different quality seems unaffected by both sources being equidistant from either ear.

Under (2) Dr. Hartridge should know as well as I know that the *pitch* of a note depends solely upon the period of its fundamental tone. The example which I proposed eliminates the possibility of beats, the two notes being in perfect physical unison. And, further, since the note made by the teeth is generated by the other note, it cannot be heard except in the combination. Its perception is, therefore, a cognition, not a recognition. *At any instant* during the production of the two notes (which may be sustained for twenty seconds easily) it is possible to turn the attention to the note made by the teeth and to hear that its pitch is that of the hummed note. *At no instant* could the resonators which Dr. Hartridge, outstripping Sir Arthur Keith, "finds" in the cochlea furnish the data for anything but a change in the quality and intensity of the hummed note. This objection remains untouched by Dr. Hartridge's animadversions. It goes to the root of the matter, and cannot "fall to the ground" as a superstructure may.

W. PERRETT.

University College, Gower Street, W.C.1, January 26.

Aurora Borealis of January 30.

HAPPENING to look out at 11.30 last night I perceived a strong auroral glow extending from N. by E. through N. to W. The light was quite bright, and on going into the garden I noticed that my body cast a shadow and that I could read the headlines of the *Times* quite readily. There were no streamers, but several luminous patches, especially due N., where a blunted cone of greenish light rose vertically up from the horizon to a height of 10°.

The sky was partially, and later almost totally, covered by thin clouds, which drifted up from S. under the influence of light airs. The atmosphere was misty and the temperature decidedly warm.

CHARLES S. LEAF.

7 Grange Road, Cambridge, January 31.

Some Statistics of Evolution and Geographical Distribution in Plants and Animals, and their Significance.

By DR. J. C. WILLIS, F.R.S., and G. UDNY YULE, C.B.E., F.R.S.

IN a paper read at the Linnean Society under the above title on February 2, the statistical methods long employed in "Age and Area" were pushed to their final conclusion. Age and area (review in *Ann. of Bot.*, October, 1921, p. 493) is the name given to a principle gradually discovered in many years of work upon the flora of Ceylon, which, in brief, affirms that if one take groups of not less than ten allied species and compare them with similar groups allied to the first, the relative total areas occupied in a given country, or in the world, will be more or less proportional (whether directly or not we do not yet know) to their relative total ages, within that country or absolutely, as the case may be. The longer a group has existed the more area will it occupy. Tens are compared in order to eliminate chance differences as much as possible, and allied groups to avoid as far as may be the complications introduced by different ecological habit, etc. Herbs, for example, probably spread much more rapidly than trees, but both will obey Age and Area. It is of course obvious that age of itself cannot effect dispersal, but inasmuch as predictions as to distribution of species, occurrence of endemics, etc., can be successfully made upon the basis of age *alone*, it is clear that the average rate of spreading of a given species, and still more of a group of allied species, is very uniform, and therefore affords a measure of age. The result of the work is to show that in general the species (and genera) of smallest areas are the youngest, and are descended from the more widespread species that usually occur beside them.

To Age and Area must be added, as will be shown in a forthcoming book, the twin principle of "Size and Space," which affirms that within any circle of affinity the total of areas occupied by any group of ten genera will go with the total number of species, being large when that is large. The monotypic genera, like the species of small area, must in general be young beginners, and descended from larger genera. Putting these two principles together, it is clear that age, area (or space), and size go together, and as age (representing the resultant of the active factors) is the only working factor of the three, whatever phenomena are shown by size should be similar to those shown by space. But size of genera represents evolution, and area or space represents geographical distribution. These two phenomena should therefore show similar expressions.

But the characteristic feature of geographical distribution, as indicated in all the work upon Age and Area, is that species, whether of endemic or of non-endemic genera, are arranged, as regards their areas of dispersal, in "hollow curves."[1] They show (*cf.* last curve of Fig. 1) many on the smallest area (here one island), fewer on the area next larger (here two islands), and a tail of a few on areas larger again. This type of distribution is practically universal; if one take, for example, a large and widely distributed genus like Cyrtandra, one finds

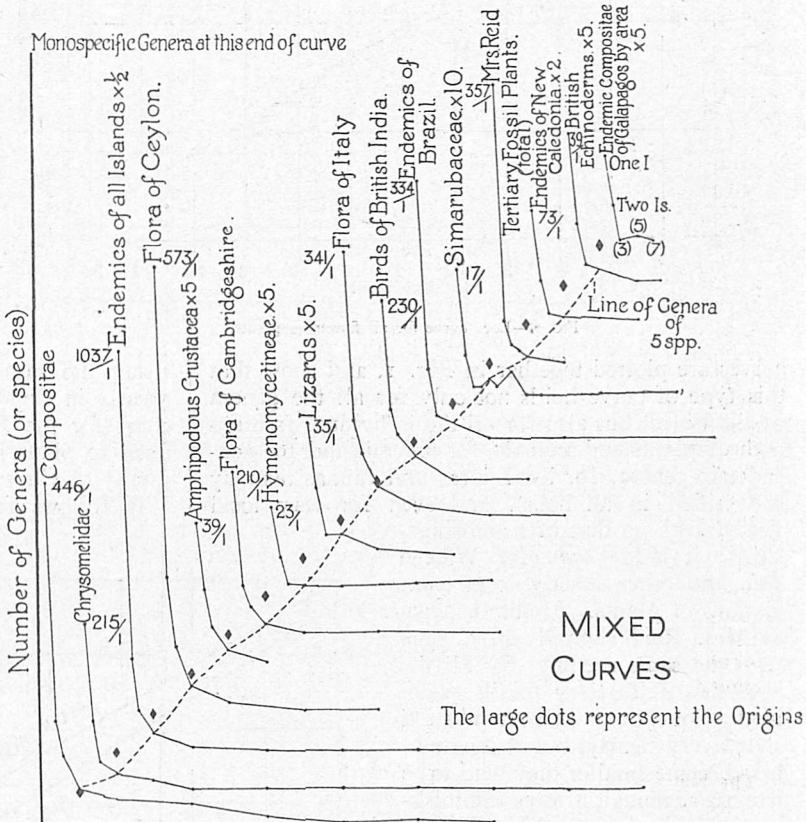

FIG. 1.—Mixed hollow curves. The numbers (thus 446/1) at the beginning of each are the numbers of monotypes.

145 species on small areas, twenty on areas of moderate size, and two on very large areas. If one take the Hawaiian Islands alone, one finds that this genus has twenty-four on single islands, two on two, two on three, and one on four.

Now evolution, as expressed in the sizes of genera, shows exactly similar phenomena, and if one group together genera that are associated in any way, systematically, ecologically, or in a given local flora, one gets just the same type of hollow curve, as

[1] By a hollow curve is meant the curve obtained by plotting graphically a series of numbers of which the first is much the largest, while there is a considerable drop to the second and again to the third, and then a gradual falling off to the end. The first two make up about half the total. For instance, a hollow curve will be obtained by plotting 40/1 (40 of one species), 15/2, 8/3, 6/4, 5/5, 3/10, 2/20, 1/30. Many examples are given in Fig. 1.

Fig. 1 shows. It begins with many genera of one species, fewer (but still many) of two, and tapers away in a tail to the larger genera, the tail being longer the larger the family or area dealt with (the tails in the figure are usually very incomplete: Compositæ, for example, run to 1450). A number of

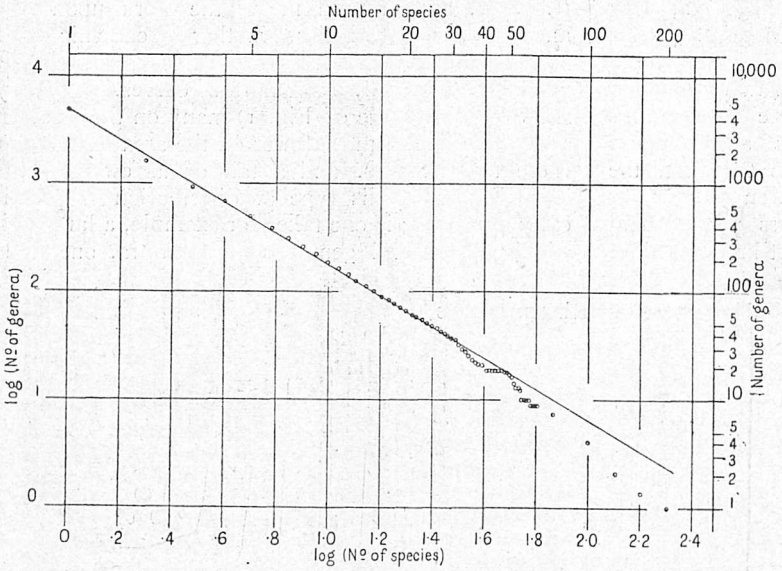

FIG. 2.—Log. curve for all flowering plants.

curves are plotted together in Fig. 1, and show that this type of curve holds not only for all the genera of the world, but also for all the individual families both of plants and animals, for endemic and for non-endemic genera, for local floras and faunas (as may be verified in an hour), and even for very local floras, such as that of Cambridgeshire; it holds even for Wicken Fen and other strictly local associations of plants. It obtains, too, as Mrs. Reid showed in a note read the same evening, for all the deposits of Tertiary fossils examined. For the first three numbers it shows very clearly, but as the numbers become smaller they tend to be irregular, though always diminishing towards the end. If one take only the tens, twenties, etc., one obtains a practically smooth curve.

But now, if species of very limited area and genera of one species (which also have usually small areas) are, with comparatively few exceptions, the young beginners in the race of life, and are descended in general from the species of wider dispersal and the larger genera, and if the number of species in a genus is, broadly speaking, a measure of its age, the idea at once suggests itself that a given stock may be regarded as "throwing" generic variations much as it throws offspring, so that the number of genera descended from one prime ancestor may be expected to increase in geometric ratio or according to the law of compound interest. The number of species descended from one ancestor might be expected to follow the same form of law with a more rapid rate of growth. On such a very rough conception it is found that the form of frequency distribution for sizes of genera should follow the rule that the logarithm of the number of genera plotted to the logarithm of the number of species gives a straight line. Fig. 2 shows the results of this method of plotting for all the flowering plants of the world. The dots give the data, graduated; some process of graduation had to be used, as the statistics were based on the figures given in the "Dictionary of the Flowering Plants and Ferns," which are rounded off in doubtful cases to the nearest 5 or 10 (or greater number in the large genera). It will be seen that, up to genera of some thirty or forty species, there is an excellent fit to a straight line, though there is a marked deficiency of the larger genera—a point on which further investigation is required. Single families show precisely the same rule, the lines not differing very greatly in slope: Fig. 3 gives an illustration of the chart for the Rubiaceæ. Nor is the law one confined to plant life, as is shown by Fig. 4, for the family of Chrysomelidæ amongst the beetles.

It follows from the conception stated that the excess of the slope of the line over unity should measure the ratio of the rate of increase of genera to that of species. The slope should always, therefore, lie between the limits 1 and 2, for a slope of less than unity would have no meaning, and a slope exceeding 2 would imply that generic variations

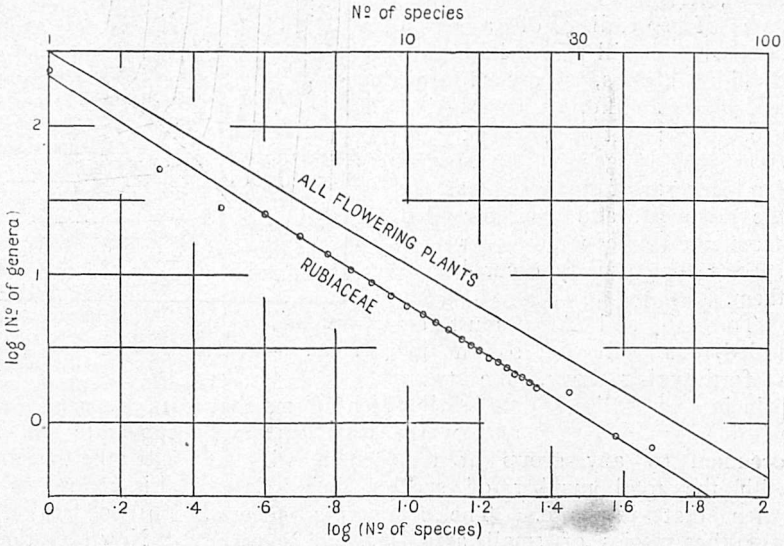

FIG. 3.—Log. curve for Rubiaceæ.

were more frequent than specific variations. Hitherto no exception has been found to the required rule. One group of fungi tested (Hymenomycetineæ) gave a line with a slope very little exceeding unity (1·08), but the figures found for flowering plants lie between the narrow limits 1·38 and 1·64, with an average of about 1·43. Snakes and lizards both give a figure very near 1·50, and the Chrysomelidæ about 1·37.

The development of a more complete theory may in some degree modify conceptions and interpretations, but the results so far obtained suggest that the basic principle put forward is correct.

Inasmuch as all families, both of plants and animals, show the same type of curve, whether graphic or logarithmic, it would appear that in general the manner in which evolution has unfolded itself has been relatively little affected by the various vital and other factors, these only causing deviations this way and that from the dominant plan. And since, assuming that genera "throw" other genera and species, it was predicted that the logarithmic curves would be straight lines, and it was then discovered that they actually were so, it is probable that the assumption was correct. But if this be so, then not only must evolution have been by mutation, but it must also have been, as one of us has contended for many years, by mutations that were at times of rank sufficient to give rise to Linnean species, genera, or even families. Not only so, but evolution must have proceeded on the lines of Guppy's theory of differentiation, the larger genera, and the species of larger area, being the parents of the smaller: *i.e.* it must have proceeded on the whole in the reverse direction to that postulated by the Darwinian theory, as one of us has long maintained.

Finally, it is clear that geographical distribution has been largely mechanical, the general effect of the many factors that are operative being to cause species to spread at a fairly regular speed (differing for each), so that spread forms a measure of age.

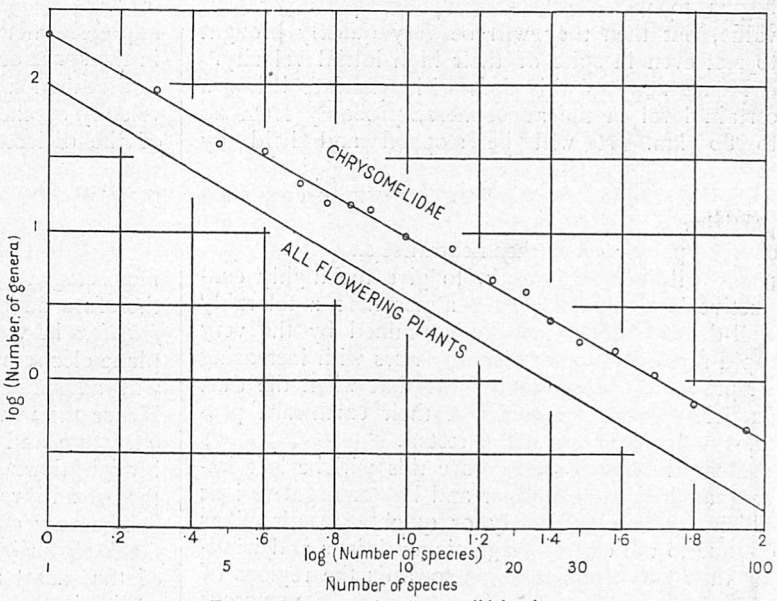

FIG. 4.—Log. curve for chrysomelid beetles.

Space does not permit of detailed argument, which must be left for forthcoming books; but a couple of hours' work at statistics of genera (by sizes) will suffice to make clear the general position taken up.

Some Problems of Long-distance Radio-telegraphy.[1]

By DR. J. A. FLEMING, F.R.S.

II.

ANOTHER cause operating to effect a separation of the positively and negatively charged dust is found in the viscosity of the atmosphere. Roughly speaking, the viscosity of a gas is that quality of it in virtue of which fine particles experience a resistance in moving through it. Maxwell showed long ago that the viscosity of a gas is independent of the pressure over wide limits. Crookes continued these researches and demonstrated that between atmospheric pressure and a pressure of about one ten-thousandth of an atmosphere the viscosity remains constant, but that when the pressure falls below this last figure the viscosity very rapidly decreases to zero. Again, both Maxwell and Crookes found that the viscosity of hydrogen is about half that of oxygen or nitrogen. The viscosity of air at 760 mm. is 0·00018 C.G.S. units.

Sir George Stokes proved that if a small sphere of diameter d and density σ is falling through a gas of density ρ and viscosity μ under the action of gravity it will attain a final velocity v such that

$$v = \frac{1}{18}\frac{d^2 g}{\mu}(\sigma - \rho),$$

where g is the acceleration of gravity. This explains the extremely slow rate of fall of water particles constituting clouds, and also the very slow settlement of fine dust particles through air.

The positively-charged solar dust particles are probably larger than the negatively-charged particles, as the latter consist of electrons having condensed round them molecules of gases, probably hydrogen and helium, gathered from the solar chromosphere. Accordingly the negative ions will be brought to rest before the positively-charged particles and gas viscosity will assist the separation.

But Stokes's expressions apply to smooth spheres and not to irregularly shaped particles. Also, if the diameter of the particle is much less than the mean free path of a gas molecule, the expression

[1] Continued from p. 143.

for the frictional resistance, $3\pi d\mu v$, must be divided by $1+2\alpha L/d$ where L is the mean free path of a gas molecule and α is a constant depending on the nature of the particle and its form.

If, then, particles of dust enter the highly rarefied upper hydrogen levels of the atmosphere, they will experience very little retardation until they reach that level (about 100 km.) at which viscosity begins to increase rapidly to its normal or full value, but then they will be very quickly brought to rest even in spite of their high initial velocity.

Hence none of this dust will penetrate below a certain level in the atmosphere, probably from 60 to 80 km. It will be stopped and held by air viscosity. The moment its velocity falls off the forces tending to separate the oppositely electrified particles will also decrease, and the oppositely charged particles may then neutralise each other. The result will be, as I think, to give the highly conductive layer in the earth's atmosphere a tolerably well-defined under-surface determined by the very rapid rate at which air viscosity rises with increasing air-pressure. Hence it is clear that when the dust particles reach a certan level their earthward progress will be practically arrested.

Meanwhile the region above this will be left impregnated with the smaller and lighter negative ions which are moving slowly or quickly in directions oblique to the earth's magnetic meridians and winding their way spiral-fashion towards the regions of the magnetic poles. The explanation of numerous astronomical, meteorological, magnetic, and atmospheric electric phenomena by the aid of this hypothesis of electrified solar dust projected by light pressure from the sun to the earth has been worked out in great detail by S. Arrhenius, K. Birkeland, W. J. Humphreys, and others. This solar dust hypothesis seems to be supported by the observations of Newcomb, Yntema, Abbot, and W. W. Campbell on the fact that on clear moonless nights the sky sends to us more light than can be accounted for by the sum total of starlight, and that this extra light is notably greater near the horizon than at the zenith, and also by the spectroscopic observations which show the green auroral line in all parts of the tropical sky on moonless nights.

In addition to this hypothesis of a permanently conducting upper region of the atmosphere we are compelled to postulate that beneath this there must be a region of variable ionisation due to solar light, which is ionised during the day above the level of clouds, dust, and water-vapour, but more or less dis-ionised during the night.

Dr. Eccles has worked out the consequences of assuming an atmospheric region in which ions of molecular mass are present, possibly formed by the action of ultra-violet light on molecular groups which are photo-electric. The presence of these heavy ions acts so as to produce what is in effect a reduction in the dielectric coefficient and therefore an increase in the velocity of electric waves through the ionised region.

This action may be illustrated by a magnetic parallel. If iron spheres were placed in a magnetic field they would be magnetised, but owing to the reverse action of the free poles the magnetic force in the iron would be less than the force at that point if the iron were not there. Hence the magnetisation produced is not that which corresponds to the external impressed magnetic force, but to the reduced magnetic force.

In the same manner if heavy ions are present in the air the orderly arrangement of them by the impressed field reduces the effective electric force in the space occupied by them, and this is equivalent to a reduction in mean dielectric constant. But the velocity of the wave is inversely as the square root of the dielectric constant, and therefore the wave speed is increased. From this it follows that if there is a gradually increasing density of heavy ions of both signs as we rise higher in the atmosphere, there will throughout that region be a gradually increasing electric wave velocity with height, and therefore an effect which has been called *ionic refraction* in virtue of which the higher levels of a plane electromagnetic wave advancing over the earth will advance more quickly than the lower parts. Hence the wave track will follow round the earth's curvature and an obliquely rising ray may even be brought down again to earth by an action resembling that of an inverted mirage.

The very complicated phenomena connected with freak signalling, the great effect on signal strength of the sunset and sunrise periods, the curious anomalies in the difference between daylight and night-time radio-transmission for various wave-length, and the variation in range between north–south and east–west transmission have all received certain plausible explanations on the theory of a variable ionisation by sunlight of the atmosphere, and its irregularities at the bounding surface of the earth shadow cone as it sweeps through the atmosphere. The atmospheric ionisation at this surface will tend to become "patchy," and will therefore bestow a certain increased opacity and increased reflecting power on that region for electric waves just as small air bubbles in water give it a certain opacity for visible light.

The general increase in range of radio-communication by night is accounted for on this theory as due to partial removal of the ionic refraction which in the daytime brings the ray down again to earth at ranges less than that due to the guiding properties of the permanently ionised higher layer.

There are, however, curious exceptions to this in the case of certain long-wave transmission. Senatore Marconi long ago pointed out that with certain wave-lengths from 5000 to 6000 metres transatlantic radio signals are often stronger by day than by night. These anomalies and others recorded by Dr. Eccles seem, however, to meet with reasonable explanations on the ionic refraction theory.

On the other hand, our difficulties are great in bringing these hypotheses to critical test. The atmospheric region in which the phenomena take place is far beyond the reach of our meteorological sounding balloons or possibilities of testing the actual ionic distribution. We can only, therefore, patiently

continue to collect the facts and trust to cautious inductive reasoning and observations to give us the true interpretation of them. All the phenomena seem, however, to point to the existence of three superimposed layers in the atmosphere: one, the higher, beginning perhaps above 80–100 km., which is permanently ionised with negative ions. The other, the middle, which has in part variable ionisation, depending on the position of that part with regard to the sun. The third or lower level has a relatively small ionisation, but electromagnetic waves travelling in it may have their energy considerably affected and reduced by the nature of the earth's surface over which they are moving. Powerful absorption is caused by some soils and by vegetation for certain wave-lengths.

From the earliest days of long-distance wireless telegraphy the difficulties in reception due to vagrant or natural electric waves and atmospheric electric discharges passing down the receiving aerial have been the bane of the wireless telegraphist. These waves create sounds in the telephone in aural reception which often drown completely the signal sounds and make false records in the case of printing or photographic reception. In the case of telephone reception, these noises have been classified into (1) rattling or grinding, (2) hissing, (3) clicking or snapping, and (4) crashing noises. These last two seem to be associated with thunderstorm conditions. Having regard to the fact that the positive atmospheric electric potential gradient of the earth increases at the rate of about 100 volts per metre of ascent, it is not surprising that aerials several hundred feet high may be traversed by quite large currents, due to this cause alone, which may utterly swamp the feeble signal currents. The strength of a signal or noise in the telephone is generally estimated by its "audibility," and this is measured by ascertaining the resistance S of the shunt which must be put across the telephone of resistance R just to render the sound inaudible to a normal ear. The audibility A is given by the expression $A=(R+S)/S$. Hence the audibility is unity for a just audible sound. We can in this way measure the audibility of a signal on a background of disturbing noise, and a readable signal is generally obtained if the ratio of signal audibility to stray audibility is more than 25 per cent.

Owing to the serious extent to which these strays hinder regular reception, especially at certain times of the day and year, an enormous amount of attention has been given to their study and to the problem of eliminating them. They are most troublesome in the summer and during the night, and more severe in tropical than in temperate climes. Even in our latitudes they hinder reception at times immensely. Dr. L. W. Austin has stated that receiving at Washington, U.S.A., with a simple loop aerial from high-power radio stations in Europe with aerial sending currents up to 300 amperes, signals were unreadable for about 2000 hours a year. In tropical countries over long-distance circuits the power required to get a signal through may be often from six to eight times that which must be used at favourable times, and there are short periods when signalling is absolutely impossible. Having regard to the effect such interruptions have upon the earning power of a commercial station or upon certainty of communication in time of war or other urgent occasions, the problem of elimination of strays is perhaps the most important of all the practical questions connected with long-distance wireless telegraphy. It has been the subject of countless patents already. Early attempts went on the supposition that the strays were highly damped vagrant waves or had particular frequencies and could be eliminated by giving the receiving system a very pronounced resonance and making it a so-called stiffly-tuned circuit. These methods had a very limited application, for the reason that any impulse given to the receiving aerial sets it in electric vibration with its own natural period. Then, again, a number of inventions depend upon the peculiar properties of certain detectors, such as crystals and thermionic valves, in limiting the current which they pass or rectify. One most practically useful discovery was that by giving to the spark or wave train in the case of spark systems, or to the beats in the case of C.W. heterodyne reception, a regular frequency of 500 or 600, thus imparting a rather shrill musical sound to the signal, the ear could much more readily fasten attention on it even against a background of irregular but louder noise due to atmospherics.

Dr. de Groot made an immense number of observations on stray strengths at various hours of the day and months of the year about 1916 in the Dutch East Indies, and prepared diagrams showing the mean stray strength for various hours for each month of the year. From these he prepared a diagram giving the hourly stray strength during the day averaged throughout a year. The results were that in general the strays were more numerous and stronger during the night than during the day.

We have seen that there must be a certain intermediate but high-level region in the atmosphere in which the gases are ionised by the ultra-violet sunlight during the day, but re-combine again during the night. This region lies beneath the permanently ionised layer. In this permanently ionised layer there are drifting collections or masses of positively electrified and negatively electrified solar dust. If these masses are drawn together by their electric attractions or commingled, it is highly probable that electric recombinations will occur, which would generate electric waves. Suppose, then, that we assume the origin of a certain part of the strays to be in the upper permanently conductive layer of the atmosphere, these natural waves would find a certain obstacle to their downward transmission in the conductivity produced by the ionisation of the middle layer of the atmosphere by day. But at night-time this middle layer ionisation largely disappears and the natural electric disturbances in the upper layer would more easily find their way down to the earth. In other words, there would be a more unhindered access for the strays to descend. Hence in the night-time they would be more numerous

and more apparent in the effect they produce on receiving appliances.

The view that the strays which produce continuous rattling or grinding noises in the telephone have their origin in the high-level permanently conductive layer of the atmosphere was also put forward by Dr. de Groot, and he has employed ingenious arguments to obtain an estimate of the height of this layer, which he places at between 180 and 200 km.

These estimates must, however, be brought into comparison with the observations which have been made on the heights of the aurora. Störmer has made precise measurements of the parallax of the beams and arches of auroræ by photographic observations at places connected by telephone, and found, out of 150 observations, that the lowest occurred at 40 km. and the highest at 260 km. Much, however, depends upon latitude and the height of the region ionised by cosmic dust may be greater at the terrestrial equator than at the poles. The whole subject is of great importance in connection with meteorology and terrestrial magnetism, and invites the co-operation of physicists, astronomers and meteorologists, as well as radio-engineers.

The matter is, however, of such immense practical importance in radio-telegraphy that improvements or inventions connected with it are generally kept as carefully-guarded secrets, at least, for some time. Senatore Marconi spoke recently of inventions due to himself and his technical staff which promise a great advance in overcoming the interruptions of service due to strays, but details are at present withheld.

The problem of eliminating altogether the effect of strays on the receiver is at present the paramount one in long-distance wireless telegraphy, as they are a source of far greater difficulty than in short-distance working.

A Journal for Physical Measurements and Instruments.

READERS of NATURE, whether physicists or others, will be interested to learn of the steps which are being taken and the progress which has been made in connection with the proposed new journal dealing with physical instruments, the first important task which the newly founded Institute of Physics has set itself to accomplish. At the National Physical Laboratory the need for such a journal has long been felt; accordingly in 1919 the director addressed a letter directing attention to the needs of a number of Government departments and workers in various branches of science.

The response was most gratifying. The Admiralty, War Office, Ordnance Committee, engineering department of the Post Office, and other important bodies, all wrote approving the suggestion and in many cases offering support, while men of science—physicists, physiologists, miscroscopists, zoologists, and engineers—warmly commended the scheme, which also received the support of some leading instrument makers, including the British Optical Instrument Makers' Association and the British Electrical and Allied Manufacturers' Association. As a result the Institute of Physics brought the proposal before the Department of Scientific and Industrial Research. A meeting was held between representatives of the department and of the institute under the chairmanship of Sir J. J. Thomson, at which a suggestion was made that a single number might be prepared and issued as a specimen with the view of seeing what support could be obtained.

This suggestion was, at a later date, conveyed in a more formal manner to the department and approved by their advisory council, and a joint committee appointed by the department, the National Physical Laboratory, and the institute has been formed to give effect to it.

The institute has accepted financial responsibility for the publication of the journal provided scientific and industrial associations and individuals to whom the journal will be of service are prepared to furnish adequate guarantees for its support. The department will make a grant towards the cost of printing the specimen number.

The institute is to have the assistance of the staff of the National Physical Laboratory in the preparation of this number, and Dr. Rayner has, at the request of the committee, undertaken the duties of editor. An announcement of the proposed journal has been prepared and will be widely circulated along with a request for support, and it is hoped that the response will be such as to enable the institute to continue the task it has set itself and produce a work which will fill the acknowledged need.

Obituary.

SIR HENRY JONES.

IN Sir Henry Jones, professor of moral philosophy in the University of Glasgow, who died on February 4 at his home in Argyllshire, we lose one of our greatest teachers and, since Edward Caird, the leading representative of the Hegelian influence and tradition in English university life. A pathos surrounds the last few years of his life and also throws light on his personal character and strong mentality. He struggled against the painful disease which has proved fatal with a courage nothing short of heroic. He refused to give up, or even to slacken, his regular work. He persevered with his last undertaking, the Gifford lectureship, under conditions which few could have endured. He lectured even when speech was becoming

physically difficult, and he succeeded in delivering the first course. The second course has been interrupted by death, but the series of lectures is written and about to be published under the title "A Faith that Enquires."

Sir Henry Jones was born in 1852 in North Wales. In his twenty-third year he obtained the means to enter as a student in the University of Glasgow, and there came under the influence of Edward Caird, from whom he learnt the Hegelian idealism of which he was throughout his life an enthusiastic and consistent exponent. In 1878 he graduated with first class honours in philosophy and became Prof. Caird's assistant. After various appointments, and when Prof. Caird became Master of Balliol in 1894, he was appointed his successor and has held the chair since. He was an LL.D. of the University of St. Andrews, a D.Litt. of the University of Wales, and a fellow of the British Academy. He was knighted in 1912. He served on the Commission of Inquiry which preceded the Act for the Disestablishment of the Church in Wales. His name was included in the last New Year's honours list.

It is as a teacher that Sir Henry Jones will live in the memory of the many students who were inspired by him. As an author the value of his work is literary and social rather than scientific or philosophical. His books are popular expositions, marked, indeed, by keen appreciation and insight, but motived by strong moral enthusiasm rather than by any theoretical interest in investigating scientific or philosophic problems. His most important work in philosophy was a small volume on "The Philosophy of Lotze," published in 1894, which was for many years the chief source for English readers of their knowledge of the philosophy of the German professor.

Prof. V. Giuffrida-Ruggeri.

Dr. Vincenzo Giuffrida-Ruggeri, professor of anthropology in the University of Naples, one of the leading anthropologists in Europe, died on December 21, after a brief illness. He was born at Catania, Sicily, in 1872, became a doctor of medicine in the University of Rome, 1896, and was thereafter appointed assistant to the professor of anthropology in that university, G. Sergi. He then commenced a career of extraordinary industry, contributing year after year some eight or ten original papers to the current literature of his chosen subject. Although Prof. Giuffrida-Ruggeri neither initiated any form of revolutionary idea nor opened any new chapter, yet his voluminous writings reflect more fully than those of any other writer the anthropological problems discussed by his contemporaries in Europe and America. The papers of his earlier years were devoted to studies of the skull, particularly of the face, but as time went on they broadened out into a study of human races in all parts of the world. He made a close study of the fossil remains of man, and in more recent years devoted himself to the evolution of man and to the origin and relationship of modern human races. The conclusions he had reached are set forth in two of his more recent books, "L'Uomo Attuale, Una Specie Collettiva" (1913), and "Su l'Origine dell' Uomo," 1921. By his death modern anthropology loses one of its most imposing and interesting figures.

A. K.

Current Topics and Events.

Mme. Curie was elected a free associate member of the French Academy on Tuesday—an event which marks a red-letter day in the history of feminism, and is a richly merited recognition of the memorable achievements of a woman who, although not French by birth, has conferred imperishable lustre on French science. So signal a distinction—unique in the history of that particular section of the Academy of which Mme. Curie becomes a member—is but the just reward for services rendered, not only to France, but also to the whole world, and brings honour to the illustrious body that has bestowed it. It was significant of the universal sentiment of approval with which Mme. Curie's candidature was greeted that her several male competitors should, one after the other, have waived their claims in her favour—a circumstance which adds a measure of grace to her triumph. On behalf of British workers in science—men and women—we beg to tender our warm congratulations to the new Academician, and trust she may long enjoy her well-earned *fauteuil* among the Immortals.

The address of the president of the Paris Academy of Sciences, M. Georges Lemoine, published in *Comptes rendus* of December 12 last, refers to matters which must be kept in mind in England also. After pointing out the growing necessity for costly apparatus and laboratories in the progress of physical and natural science, M. Lemoine deplored the fact that the most important factor of all, namely, the man of science himself, is being more and more tempted to forsake the domain of science and to devote himself to industrial pursuits. Although the general rise of prices may partly account for this fact, it does not justify it. The supply of research workers from the universities and colleges is insufficient for national needs. It is absolutely necessary for the production of good work that the material conditions of existence should be assured for a much larger number of young men of science, at all events for a period of a few years. But there must also be an adequate number of posts, teaching and otherwise, free from anxiety as to the supply of daily needs and affording time for individual work, to which the young investigator can look forward as a future career. The address closes with an eloquent appeal to young people not to place too high a value on material wealth, but to remember the incomparable satisfaction which awaits the discoverer of new knowledge.

THE recent offer of a prize of 22,000*l.* by Lord Atholstan to the discoverer of a medicinal cure for cancer has been followed by one of 10,000*l.* by Sir William Veno for the same purpose. These offers have naturally created a good deal of interest, not only among the general public, but also among those engaged in the organisation and prosecution of cancer research. If successful treatment of this disease is going to be secured, it is certain that more financial support must be given to investigators than has been provided in the past. The present difficulties of this provision are so acute that Lord Athlone, the chairman of the Board of the Middlesex Hospital, has directed the attention of these intending benefactors to the urgent need of supporting existing researches. We are glad that this suggestion has been acted upon, for it is now announced that Lord Atholstan has given an additional 22,000*l.*, to be used for research work in cancer, and Sir William Veno has agreed that his gift should be used for research. It is possible that some further financial help may come for cancer investigation in this country as well as in others. Should this eventuate, it might well be the opportunity for some concerted action among the different cancer research centres. At present investigations upon causation or cure are unco-ordinated, and something might be gained by intensive work along avenues which a collective opinion would indicate.

AN earthquake of great interest, though by no means of the first order of magnitude, occurred on January 31 at 1h. 17m. 30s. p.m. (Greenwich mean time). In the United States the oscillations were so large that seismographs at Washington and Harvard University were temporarily put out of action. The origin was about 600 miles from San Francisco, 2420 from Ottawa, and 5140 from Oxford. In a letter to the *Times* of February 3 Prof. H. H. Turner locates it in lat. 42° N., long. 125° W., or about sixty miles from the coast where Oregon joins California. The shock is said to have been felt at many places along the Pacific coast as far as the Canadian border, and this seems to point to an elongated focus parallel, or nearly parallel, to the coast-line. It is interesting to notice that the epicentre lies along, or close to, the continuation, some two or three hundred miles to the north, of the San Andreas fault. Except for three short interruptions by the sea, this great fracture has been traced from Cape Mendocino on the north to the Colorado Desert on the south, a distance of more than 600 miles, and it was along its northern half, from Cape Mendocino to San Juan (about 290 miles), that the remarkable displacement occurred which gave rise to the San Francisco earthquake of 1906.

SOME disappointment has been expressed in Glasgow regarding the refusal of the managers of the Royal Infirmary to undertake the permanent retention on its present site of the old ward which was formerly occupied by Lord Lister, and in which his first successful experiments in antiseptic surgery were carried out. The infirmary has been largely rebuilt, and the old ward is said to obstruct the lighting and ventilation of the newer structure. The Lister Memorial Committee proposed to preserve the ward in perpetuity and fit it up as a museum of relics, portraits, etc. Failing in this purpose, the committee has now decided to devote its funds to the erection of a statue of Lister, near that of Lord Kelvin in the Kelvingrove Park, on the slope adjoining the University, in which they were colleagues as professors. The Lister relics collected by the committee will be displayed in the hall of the Pathological Institute at the Royal Infirmary. Meanwhile, no immediate steps are likely to be taken for the demolition of the old ward.

AT the meeting of the Royal Geographical Society on Monday, February 6, the president announced that this year's Mount Everest Expedition is already in movement. The definite sanction of the Tibetan Government has just been received, and Gen. Bruce has left England for India to make all the initial preparations, especially the organisation of a corps of Himalayan porters at Darjeeling. Lord Rawlinson has particularly attached himself to the expedition, and through his interest it has been possible to secure the services of Capt. Geoffrey Bruce, of the 6th Gurkhas, to help his cousin in the very important work of training, equipping, clothing, and feeding these porters. A second Gurkha officer has also been asked for. Besides these there will be six climbers, Lt.-Col. E. L. Strutt, Mr. Mallory (from last year's expedition), Mr. George Finch, Mr. Somervell, Dr. Wakefield, and Major Norton—all in the first rank of mountaineers. The veteran Himalayan climber, Dr. T. G. Longstaff, will accompany the expedition as physicist and naturalist, and Major J. B. Noel will act as photographer. Before the end of March these will all have arrived in Darjeeling, and a start will be made in time to reach the base camp near Mount Everest early in May.

THE National Institute of Industrial Psychology was founded in 1919 by the co-operation of Dr. C. S. Myers and other psychologists, with representatives of several well-known industrial firms, and it was finally incorporated in February, 1921. We now welcome the appearance of the first issue of the Journal of the institute, which is to appear quarterly. This journal aims at describing in non-technical language the methods and results of applying scientific knowledge to the human aspects of industry. It will publish accounts of research and propaganda work carried out, not only by the institute, but also by other similar bodies and by individual investigators, and will contain abstracts and reviews of books, reports, and periodicals. Amongst other contributions the present issue contains accounts of investigations on tin-box manufacture and on chocolate packing, in which it has been possible by the introduction of simple improvements in the methods of work to improve output by 30 to 40 per cent., and at the same time to diminish the fatigue of the workers. The assistant director of the institute, Dr. G. H. Miles, discusses vocational guidance, and Mr. Eric Farmer describes the reduction of

fatigue through the adoption of rhythmical methods of work in various industries.

A SUGGESTION has reached us from Mr. F. J. W. Crowe, St. Peter's House, Chichester, that fine concrete might be used for making mirrors of large size and accurate surface such as are employed in large reflecting telescopes for astronomical work. Dr. J. W. French, of the firm of Messrs. Barr and Stroud, to whom we submitted the communication, is of the opinion that such a surface would not be satisfactory. Silvering shows up minute defects very plainly; in fact, rustless steel is the only material other than glass which gives reasonably good results, and to grind a plaster surface with the necessary accuracy would be almost impossible on account of the way in which all plasters absorb water. The greatest difficulty to be met, however, is the distortion which occurs when plaster sets. Both at the time of setting and afterwards there are rapid crystalline changes which may continue for at least one year. Any plaster containing unslaked lime will undergo distorting changes which would make the production of a good optical image impossible. This defect might be remedied by using a blend of cements, but, unfortunately, they are not of a kind that could be worked to give a good continuous surface.

IN a report to the Mercantile Marine Department of the Board of Trade on the proposed standard of rejection of seamen for colour-blindness, Dr. Edridge-Green states that 5 per cent. of men have diminished colour perception. As there is a gradual change from normal to absolute colour-blindness, it is difficult to fix a point at which it shall be considered that colour-blindness incapacitates a man from work as a seaman. The Nautical Advisers of the Board of Trade agree that a man who can distinguish between red, green, and white lights a mile distant shall be considered competent. Dr. Edridge-Green finds that the men who fail under this test can see only three or less distinct colours in the spectrum, while those who pass the test see four or more. He therefore fixes the line of demarcation between those who can distinguish red, yellow, green, and violet and those who see only red, green, and violet in the spectrum.

THE National Institute of Botany has recently issued a very encouraging Second Report (1920–21). During the year the headquarters at Cambridge were completed and came into use, the official Seed Testing Station being transferred thereto in September last. Within a month a private visit was paid by their Majesties the King and Queen and Princess Mary, who expressed their appreciation of the importance of the work carried on. In order to bring the institute into closer touch with the agricultural community a fellowship is being established (annual subscription one guinea), in which Mr. Lloyd George has asked to be enrolled as one of the first life fellows. For the welfare and progress of the work it is essential that a considerable income be raised by annual donations and subscriptions, and it is hoped that very many agriculturists will avail themselves of the opportunity of assisting in this by becoming fellows. In the crop improvement branch, field trials of cereals have been established, "preliminary trials" being made to provide seeds for "full trials" which will last for two years. A collection is also being made of stocks of varieties of cereals, especially of historical varieties of wheat, some of which are rapidly disappearing. An interesting feature of the current year's work will be an exhibition of yield trials of growing cereals and potatoes on the Royal Agricultural Show ground in Cambridge. At Ormskirk the immunity and maturity trials of potatoes have been continued; they indicate that the system of experiment used promises to lead to satisfactory results when modified and extended over a longer period of time. The official Seed Testing Station reports a considerable increase in the year's work, in spite of the disorganisation due to the transfer from London. It is proposed to hold a summer course for the training of seed analysts, and a handbook of seed-testing methods is in preparation. An International Conference on Seed Testing at Copenhagen was attended by representatives of the institute, and it is hoped that the next conference in 1924 will be held partly at Cambridge.

IN the French newspaper *Savoir* for December 24 last Prof. Capitan discusses Mr. Reid Moir's discoveries of worked flints at the base of the Crag near Ipswich and in the Forest Bed near Cromer. He concludes that the simple chipping round the edges of these flints is undoubtedly the work of man or one of his precursors. He therefore agrees that Mr. Reid Moir has found definite evidence of Pliocene man in Britain.

SIR OLIVER J. LODGE will deliver the fifth Silvanus Thompson memorial lecture at a special meeting of the Röntgen Society to be held on Tuesday, March 21, at the Institution of Electrical Engineers.

ON Thursday next, February 16, Prof. Arthur Perkin will begin a course of two lectures at the Royal Institution on "Dyeing: Ancient and Modern"; and on Saturday, February 18, Prof. Ernest Gardner will deliver the first of two lectures on "Masterpieces of Greek Sculpture." The Friday evening discourse on February 17 will be delivered by Prof. D. S. M. Watson on "The History of the Mammalian Ear."

THE annual general meeting of the Institute of Metals on March 8–9 will be held at the Institution of Mechanical Engineers. On the opening day of the meeting the new president, Mr. L. Sumner, will deliver his inaugural address, and in the evening the annual dinner of the institute will be held at the Trocadero Restaurant, Piccadilly Circus, W.1. Papers on the constitution and properties of copper and aluminium and their alloys will occupy the scientific sessions of the meeting.

IN the annual report of the Physical Society to be presented at the annual meeting to-morrow, February 10, it is stated that Prof. A. Fowler has prepared for the society a report on "Series in Line Spectra," which will shortly be issued. A second

report on "Atomic Structure," by Prof. Bohr, is in preparation. An appeal for funds for a Duddell memorial medal resulted in a sum of about 650*l.* being raised. The committee dealing with the memorial has asked Mrs. Mary G. Gillick to undertake the preparation of the medal, which it is hoped will be ready during the early part of 1922.

THE following lecture arrangements have been made by the Royal College of Physicians of London :—The Milroy lectures on "The Influence of Industrial Employment on General Health," by Dr. Major Greenwood, on March 9, 14, and 16; the Goulstonian lectures on "The Interpretation of Symptoms in Disease of the Central Nervous System," by Dr. A. Feiling, on March 21, 23, and 28; the Lumleian lectures on "Diseases of the Thyroid Gland," by Dr. H. Mackenzie, on March 30 and April 4 and 6. The lecture-hour in each case will be 5 o'clock.

IN a paragraph in NATURE of February 2, p. 151, it was suggested that the list of British research chemicals issued by the Association of British Chemical Manufacturers should be revised and issued as soon as possible. Mr. W. J. U. Woolcock, general manager of the association, informs us that the suggestion has been anticipated, and that a revised and enlarged edition of this list is at the moment in the press. Not only will this second edition contain a larger number of organic chemicals, but inorganic chemicals will also be included.

MANY libraries doubtless contain duplicates of astronomical periodicals and books that are needed in other institutions. For the purpose of facilitating their purchase, exchange, or gift, the National Research Council contemplates the compilation of a list of all duplicates that can be spared. This list will be mimeographed and widely distributed. Those who have duplicates to dispose of are asked to send a list of them to the National Research Council, Division of Physical Sciences, 1701 Massachusetts Avenue, Washington, D.C., U.S.A. A copy of the complete list will be sent on application.

Our Astronomical Column.

CONJUNCTION OF MARS WITH A STAR.—Mr. W. F. Denning writes :—The planet Mars will make a very near approach to the star β Scorpii (third magnitude) on the night of February 22. Mars will rise at 1.35 a.m. on the morning of February 23, and the planet may be observed if the sky is clear from that time until sunrise, with the star lying slightly to the north-west. It will be interesting to watch the gradual approach of the two objects from the present time up to the date of conjunction, and then to follow them as the distance between them becomes greater from night to night. On February 10 Mars will be 7° west of the star, and on March 7 7° east, its motion carrying the planet daily about half a degree eastward. The near approach of the two objects may be followed with the unaided eye, though the view will be much improved by means of a field-glass or telescope.

COMET NOTES.—H. Mahnkopf gives the following search ephemeris for comet 1916 I (Taylor), due at perihelion about 1922 June 13. It is for Greenwich midnight. Magnitude about 15 :

		R.A. h. m.	S. Decl. ° ′			R.A. h. m.	S. Decl. ° ′
Feb.	10	1 26·1	4 21	Feb.	26	1 54·5	0 5 N. Decl.
	14	1 32·8	3 18				
	18	1 39·8	2 14	Mar.	2	2 2·2	1 0
	22	1 47·0	1 10		6	2 10·2	2 6

Log r, log Δ, February 2, 0·303, 0·357; February 18, 0·284, 0·368; March 6, 0·264, 0·376.

A new very faint comet, 1922*a*, was discovered by Mr. W. Reid at the Cape on January 20; its place on January 24d. 9h. 34·3m. G.M.T. was R.A. 9h. 54m. 30·9s., S. decl. 33° 46′ 31″; daily motion *minus* 56s., south 7′.

INTERNAL MOTIONS IN THE SPIRAL NEBULA M 81.—The *Astrophysical Journal* for December contains Mr. van Maanen's discussion of the internal motions in this spiral deduced from two photographs taken with the 60-in. reflector at Mount Wilson at an interval of eleven years. The results of an earlier discussion based on a six-year interval are in all cases confirmed in sign, but the numerical values are considerably increased. Taking 0·001″ as unit, the mean of 104 points measured gives the rotational component as 38, the radial component outward as 13, the stream motion (along the whorls of the spiral) as 39, and that transverse to the whorls as 7. The indicated periods of rotation about the centre for four spirals are :—For M 101, 85,000 years; for M 33, 160,000 years; for M 51 (Canes Venatici), 45,000 years; and for M 81 (Ursa Major), 58,000 years. These figures are all much smaller than any possible period of rotation of the Galaxy, and seem to indicate an entirely different character for these objects. The only possible way of avoiding this issue would seem to be the adoption of Dr. Jeans's suggestion that the Galaxy was originally much more compressed than it is now, so that its period of rotation would have been shorter.

It is, however, emphasised, that the motion is not pure rotation, but outward along the spiral arms. The figures given have been corrected for foreshortening, the plane of the nebula being inclined 49° to the celestial sphere. The proper motion of the nebula referred to fourteen faint comparison stars is +0·014″ per annum in R.A. (great circle) and −0·005″ in dec.

Sixty-three stars in this region, of about the ninth magnitude, have a mean motion of −0·0014″ in R.A. and −0·0047″ in dec. (Greenwich Astrog. Cat., vol. 4). It is therefore probable that the greater part of the motion of the nebula in R.A. belongs to it, and not to the stars.

The author considers that the character of internal motion established in several spiral nebulæ supports Dr. Jeans's theory that the spiral form is due to tidal action arising from the approach of two nebulous masses.

Research Items.

CULTURE OF ANCIENT PERU.—One difficulty in the sequence-dating of the textiles of ancient Peru, which, with the pottery, are the best evidence of the pre-Spanish culture, is that Peruvian looms are very scarce in museums, and, when found, are usually incomplete, and almost invariably undatable, even in accordance with the sequence-dating at present accepted. In *Man* for December last, Mr. T. A. Joice reports that a vase presented to the British Museum in 1913 by Sir Herbert Gibson shows a definite and indisputable correlation between a certain type of loom and a certain type of pottery. This vase, which definitely belongs to the Proto-Chimu period, that is to say, the earliest period of any sort of developed culture on the northern Peruvian coast, presents a scene showing the weaving of tapestry on a loom without a treadle, and associated with pottery also belonging to the same early period. It does not prove, but it suggests, that the principle of the treadle was unknown to the Proto-Chimu weaver; if so, then the treadle belongs to a comparatively late period of South American culture. Much further inquiry is needed before the significance of this discovery can be used as a proof of sequence-dating.

PARASITIC WORMS FROM ANIMALS.—Dr. G. A. MacCallum gives (*Zoopathologica*, vol. 1, No. 6, 1921, published by the New York Zoological Society) an account of parasitic worms from animals in the New York Zoological Park and Aquarium, with a figure and brief description of each species; some of the descriptions, however, are too brief and not altogether serviceable. A new species of Heronimus is viviparous—the uterus contains miracidia. The author, who is pathologist to the New York Zoological Society, deserves commendation for his zeal in searching for and recording the parasites of the animals which pass through his hands.

INDIAN MARINE POLYCHÆTA.—A further instalment of the reports on the fauna of the Chilka Lake has been published in vol. 5, No. 8, of the Memoirs of the Indian Museum. This part contains a systematic account of the Polychæta by Mr. R. Southern, who also reports on collections from the Gangetic delta and from the Cochin backwater. The majority of the species live either in brackish water of low salinity or are euryhaline, *i.e.* can live in water the salinity of which varies between wide limits. Euryhaline forms appear to be relatively more numerous in India than in Europe, and Mr. Southern suggests this adaptation may be correlated with the sharp division of the climate into wet and dry seasons, one result of which is that the littoral region, especially in bays and estuaries, is periodically flooded with water of low salinity. Mr. Southern points out that there are so few records of Indian littoral marine Polychæta that there is no basis for instituting a comparison between the Polychæta of the lake and those of the seashore. Of the twenty species from the lake, eighteen are described as new. The collection has a typically marine facies, and probably represents an impoverished remnant of the Polychæta which inhabited the open bay before the present lake was almost completely cut off from the Bay of Bengal by the spit of sand which forms its eastern boundary.

SELECTION EXPERIMENTS WITH CLADOCERA.—Dr. A. M. Banta has published (Carnegie Institution of Washington, Publication No. 305) the results of extensive selection experiments with Cladocera. He chose responsiveness to light, as measured by reaction-time, and selected simultaneously in different strains for increase and decrease of this physiological character. Pure lines of Simocephalus and Daphnia have been bred parthenogenetically for more than eight years. In such parthenogenetic eggs there is only one maturation division, and in the absence of a reduction division there is apparently no opportunity for segregation or recombination of genetic materials. In the course of the experiments a great deal has been learned about the biology of the organisms, and their reactions to varying environments. Selection experiments produced a significant difference between plus and minus strains in only one of fifteen distinct lines studied, although there were indications of an effect in several others. The nature of this effect of selection is discussed at length. The change appears to have been a gradual one, which can scarcely be accounted for by the occurrence of a few marked mutations. The two strains obtained differed only in reactiveness to light, and this difference was maintained for at least 112 generations after selection ceased. These results would appear to limit the universal application of Johannsen's law that selection within the pure line is of no avail in modifying its genetic properties.

FACTORS OF GROWTH AND MULTIPLICATION.—Two recent papers (*Biochemical Journal*, vol. 15, pp. 595–612) by Prof. Brailsford Robertson contain some important observations on the mutual influence of individual organisms in promoting growth and multiplication. Working with the ciliated protozoon Enchelys, he shows that it feeds mainly upon bacteria, and that its rate of growth is much influenced by some soluble thermostable substance which arises from them. During the early stages of development of a culture the multiplication rate increases progressively with each division, and partakes of the autocatalytic character which has been previously described in various animals and plants from man downwards. This has nothing immediately to do with its food, but depends on the contiguity of the infusoria, and in a special series of experiments Prof. Robertson shows that a culture started with two individuals will produce, not twice, but about five times as many descendants in twenty-four hours as a culture started with a single Enchelys. Conjugation was never seen under the conditions of the experiments, and the effect appears to be due to some accelerator substance produced by the protozoa in the presence of the accelerator arising from the bacteria. It would be of much interest to determine whether the same phenomena accompany the growth of an organism feeding only on soluble substances such as the bacteria-free race of the ciliate Colpidium described by Dr. Peters (*Journal of Physiology*, vol. 55, p. 1), where the conditions are much simpler than those examined by Prof. Robertson.

MIXED PRODUCTS OF GRANITIC INTRUSION.—Mr. Charles H. Clapp, in his study of "The Geology of the Igneous Rocks of Essex County, Massachusetts" (U.S. Geol. Survey, Bull. 704, 1921) makes a noteworthy claim for regarding several unusual types of rock as products of the intermingling of an invading granite with material derived from the cover into which it penetrates. He recognises a gravi-

tational differentiation during crystallisation as accounting for the production of an underlying gabbro-diorite and an overlying granodiorite from an original basaltic magma; but granite afterwards intruded into the more basic of these masses, and has produced a number of "hybrid" rocks. The gabbro-diorite was cold at the time of this intrusion, and thus lent itself to extensive shattering, and the detached blocks have been melted up on an extensive scale. From analogy with undoubted composite products, the author considers that the well-known "essexite" of Salem Neck, consisting of the minerals of gabbro side by side with species more rich in sodium, has arisen from similar intermingling and recrystallisation.

PETROLEUM RESOURCES OF CALIFORNIA.—The geology and petroleum resources of North-Western Kern County, California, have been dealt with in a bulletin of the United States Geological Survey (No. 721) recently to hand. New information concerning this interesting region is always welcome, and the oil prospects of this part of the San Joaquin Valley, with its bordering hilly country, would seem to be decidedly favourable. The area described embraces the already developed fields of Belridge and Lost Hills, which produce oil from Miocene beds, the structures being essentially anticlinal; prospective areas are suggested in the Temblor Valley (hill region) and in the San Joaquin Valley itself, though in the latter instance "wild-cat" drilling will probably have to be resorted to on account of the thick covering of alluvium masking the solid geology. The detailed work of the California State Mining Bureau on the study of underground structural conditions as affecting development and production of existing fields is now in progress, and as results accrue some further valuable information should eventuate which may have a far-reaching influence on the progress of development of the untested areas here described.

DAY AND NIGHT DISTRIBUTION OF RAINFALL.—The differences between summer daytime and night-time precipitation in the United States are the subject of a communication by Mr. W. J. Humphreys in the *Monthly Weather Review* for June last. A chart based on about 175 Weather Bureau stations is given showing the percentage of average precipitation that occurs at night, 8 p.m. to 8 a.m., for the season April to September over the United States. The various percentages of the twenty-four hours' rainfall that occur at night in different portions of the United States during the summer are shown by curves for each 5 per cent. from 25 to 65. Referring to the inequalities between the day and night distribution of summer rainfall, and accepting this as due to the distribution of thunderstorms, it is stated to be consequently in substantially the same proportion as is the strong vertical convection of tolerably humid air. The map shows very markedly that in the south-east portion of the United States the summer rains are most frequent during the day, and the author states that most of these rains are due to heat thunderstorms resulting from convection induced by strong surface heating. The excess of rains in the daytime in some other parts of the United States is similarly explained. Consideration is also given to the regions in which the summer rain is most abundant by night, and various causes are put forward. The movement of cool anticyclones is asserted as exercising considerable influence in the main by "breaking" the "hot waves" of the Mississippi, Missouri, and Ohio valleys, thunderstorms being developed. In parts the cooler air is said to overflow the warmer, and thereby establishes that convectional instability essential to the genesis of the thunderstorms. In this way the author is of opinion that in parts at least the thunderstorm is more frequent and the summer precipitation more abundant during the night than during the daytime.

GRAVITY OBSERVATIONS.—The United States Coast and Geodetic Survey has issued as a Special Publication (No. 69) a report by Mr. Clarence H. Swick on "Modern Methods for Measuring the Intensity of Gravity." The instruments and methods, which are dealt with in usefully great detail, are those employed by the Survey for their gravity expeditions. The determinations are made with half-second (quarter-metre) pendulums, which in 1890 replaced the metre pendulums formerly used. This step marked an epoch in the gravity work of the Survey; the change not only greatly reduced the cost of transport and of preparing the stations, but also increased the accuracy so much as to render the observations prior to 1890 obsolete as material for investigations into the theories of gravity and isostasy. The observations made are relative, the time of oscillation of the pendulums measured at each station being compared with the corresponding times at the pendulum-room of the Survey in Washington, where the absolute value of gravity has been carefully determined. The pendulums are swung at low pressure in an airtight case, and corrections are applied for temperature, pressure, arc, flexure, etc. An interferometer is used to determine the flexure of the pendulum support. Up to 1920 the number of gravity stations "occupied" with the modern instruments was 276, of which 230 were established since 1909. In 1920 a further important instrumental improvement was introduced by the construction of pendulums with invar instead of bronze; the reduction of the temperature-coefficient to one-fifteenth its former value greatly simplifies the observing conditions. Another advance is the use of wireless signals for determining the chronometer rates. The report closes with an interesting appendix instructing the observer in the art of justifying his work to the lay citizen of the United States, by explaining briefly the purpose and value of gravity observations.

TESTS OF WELDLESS STEEL TUBING.—A paper by Mr. W. W. Hackett read before the Institution of Automobile Engineers gives an account of a large number of alternating stress experiments on weldless steel tubing such as is used in motor-cycles and on components, *e.g.* motor-cycle forks. These experiments enable the author to make several suggestions for improvements in constructional details. He also makes out a case for the use of tubes made from steel containing a higher percentage of carbon than has formerly been accepted. From experiments carried out during the war period on aeroplane tubing it was found that excellent results could be obtained by using 0·5 per cent. carbon steel tubing, giving in the bright or blued state a yield of 40 to 45 tons per sq. in. and an ultimate stress of 45 to 50 tons per sq. in.; when annealed, the steel should give 23 tons per sq. in. yield and 35 tons per sq. in. ultimate. The author has found that in the motor trade there was no inclination to use these high-carbon steel tubes, for it was feared that they would be brittle. The author's tests were carried out on joints brazed in his shops in a commercial manner, and show consistently that the 0·5 per cent. carbon steel has always been superior to 0·3 per cent. steel, and that the latter has always been better than 0·15 per cent. steel.

Botany at the British Association.

(a) *The Oldest Land Flora.*

THE Edinburgh meeting will be long remembered among botanists as that at which a consideration of the oldest land flora, namely, that of the Rhynie Chert beds, took a prominent place. This subject bulked largely in the president's address; it formed the basis of a series of papers presented to a joint meeting of the Sections of Botany and Geology, and it was fully illustrated by a marvellous series of microscope preparations demonstrated by Dr. Lang and Dr. Kidston in the laboratory of the Royal Gardens.

The Rhynie Chert beds of Devonian age contain identifiable remains of algæ, fungi, and bacteria, but the chief interest attaches to the forms which, though classified as vascular cryptogams, present in many respects little more differentiation than a seaweed, and, indeed, show many resemblances to some of the higher seaweeds of the present day. They are leafless and rootless forms bearing sporangia scarcely differentiated from the vegetative portion of the axis. Nevertheless, they are undoubted land plants, as shown by "the presence of water-conducting tissue and stomata and by manifestly air-borne spores." The function of roots was apparently performed either by root-hairs or by special branches of the rhizome. The spores were usually borne on terminal sporangia which were evidently fertile branch endings.

Dr. Lang described the plant remains found in these beds, and more particularly those of the vascular forms constituting the family of the Rhyniaceæ, viz. a filamentous alga probably allied to the modern blue-greens; another form which appears to be connected with the Characeæ; and a fragment of the supposed seaweed Hematophyton, showing for the first time its external characteristics, together with several members of the fungi. The Rhyniaceæ include *Rhynia major* and *R. Gwynne Vaughanii*, *Hornea Lignieri*, and *Asteromyelon Mackei*, the latter with its small investing leaves being the most complex. The vascular tissue is of a very simple order, the water-conducting elements being spirally thickened and the phloëm elements large and thin-walled with oblique ends. The latter tissue is continuous with a central column in the sporangial heads, recalling the columella of the mosses.

The vertical distribution of the various forms in the peaty beds of the chert indicates that petrifaction occurred in the lower parts of the bed while plants were still growing on the higher parts. Probably the irritating action of vapours from a volcanic fumarole in the neighbourhood caused the necroses and swellings observed on the plants.

Dr. Horne stated that recent work pointed to the Continental origin of the deposit and indicated that the Rhynie plants actually grew where they were preserved.

Dr. Kidston concluded that if Asteroxylon were flattened out and preserved as an impression it would resemble very closely the middle Devonian species called *Thyrsophyton Milleri*, and he believed that the fact afforded some indication of the Middle Old Red Sandstone age of the Rhynie bed.

Several of the later speakers directed their remarks more to the theoretical importance of these discoveries and their relation to modern theories of evolution. This had been dwelt upon at some length by Dr. Scott, who emphasised the present-day lack of unanimity with regard to the nature and extent of variation as the material upon which evolution works. Dr. Lotsy pointed out the dilemma summed up in the phrases "like breeds like" and "like may breed unlike." He thought that the great phyla were widely separated, and had possibly separate origins, and while for *classes* of plants, as generally considered by the palæobotanist, the first phrase emphasised the truth, when the smaller units or *species* were considered it was clear that frequently "like breeds unlike."

(b) *Forestry and its Problems.*

A whole day was devoted to forestry, the Botany and Zoology Sections holding joint session during the part of the programme concerned with insect problems. Mr. J. Sutherland, Assistant Commissioner for Forestry in Scotland, gave a very complete account of the past and present position of forestry in Great Britain, and enumerated in an exhaustive manner the advantages of a consistent State policy of extended afforestation. The new forestry policy now provides that the 3,000,000 acres of 1914 shall be increased during the present century by 1,750,000 acres of coniferous trees, and that two-thirds of the programme shall be completed during the next forty years. This programme cannot, however, be put into actual effect without the co-operation of landowners and State. A large proportion of money expended in forestry becomes available as wages, and consequently it provides a great stabilising influence in keeping workers in rural areas. He quoted the increase of population from 69,000 to 289,000 which has taken place in the Landes Department of France as a result of afforestation. He further indicated the immense importance of forests in time of war.

Prof. Stebbing traced the history of Indian forestry since 1850, when a committee of the British Association was set up at the instigation of Dr. Cleghorn "to consider the probable effects from an economic and physical point of view of the destruction of tropical forests in India." The result of the efficient management of the Indian Forest Department shortly afterwards set up has been a plentiful supply of forest products and a considerable annual revenue.

Dr. Borthwick and Prof. Henry both urged the importance of selecting the varieties most suitable to the climatic conditions found in the country, and expressed the opinion that the State might reasonably undertake the protection of forests from devastating fires.

(c) *Quantitative Analysis of Plant Growth.*

The discussion on "The Quantitative Analysis of Plant Growth" was introduced by Dr. Lawrence Balls, who illustrated his points largely by reference to the cotton plant. The problem of plant growth is a physico-chemical one, and therefore must be explored by quantitative methods and checked by statistical treatment. Dr. Balls hinted at the possibility of elucidating geometrical constructions in the cell parallel to those established by Dr. Church for external form. This would furnish developments akin to those which the study of atomic structure has brought to the physicists. The recent advance in physiological thought as well as in actual technique gives us reason to expect rapid increase of knowledge even in so intricate a problem as that of growth.

Contributions to this discussion were made by Messrs. Briggs, Kidd, and West on "The Quantitative Study of the Growth of *Helianthus annuus*," and by Prof. Priestley and Miss Evershed on "A Quantitative Study of the Growth of Roots."

(d) Some other Papers.

The papers delivered before the Section dealt with a diversity of subjects. Mr. Matthews contributed a paper on "The Distribution of Certain Elements of the British Flora." These show peculiarities of geographical distribution in Great Britain which, when studied cartographically and compared with their occurrence on the Continent, seem to furnish additional evidence in favour of the views of some of the earlier students of the problems of plant repopulation after the Glacial period. The Palæarctic flora of post-Glacial times is now confined to the highest Scotch mountains, and has been replaced elsewhere in Great Britain by a temperate flora from the Continent.

Mr. Hamshaw Thomas gave an account of his investigations into the structure of some angiospermous fruits discovered in the Middle Jurassic rocks of Yorkshire. Each fruit, which shows traces of what may be a stigma, contains about eight small seeds clothed with a double fibrous integument. While the specimens are obviously Angiosperms in that the seeds are developed inside a fruit-wall, the seeds themselves show resemblances to some of the primitive Gymnosperms or Pteridosperms, and may yet throw light on the origin of the flowering plants, that difficult problem referred to by Charles Darwin as an "abominable mystery."

Prof. McLean Thompson, in his account of the floral development of the cannon-ball tree and its bearing on the floral morphology of the Myrtales, put forward the view that the gigantism of cells and sterility of pollen found associated with the floral lopsidedness had arisen as a mutation.

Dr. Batten gave an account of the organs of attachment in Polysiphonia; Miss Saunders put forward a theory of the morphological nature of the Dicotyledon shoot, viz. that each internode consists of an axial core clothed with a skin of the extended bases of the leaves immediately above.

Major Hurst's paper on "The Origin of the Moss Rose" raised many interesting problems, particularly in view of the recent cytological work on this genus. Täckholm and Blackburn and Harrison ascribe hybridity as the cause of the irregular distribution of unpaired chromosomes found to be associated with abortive pollen. Darwin's view that the moss rose is a bud variation of the familiar cabbage rose (*Rosa centifolia*) seems to be confirmed. The moss rose would appear to have arisen as a mutation, and to have been in cultivation only since the end of the seventeenth century, while the cabbage rose has been cultivated for more than two thousand years. In conclusion, Major Hurst expressed his views thus:—"In terms of the recent development of the chromosome theory of heredity it may be said that the *moss* mutation arose through the presence of an additional factor in a single locus of a single chromosome of a somatic cell."

"The Behaviour of the Somatic Nucleus in Development" formed the subject of a paper by Prof. McLean, who described briefly the discovery of the binucleate phase, and discussed its significance in relation to senescence, normal histogenesis, and somatic segregation of characters.

The eminent Dutch botanist, Dr. J. P. Lotsy, furnished a paper on "Factors of Evolution." He deprecated the custom of tracing the course of evolution through the genealogy of species which exist only as a conception. Nature produces individuals, some of which interbreed freely and may be termed "syngameons," and these have been mistaken for species. The course of evolution should rather be traced by the genealogy of the gametes, and the questions of fundamental importance are: Can a gamete vary by itself without loss of chromosomes? And are such variants transmissible? The only transmissible changes proved to occur are the results of crossing, and they transgress the limits of the Linnean species. Not enough attention has yet been given to the crosses between gametes differing in the number of chromosomes and the consequent irregular distribution which causes changes that may even simulate Mendelian segregation.

E. N. M. T.

Mont Blanc Meteorological Observations.

THE seventh volume of Annales de l'Observatoire Météorologique Physique et Glaciaire du Mont Blanc (altitude 4350 metres) has now been published, under the direction of M. J. Vallot, founder and director of the observatory, following the sixth volume which was published in 1905 (tome 7, Paris, G. Steinheil, éditeur, 1917). It records the death of Janssen in 1908 and the transformation of the provisional society of his observatory at the summit (4808 metres) into a *société définitive* which placed that observatory also under the direction of M. Vallot. Both were utilised in 1908, but that on the summit became not merely uninhabitable, but dangerous, and it was therefore demolished in 1909. Since that date work has been carried on only at M. Valot's observatory, which he had placed at the disposal of the society. The volume referred to deals only with the work accomplished before the union of the observatories. The researches made at the cost of the society have been published *en résumé* in the *Comptes rendus*; those which cannot find a place there, as well as reports *in extenso*, will appear in later volumes of the Annales.

The publication of the seventh volume has been delayed by M. Vallot's ill-health and by the war. It contains two papers by M. Henri Vallot, one on some modern maps of the massif of Mont Blanc, the other on the progress made with the map on the scale of 1 : 20,000 by the brothers Vallot; also some "Notes expérimentales sur le mode d'action des cures d'altitude," by M. G. Kuss, of the Sanatorium d'Angicourt. The greater part of the volume is occupied by an elaborate discussion by M. J. Vallot of the barometric calculation of altitudes, particularly on the correction for the diurnal variation of the temperature of the air, which with the ordinary formula may cause differences of as much as a hundred metres in the estimation of a difference of level of 2800 metres. The discussion leads up to the suggestion for correcting the value of the difference of height obtained by the "classical" tables by a correction based on the mean temperature of the day for the base station, on a temperature for the upper station obtained from the base temperature by subtracting one degree for every 154·5 metres, and on a special correction for diurnal variation of temperature based on a month's observations in 1887 of Mont Blanc with reference to Geneva. Suitable winter values have still be to be ascertained. Examples of the application of the method are given and a defence of the procedure in view of recent work on the subject, which is of practical importance for meteorological maps as well as for Alpinists. It is, however, full

of difficulty in consequence of the changing thermal character of the air column between stations at different levels. Perhaps the diurnal variation of pressure affords the best line of approach. A proper formula regularly applied to observations at the top ought to give a diurnal variation of pressure at the base comparable with that obtained from direct observations at the bottom. What M. Vallot calls the "classical" method would certainly not do so. There is an interesting paper by Buchan on experiences at Ben Nevis which bears upon the subject.

NAPIER SHAW.

Sponge-spicules.

PROF. DENDY'S memoir (in *Acta Zoologica*, 1921, pp. 95–152, 50 figures) on the evolution of the tetraxonid sponge-spicule will appeal equally to those interested in problems of evolution or in sponge-spicules from the point of view of form and of their great taxonomic value. It is not only possible to arrange these spicules in an apparently phylogenetic series with a degree of completeness which is perhaps unparalleled in any other group of the animal kingdom, but the structure of the spicule itself, and the different forms which it assumes, are relatively so simple and definite that the problem of accounting for them in terms of physiological or physico-chemical processes seems far more capable of solution than similar problems among the higher animals. Prof. Dendy describes the forms of spicules of the primitive Plakinidæ, showing that they can all be derived from the tetract, and discusses concisely the evolution of megascleres (tetract, diact, and monact) and microscleres (polyact and diact) and the development of spines leading to the pseudopolyact forms. He also puts forward provisional conclusions as to the development of a spicule. Two kinds of cells—initial cells and silicoblasts—are concerned in spicule formation; the former cells secrete the organic material (spiculin) which forms the axial thread or protorhabd around which the silicoblasts collect and deposit silica. A growing spicule may come to be completely enveloped by a silicoblast, which has accordingly been regarded by nearly all observers as the mother-cell in which the spicule originates. In many cases the number of initial cells increases by cell-division as the spicule grows, and the development of spines and other outgrowths on the primary spicule is effected by the establishment of secondary growing points at the places where spiculin is deposited by initial cells. The causes which determine the form of the spicule are briefly considered, and though some of the characters of spicules are adaptive the vast majority are non-adaptive; for adaptation in spicule-form, where such exists, no satisfactory explanation seems to be forthcoming. To say that some "instinct" directs an amœboid silicoblast containing a spicule towards the gemmule or towards the surface of a sponge is, as the author remarks, not an explanation.

Iron Production in India.

THE *Journal of Indian Industries and Labour* for November last (vol. 1, part 4) contains, amongst other interesting matter, a summary of the present position of iron production in India which deserves the serious attention of all engaged in iron and steel industries. The large and rapidly developing coalfields, the enormous deposits of high-grade hæmatite iron ore, ample supplies of limestone and of refractory materials, abundant and low-priced labour, all combine to place India in the position of a very serious potential competitor in the world's markets. Two firms are producing iron to-day—the Bengal Iron Co., with works at Kulti, on the Barakar River, comprising five blast furnaces, each with an output of 450 tons of pig-iron per twenty-four hours, and the Tata Iron and Steel Works at Jamshedpur, in Singbhum, with three blast furnaces having a capacity of 900 tons of pig-iron per diem; the latter firm also possesses a steel works with seven furnaces capable of producing 17,500 tons of ingots per month, whilst extensions to both the blast-furnace plant and the steel works are in course of erection and a plate-mill has just been completed. A number of new works are being projected; the Indian Iron and Steel Co. is building blast furnaces for an output of 600 tons of pig-iron per diem at Hirapur, the Eastern Iron Co. is building blast furnaces close to the Jharia coalfield, whilst the United Steel Corporation of Asia is to establish works producing both iron and steel at Manoharpur; this last works intends to use coal from the new Karanpura coalfield. The Kirtyanand Iron and Steel Works, near Sitarampur, does not at present propose to make pig-iron, but is confining itself to the production of iron and steel castings. In connection with the Tata works a group of subsidiary concerns have been, and are being, formed at Jamshedpur to work up the iron and steel produced by these works; they comprise the Calcutta Monifieth Works (for producing machinery for jute manufacture), Enamelled Ironware, Ltd., the Tinplate Co. of India (which will supply the Burma Oil Co. and other Indian oil companies), the Agricultural Implements Co., the Indian Steel Wire Products, Ltd., the Enfield Co., and the Hume Pipe and Construction Co.

University and Educational Intelligence.

CAMBRIDGE.—The governing body of Emmanuel College offers to a research student commencing residence at the college in October next a studentship of the annual value of 150*l*., which shall be tenable for two years and renewable, but only in exceptional circumstances, for a third year. The studentship will be awarded at the beginning of October, and applications should be sent so as to reach the Master of Emmanuel (the Master's Lodge, Emmanuel College, Cambridge) not later than September 18.

The following grants from the Gordon-Wigan Fund are reported:—For plant-breeding experiments, 50*l*.; for museum cases, 35*l*.; for apparatus for studying marine organisms, 35*l*.; for the preparation of rock slices, 20*l*.; and for the preparation of sections of fossil plants, 10*l*.

The annual report of the General Board of Studies for the academic year 1920–21 refers to a distinct relief in the congestion in the scientific departments on account of the completion of new buildings. Fresh accommodation for chemistry and engineering has improved the position of affairs in those departments, and is easing it also in other departments. Several laboratories are faced with serious deficits on the year's working, and complaints are made of the effect of the 100 per cent. tax charged on certain things only procurable abroad. Valuable loans are announced of sound-ranging apparatus from the War Office and of radium from the Medical Research Council.

LONDON.—The three following courses of free public lectures are announced:—"The Crystallisation of Metals," by Col. N. T. Belaiew, at the Royal School of Mines, South Kensington, S.W.7, on Tuesdays, February 21 and 28 and March 7 and 14, at 5.30; "Some Recent Developments in Pharmacology," by Dr. H. H. Dale, at the London (Royal Free Hospital) School of Medicine for Women, Hunter Street, W.C.1, on Wednesdays, February 22 and March 1, 8, and 15, at 5; and "Certain Aspects of Fresh-water Algal Biology," by Prof. F. E. Fritch, at the East London College, on Wednesdays, February 15 and 22 and March 1, 8, 15, and 22, at 4.

OXFORD.—An examination for a natural science scholarship at Keble College is to be held on March 14. The annual value is 80*l.*, with 20*l.* extra for laboratory fees. Applications should be made to Dr. Hatchett Jackson, Keble College, Oxford.

PROF. T. MATHER is retiring from the chair of electrical engineering in the City and Guilds (Engineering) College at the end of the present session after more than thirty-seven years' service in the college, first as assistant to the late Prof. Ayrton and then as his successor.

THE Association of Heads of Departments in Pure and Applied Science in Technical Institutions has forwarded a letter to the London County Council Education Committee directing attention to some anomalies arising from the revised scales of salaries following on the Burnham Report. It is pointed out that on the new scales the salaries of an assistant will rise automatically to a maximum which approximates to that of the head of a department, a state of affairs which gives an assistant little incentive to work for higher appointments involving additional responsibilities and qualifications.

A PAMPHLET entitled, "The Handicap," has been issued by the University of Glasgow as an appeal for support in an attempt to develop what may be termed the social, as opposed to the academic, side of university training in Glasgow. Benefactors in the past have contributed generously for the provision of professorships, scholarships, and laboratories—as much as 180,000*l.* has been given for such purposes during the past five years—but few have thought of providing for the well-being of the student outside the classroom. A notable exception was Dr. John M'Intyre, who, in 1889, presented a Students' Union to the university, but in spite of extensions, this building cannot accommodate more than 500 of the 3300 men students now in Glasgow. Another step towards the provision of a liberal education might be achieved by an extension of the hostel system in the hope of capturing some of the spirit of the older residential universities. At the present time hostel accommodation can be found for 40 men and 50 women, while 1016 men and 310 women students have to find such lodgings as are available in the city. It is for providing hostels and contributing in other ways to the welfare of the student that the appeal is being launched; grants and gifts amounting to some 40,000*l.* have already been promised, but it is considered that 150,000*l.* is really required. Contributions, which should be forwarded to Dr. A. E. Clapperton, secretary of the University Court, Glasgow, are therefore earnestly solicited, and it is hoped that a generous response will be forthcoming, particularly from the graduates and alumni of the university.

Calendar of Industrial Pioneers.

February 10, 1886. Edward Williams died.—First forge and mill master at the Dowlais Iron Works, South Wales, where under Menelaus he rolled the first steel rails from an ingot supplied by Bessemer, Williams was afterwards connected with the Cleveland iron trade at Middlesbrough, and for ten years was manager to Bölckow and Vaughan. He assisted in founding the Iron and Steel Institute, and in 1879–81 served as president.

February 10, 1912. Louis Delaunay Belleville died.—From the Ecole Polytechnique and the Ecole Navale Delaunay Belleville in 1867 entered the Belleville Engineering Works in Paris, and there brought out his well-known water-tube boiler for steamships. First fitted in French despatch vessels and cruisers it was afterwards extensively adopted in the French, Russian, and British Navies, allowing of the use of very high steam-pressures. Its use in our own Navy led to a vigorous controversy, and the Belleville boiler has since been superseded by others of simpler construction.

February 11, 1907. Léon Serpollet died.—A great French automobilist and a pioneer of the modern steam car, Serpollet brought out an improved form of flash boiler which in 1887 he used in a steam-propelled tri-car. Four years later he was the first to obtain authority to run his cars in the streets of Paris. His statue stands in the Rue Brunel.

February 12, 1874. Sir Francis Pettit Smith died.—The most prominent among the many inventors of screw propellers, Smith began life as a farmer. His patent was taken out in May, 1836, and during the next two years his screw was tried in the *Francis Smith* and the *Archimedes*. The success of the latter led Brunel to adopt screw propulsion for his trans-Atlantic liner, the *Great Britain*, while the Admiralty ordered the building of the H.M.S. *Rattler*, the first screw-driven man-o'-war. In 1845 the screw was adopted for all war-vessels. Smith remained Adviser to the Admiralty for a few years, and from 1860 until his death was curator of the Patent Office Museum.

February 13, 1824. Pierre Louis Guinaud died.—An improver of the manufacture of optical glass, Guinaud was a Swiss clockmaker. He was the first on the Continent to make flint-glass discs suitable for achromatic telescopes, and his success led to his co-operation for some years with Fraunhofer at Munich. Guinaud's methods were communicated by his son to Bontemps, who about 1848 was engaged by Chance, of Birmingham.

February 13, 1913. John Fritz died.—One of the great pioneers of the American steel industry, Fritz was born in Pennsylvania in 1822, his father being a native of Germany. He was intimately connected with the introduction of the Bessemer process into America, in 1857 erected the first three-high mill ever seen, and three years later became general superintendent of the Bethlehem Company. The John Fritz medal of the United Engineering Societies was founded in 1902.

February 14, 1831. Henry Maudslay died.—The founder of the firm of Maudslay, Sons, and Field, which during last century held a pre-eminent place among the builders of machinery for steamships, Maudslay, after working under Bramah, set up for himself in London, and in 1810 opened the works at Westminster Bridge Road. He patented a "table engine," built some of the earliest marine engines, constructed measuring machines, and improved machine tools. Many well-known mechanical engineers were trained in his shops. E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 2.—Sir Charles Sherrington, president, in the chair.—C. **Shearer**: The oxidation processes of the echinoderm egg during fertilisation. The oxygen consumption and the carbon dioxide output of the eggs of the sea-urchin *E. microtuberculatus* during fertilisation have been measured by means of a special form of the Barcroft differential manometer. An immediate consumption of oxygen and a corresponding output of carbon dioxide take place on the sperm being added to the eggs. At the end of one minute this increase is equivalent to a rise in the metabolic rate of the egg of more than 8000 per cent. Sections of fixed material preserved during different intervals of the process of fertilisation show that this is brought about by the contact of the sperm with the external surface of the egg-membrane. The fusion of the male and female pronuclei in the later phases of fertilisation is without any influence on the curve of the oxygen consumption. The dipeptide glutathione is present in both ripe germ-cells of the sea-urchin *E. miliaris*, but one minute after fertilisation it is found in much greater quantity in the egg in reduced form, and evidence shows that it plays a very important, if not the chief, part in the oxidation processes taking place.—J. **Schmidt**: The breeding-places of the eel. The common or fresh-water eel (*Anguilla anguilla* or *A. vulgaris*) of Europe has only one breeding area, as determined by the distribution of the larvæ, situated in the western Atlantic, south-east of Bermuda. The larvæ are pelagic, and are carried to the east and north-east by the Atlantic current; their growth and the metamorphosis into the "elver," or young eel, are described; the elvers are three years old. The breeding area of the American eel (*A. chrysypa*) is south-west of that of the European eel, but overlaps it; in the American eel growth of the larvæ is much more rapid than in the European species, and the elvers are only one year old. This explains why the European eel is not found in American rivers or the American eel in Europe; if larvæ of the American eel are carried eastwards, the metamorphosis takes place in the middle of the Atlantic; if larvæ of the European eel go north or north-west, they reach the American coast two years before the metamorphosis is due.—J. **Gray**: The mechanism of ciliary movement. Pts. 1 and 2. The rate of beat of the cilia on the gills of *Olytilus edulis* can be controlled by adjusting the hydrogen-ion concentration of the cell interior. The amplitude of the beat can be controlled by an alteration in the osmotic pressure of the external medium. The cilium is essentially a bundle of elastic fibres the tension of which varies during the different phases of the beat. The activity of cilia and muscle-cells depends on similar conditions and mechanisms. The normal properties of the cell-membrane are maintained only in the presence of divalent cations. Ciliated cells are permeable to monovalent cations, but not to anions. Ciliary activity may persist when the normal semi-permeable properties of the cell-wall have been destroyed—J. S. **Huxley** and L. T. **Hogben**: Experiments on amphibian metamorphosis and pigment responses in relation to internal secretions. Salamandra and Triton larvæ may be metamorphosed by immersion in a dilute solution of iodine. Metamorphosis is retarded by low temperature; high temperature at first causes increased growth of the gills. Sexually mature Axolotls can be made to undergo rapid metamorphosis by means of a thyroid diet. Metamorphosis is accompanied by exophthalmos, apparently in all Amphibia. Iodine free of organic combination, and fresh glandular substance of the prostate and pituitary anterior lobe, are without effect on the metamorphosis of the Axolotl. Pituitary feeding produces a marked temporary dilatation, followed by excessive contraction of the dermal melanophores in albino Axolotls. Adrenal medulla extract produces, temporarily, complete contraction of the dermal melanophores in the Axolotl. Pineal administration rapidly causes a striking transient contraction of the dermal melanophores in frog tadpoles, but has no effect on the melanophores of the Axolotl. Seven months' thyroid feeding was not accompanied by any noteworthy somatic changes in Necterus.

Royal Meteorological Society, January 18.—Mr. R. H. Hooker, president, in the chair.—R. H. **Hooker**: The weather and the crops in eastern England, 1885–1921. The objects of the inquiry were: (1) To determine by the method of correlation, on the basis of the thirty-five years 1885–1919, which were the critical periods in the growth of farm crops; (2) to ascertain how far each such period was responsible for the actual crops harvested in each year. Wheat is most seriously affected by wet weather at sowing in autumn and winter, while warmth in winter is beneficial. The chief requirement of barley is a cool, dry early summer, whereas for oats the same period should be wet and cool. Turnips need rain about June, but cool weather is even more important; for hay the fundamental necessity is rain in the late spring. A cool summer is more important than rainfall for almost all crops except hay, and even that is the better for cool weather. The requirements of potatoes are practically the opposite of all other crops. For quality of seed, absence of rain, and in some cases warmth, is desirable. One feature strongly emerges, viz. that so far as regards bulk of corn the east of England is too wet (except for oats and beans) and too warm. The worst years, particularly 1893 and 1911, were due to hot, dry summers, and the same feature was the cause of the generally bad crops of 1921, though wheat, which withstands heat and drought well, was a record. As a type of a good all-round year 1902 was selected; it was characterised by prolonged cool weather throughout the spring and summer, accompanied by rain until June, and followed by dry weather. In the east of England 1920 had a cool summer, only partly spoilt by rain in July, and the resultant crops were mostly good. The fifteen years 1895–1910 were mostly a period of good crops, but in the last seven or eight years there have been a succession of very unfavourable weather conditions, notable chiefly for dry, warm springs.

Geological Society, January 18.—Mr. R. D. Oldham, president, in the chair.—A. C. **Seward** and R. E. **Holttum**: Jurassic plants from Ceylon. The plant-impressions are from a shale resting upon Archæan rocks at Tabbowa, in the North-Western Province of Ceylon. These are the first fossil plants recorded from the island. The plant-bearing beds coincide, both in the composition of the flora and in their relation to the older igneous rocks, with those of Madras.—F. S. **Wallis**: The Carboniferous Limestone (Avonian) of Broadfield Down (Somerset). Lithologically and palæontologically the area holds an intermediate position, and forms a link, between the developments of the Bristol and the Mendip districts. A well-marked faunal assemblage is described from the top of S_1. It constitutes a very useful field determination of the datum-line between the S_1 and S_2 sub-zones. *Pustula elegans* (M'Coy) from the S_1 sub-zone and the sub-zones Z_1 and D_1 are recorded for the first time from this area.

Linnean Society, January 19.—Dr. A. Smith Woodward, president, in the chair.—A. B. **Rendle**: Specimen of wood of *Orites excelsa*, R. Br. (family Proteaceæ), one of the Australian silky oaks. The tree, which is a native of northern New South Wales and Queensland, is of unique interest from the deposits of aluminium succinate which occur in cavities of the wood. Aluminium is very rarely found in flowering plants, and only in small traces; but *Orites excelsa* absorbs alumina from the soil in large quantities, as shown by analysis of the ash. Occasionally the amount taken up is excessive, in which case the excess is deposited in cavities as a basic aluminium succinate.—E. Marion **Delf** and Miss M. M. **Michell**: Studies in *Macrocystis pyrifera*. After describing the distribution of the alga, the authors reviewed recent accounts of it. The fertile fronds are completely submerged, smooth, dichotomously branched, and usually borne on special shoots. They bear sori on both sides of the frond. Exceptional cases were described of discontinuous sori occurring in the grooves of fronds with wrinkled surface and borne on the long swimming shoots, and usually without a swim bladder at the base. The zoospores do not appear to have been previously described. Material brought from the shore in the morning and examined in the laboratory in the evening showed swarming zoospores, the next morning swimming actively, and more slowly. The authors consider that the species occurring at the Cape is *Macrocystis angustifolia*, Bory, from its rhizome-like attachments.—J. L. Chaworth **Musters**: The flora of Jan Mayen Island. The flora of Jan Mayen may be divided into four main groups. The floras of the seashore, of the bird-cliffs, of sheltered places in the "tundra," and the mountain flora. The most luxuriant flora, which consists of Taraxacum or Oxyria, grows either under the bird-cliffs or in places where tuff has been re-assorted by water. The limit of flowering plants seems to be about 3000 ft. The total phanerogamic vegetation consists of about forty-three species, all of which are common to both Norway and East Greenland. The origin of the flora presents a very complicated problem. Seeds have probably been brought there on the feet of wading birds which migrate to and from their breeding-grounds in East Greenland. It is highly improbable that Jan Mayen has ever been connected with either Iceland or Greenland. Many plants have probably reached Jan Mayen during very recent years.

PARIS.

Academy of Sciences, January 23.—M. Emile Bertin in the chair.—The president announced the death of M. Camille Jordan, member of the Academy.—D. **Riabouchinski**: Some considerations on the form of the solid and the kinetic energy of the fluid which surrounds it.—A. **Perot**: The variation in the wave-length of the telluric lines. From measurements made in 1914 and in 1920–21 on the atmospheric lines of the B group the wave-length has been found to vary with the height of the sun above the horizon, nearly proportional to the sine of the angle. The hypothesis that the variation of the wave-length as measured was caused by an unsymmetrical widening of the line has been examined and rejected as insufficient to explain the observed facts.—H. **Colin** and Mlle. A. **Chaudun**: The law of action of sucrase: the velocity of hydrolysis and the reaction of the medium. It is well known that the activity of the hydrolysing diastases, especially sucrase, depends on the acidity of the medium. Results are given of the velocities of inversion of cane-sugar by sucrase in solutions of varying alkalinity and acidity. The velocity of inversion attains a maximum for a given acidity, and then falls off with further additions of acid. The addition of acid corresponds with a diminution of the quantity of the enzyme taking part in the reaction. The apparent immobilisation of a part of the diastase is most readily explained by the hypothesis of the formation of a sugar and enzyme complex of a physical nature.—C. F. **Muttelet**: A new method for the detection of coco-fat in butter. The cholesterol and phytosterol are precipitated by digitonin and converted into acetates. The cholesterol acetate melts at 113·6° to 114·2°, the phytosterol acetate at 125°, and mixtures at intermediate temperatures.—P. **Lemoine** and R. **Abrard**: The existence of the Upper Cretaceous in the central cavity of the Channel from the dredgings of the *Pourquoi Pas?* A map of the Channel is given showing the points at which soundings have been taken and distinguishing between spots where Cretaceous deposits have been obtained and spots where the specimens of rocks do not belong to that period. The deposits from the bottom of the central cavity (*fosse centrale*) clearly belonged to the Cretaceous period.—L. **Dussault**: The geology of the province of Sam Neua (Eastern Haut Laos).—R. **Bourret**: The massifs of the north-east of Tonkin.—P. **Russo**: The structure of the Trias of the regions of Meknés, Innaouen (northern Morocco).—S. **Stefanescu**: The practical and phylogenetic importance of the T_4 of the molars of mastodons and elephants.—A. **Allix**: Observations on relief sculpture by ice. An account of the direct study of rock erosion by ice in the large crevasses of Mont Pelvoux. The views of W. D. Johnson and of B. Stracey on rock erosion by ice action are confirmed.—G. **Dubois**: Modifications of the seashore at Sangatte resulting from the storms of December, 1921.—L. **Besson** and H. **Dutheil**: The displacement of rises and falls of the barometer and the direction of movement of cirrus clouds.—R. **Combes**: The formation of anthocyanic pigments. A criticism of recent communications on this subject by Kurt Noack and St. Jonesco. The colouring matters obtained by these authors are regarded as derived from phlobatannins, and not from γ-pyronic pigments: a red coloration with alkalis is not sufficient proof of the presence of an anthocyanic pigment.—G. **Hamel**: The algæ of Rockall. In June, 1921, the Island of Rockall, 240 miles north-west of Ireland, was visited by the *Pourquoi Pas?*, and M. Le Conte and three sailors effected a landing and secured specimens of the algæ. The only brown alga was *Alaria esculenta*; neither Fucus nor Laminaria were noted.—E. **Chemin**: The parasitism of *Sphacelaria bipinnata*.—W. **Koskowski**: The action of histamine on the secretion of the gastric juice in pigeons. Histamine is not destroyed in the blood, and is not transformed in the blood into a substance stimulating the gastric secretion, but it undergoes this transformation in other tissues, principally in the skin.—C. **Levaditi** and S. **Nicolau**: A pure cerebral vaccine: its virulence for man. Vaccine virus, cultivated in the brain of the rabbit for eight months (110 passages), retains its affinity for the human skin. It produces normal vaccination without any complications, and has the advantage over ordinary vaccine of being absolutely pure without the addition of antiseptics.—A. **Donatien** and R. **Bosselut**: Acute contagious encephalitis of the ox. In 1921 a contagious disease caused the death of nine cattle in the neighbourhood of Algiers. Some of the symptoms suggested rabies, but this was proved not to be the case. The disease was transmissible to cattle, rabbits, and guinea-pigs, and was proved to be neither rabies nor Aujesky's disease. It appears to be new, and is being further studied.

Official Publications Received.

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December, 1920. Pp. 29. (Kingston, Jamaica: Department of Agriculture.)

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1920. By Major J. C. Moulton. Pp. ii+21. (Singapore.)

Indian Science Congress. Handbook for the Use of Members attending the Ninth Meeting to be held at Madras from the 30th of January to the 4th of February, 1922. Pp. x+165. (Madras: Capt. Clive Newcomb, Chemical Examiner.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September, 1921. Pp. 20. (Bristol.)

Canada. Department of Mines: Geological Survey. Bulletin No. 33, Geological Series, No. 40. Pp. ii+85+12 plates. Memoir 125, No. 107, Geological Series: Sedimentation of the Fraser River Delta. By W. A. Johnston. Pp. iv+46+maps. Geological Survey, Summary Report, 1920, Part D. Pp. 87+maps. (Ottawa.)

Iowa Geological Survey. Vol. 27: Annual Report, 1916, with accompanying Papers. Pp. viii+568+12 plates+maps. (Des Moines.)

Annuario Publicado pelo Observatorio Nacional do Rio de Janeiro. Paro o Anno de 1922. Anno 38. Pp. xiv+443+plates. (Rio de Janeiro: Ministerio da Agricultura, Industria e Commercio, 1921.)

The Geology of the Country Surrounding Johannesburg: An Explanation of Sheet 52 (Johannesburg). By Dr. E. T. Mellor. Pp. 50. (Pretoria: Geological Survey.) 5*s.*, including map.

Report on the Crocodile River Iron Deposits. By P. A. Wagner. (Memoir No. 17.) Pp. 70+1 plate. Pretoria: Geological Survey.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Conditions and Progress of the Museums for the Year ending December 31, 1920. By W. H. Fox. Pp 62. (Brooklyn, N.Y.)

Smithsonian Institution: United States National Museum. Bulletin 117: The Distribution of Bird Life in the Urubamba Valley of Peru. A Report on the Birds Collected by the Yale University-National Geographic Society's Expeditions. By F. M. Chapman. Pp. 138+9 plates. (Washington: Government Printing Office.)

Cornell University: Agricultural Experiment Station. Memoir 38: The Crane-Flies of New York. Part 2: Biology and Phylogeny. By C. P. Alexander. Pp. 691-1133. Memoir 39: The Genetic Relations of Plant Colours in Maize. By R. A. Emerson. Pp. 156+11 plates. (Ithaca, N.Y.: Cornell University.)

Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. 9: A Maya Grammar, with Bibliography and Appraisement of the Works Noted. By Alfred M. Tozzer. Pp. xvi+301. (Cambridge, Mass.: Peabody Museum.)

Department of the Interior: Bureau of Education. Bulletin, 1920, No. 34: Statistics of Universities, Colleges, and Professional Schools, 1917-18. Prepared by the Statistical Division of the Bureau of Education under the Supervision of H. R. Bonner. Pp. 223. (Washington: Government Printing Office.) 20 cents.

Department of the Interior: United States Geological Survey. Bulletin 706: The Iron Ore Resources of Europe. By Max Roesler. Pp. 152+19 plates. Bulletin 714: Mineral Resources of Alaska. Report of Progress of Investigations in 1919. By A. H. Brooks and others. Pp. 244+7 plates. Bulletin 725-A: Deposits of Chromite in California, Oregon, Washington, and Montana. By J. S. Diller and others. Pp. viii+84+5 plates. Bulletin 725-B: Chrome Ores in Pennsylvania, Maryland, and North Carolina. By E. B. Knopfe and J. V. Lewis. Pp. iv+85-139+plate 6. Bulletin 725-C: Deposits of Manganese Ore in Montana, Utah, Oregon, and Washington. By J. T. Pardee. Pp. viii+141-243+plates 7-10. Bulletin 725-D: Contact-Metamorphic Tungsten Deposits of the United States. By F. L. Hess and E. S. Larsen. Pp. vi+245-309+plates 11-14. Bulletin 726-B: Geology of the Cement Oil Field, Caddo County, Oklahoma. By F. Reeves. Pp. iv+41-85+plates 6-12. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 471: Surface Water Supply of the United States, 1918. Part 1: North Atlantic Slope Drainage Basins. Pp. 183+2 plates. Water-Supply Paper 476: Surface Water Supply of the United States, 1918. Part 6: Missouri River Basin. Pp. 266+2 plates. Water-Supply Paper 490-B: Routes to Desert Watering Places in the Mohave Desert Region, California. By D. G. Thompson. Pp. viii+269+13 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1920. (Preliminary Summary.) Introduction by G. F. Loughlin. Pp. 123. (Washington: Government Printing Office.)

Records of the Indian Museum. Vol. 21: Catalogue of the Planorbidæ in the Indian Museum (Natural History), Calcutta. By Louis Germain. Part 1. Pp. ii+80. (Calcutta: Zoological Survey.) 2 rupees.

Diary of Societies.

THURSDAY, FEBRUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Napier Shaw: Droughts and Floods (2).

HARVEIAN SOCIETY OF LONDON (at St. Mary's Hospital, Paddington), at 4.30.—Clinical Meeting.

ROYAL SOCIETY, at 4.30.—Sir J. A. Ewing: The Atomic Process in Ferromagnetic Induction.—Prof. J. W. Nicholson: Problems relating to a Thin Plate Annulus.—Prof. T. H. Havelock: The Effect of Shallow Water on Wave Resistance.—R. H. Fowler and S. N. H. Lock: The Aerodynamics of a Spinning Shell. Part II.—F. P. Pidduck: The Kinetic Theory of a Special Type of Rigid Molecule.—J. E. Jones: The Velocity Distribution Function and the Stresses in a Non-uniform Rarefied Monatomic Gas.—H. Bateman: The Numerical Solution of Linear Integral Equations.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—H. Hilton: Conics on the Pseudo-sphere.—W. F. D. MacMahon: The Design of Repeating Patterns in Euclidean Space of 3 Dimensions.—G. H. Hardy and J. E. Littlewood: Dirichlet's Series with a Barrier of Singularities.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. J. Kingston-McCloughry: The Design of Modern Water-turbines.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Annual General Meeting.—F. W. Preston: The Structure of Abraded Glass Surfaces.—A. J. Dalladay and F. Twyman: The Stress Conditions Surrounding a Diamond Cut in Glass.—Lt.-Col. J. W. Gifford: A Supplementary Note on Achromatic One-Radius Doublet Eyepieces.—F. Twyman and A. J. Dalladay: Change in Refractive Index at the Surfaces of Glass Melts.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir Ernest Rutherford: Artificial Disintegration of Elements.

INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute, Jewry Street, E.C.3), at 8.—R. T. Rolfe: Gun-metal.

SOCIETY OF ANTIQUARIES, at 8.30.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. Buzzard: Some Varieties of Traumatic and Toxic Ulnar Neuritis.

FRIDAY, FEBRUARY 10.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Annual General Meeting.—Dr. E. A. Owen and Bertha Naylor: The Measurement of the Radium Content of Sealed Metal Tubes.—Sir William Bragg: The Crystal Structure of Ice.—Dr. K. Grant: A Method of Exciting Vibrations in Plates, Membranes, etc., Based on Bernoulli's Principle.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. C. Pannett: Hydronephrosis (Hunterian Lecture).

KING'S COLLEGE ENGINEERING SOCIETY (Anniversary Meeting) (at Institution of Civil Engineers), at 5.30.—F. W. Macaulay: Water Engineering.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

MALACOLOGICAL SOCIETY (at Linnean Society), at 8.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Questions and General Discussion.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Miss I. C. Mann: The Morphology of Certain Developmental Structures associated with the Upper End of the Choroidal Fissure.—Dr. H. J. May and F. A. Williamson-Noble: Three Cases of Choroidal Sarcoma, with Notes on the Microscopic Appearances.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. D. Halliburton: The Teeth of the Nation.

MONDAY, FEBRUARY 13.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Lt.-Col. M. N. MacLeod and A. R. Hinks: Stereographic Survey.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. V. Z. Cope: The Nerve-supply of the Parietal Peritoneum and the Subperitoneal Tissues, with Remarks on its Clinical Significance (Arris and Gale Lecture).

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Lieut.-Colonel C. R. Sylvester-Bradley: Stature in relation to Physical Fitness.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Prof. H. Hartmann: Inflammatory Strictures of the Rectum.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Variable Stars (3); Our Sun.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Dr. H. H. Dale and Major C. E. White: An Experimental Method of Determining the Therapeutic Efficiency of "914" Preparations.—Dr. R. L. Mackenzie Wallis: Tests for Hepatic Insufficiency after Arseno-benzol Treatment.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Prof. The Svedberg: (1) The Relation between Sensitiveness and Size of Grain in Photographic Emulsions (Part 2); (2) The Reducibility of the Individual Halide Grains in a Photographic Emulsion.—Dr. S. E. Sheppard and A. P. H. Trivelli: Note on Prof. Svedberg's Method of Grain Analysis of Photographic Emulsions.—K. C. D. Hickman: An Optical Method of Testing Washing Devices.

QUEKETT MICROSCOPICAL CLUB, at 7.30 (Annual General Meeting).—Dr. A. B. Rendle: Presidential Address.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. G. Elliot Smith: The Brain of Rhodesian Man.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. Helen Boyle: The Ideal Clinic for the Treatment of Nervous and Borderland Cases.

WEDNESDAY, FEBRUARY 15.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. C. Singer: Recently Discovered Inscriptions recording Ancient Cures.—Dr. F. G. Crookshank: The "Trousse-galland."—Dr. H. D. Davis: A Very Early Illustration of a Skin Disease.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. F. W. Edridge-Green: New Researches in Colour-vision (Arris and Gale Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Cloudesley Brereton: The Necessity of Speech Training, and the Need of a National Conservatoire.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. B. L. Bhatia: Freshwater Ciliate Protozoa of India.—A. L. Booth: The Microstructure of Coal from an Industrial Standpoint.— Capt. F. Oppenheimer: A Portable Microscope

THURSDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (1).

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. L. Hill, D. H. Ash, and J. A. Campbell: The Heating and Cooling of the Body by Local Application of Heat and Cold.—Prof. J. B. Cohen, C. H. Browning, R. Gaunt, and R. Gulbransen: Relationships between Antiseptic Action and Chemical Constitution, with Special Reference to Compounds of the Pyridine, Quinoline, Acridine, and Phenazene Series.—D. T. Harris: Active Hyperæmia.—B. B. Sarkar: The Depressor Nerve of the Rabbit.—Prof. A. Lipschütz, Dr. B. Ottow, C. Wagner, and F. Bormann: The Hypertrophy of the Interstitial Cells in the Testicle of the Guinea Pig under Different Experimental Conditions.

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL METEOROLOGICAL SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdr.-Ldr. C. F. A. Portal: Methods of Instruction in Aeroplane Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—J. M. Bell: The Occurrence of Silver Ores in South Lorrain, Ontario, Canada.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. P. Whitaker: Rotary Converters, with Special Reference to Railway Electrification.

CHEMICAL SOCIETY, at 8.—A. Lapworth: A Theoretical Derivation of the Principle of Induced Alternate Polarities.—W. O. Kermack and R. Robinson: An Explanation of the Property of Induced Polarity of Atoms and an Interpretation of the Theory of Partial Valencies on an Electronic Basis.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—E. B. Turner: Sex Relationships.

FRIDAY, FEBRUARY 17.

GEOLOGICAL SOCIETY OF LONDON (Annual General Meeting), at 3.—Presidential Address.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Swale Vincent: A Critical Examination of Current Views on Internal Secretion (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—A. T. Wall: Electric Welding applied to Steel Construction, with Special Reference to Ships.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—W. J. Leaton: Water Purification for Boiler Feed Purposes.

SOCIÉTÉ INTERNATIONALE DE PHILOLOGIE, SCIENCES ET BEAUX-ARTS (Celtic Section) (at 8 Taviton Street, W.C.1), at 8.—Dr. W. J. E. Scott: The Mines of El Dorado: an Historical Account of the Maritime Trade of Spain with Ireland, 2000 to 700 B.C. (2).

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. G. W. C. Kaye: Radiology and Physics (Mackenzie-Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D. S. M. Watson: History of the Mammalian Ear.

SATURDAY, FEBRUARY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. A. Gardner: Masterpieces of Greek Sculpture (1).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, FEBRUARY 9.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (1).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (4).—M. Beza: Nereids in Roumanian Folk-lore.

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at the Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (3).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Skin Eruptions of Syphilis (Chesterfield Lecture).

FRIDAY, FEBRUARY 10.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (4).

SATURDAY, FEBRUARY 11.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (4).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Domestic Life of the Ancient Egyptians.

MONDAY, FEBRUARY 13.

UNIVERSITY COLLEGE, at 5.15.—A. G. R. Foulerton: Administrative Measures for the Improvement of the Public Health.

CITY OF LONDON (BOYS') SCHOOL (Victoria Embankment), at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (2).

KING'S COLLEGE, at 5.30.—Dr. J. S. Steppat: Recent Developments in German Education and Student Life (4).—Prof. C. L. Fortescue: Wireless Transmitting Valves (4).

TUESDAY, FEBRUARY 14.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (1).

WEDNESDAY, FEBRUARY 15.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (1).

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Jains.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (4).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (1).—Prof. Karl Pearson: Side-lights on the Evolution of Man: From the Knee-joint.

THURSDAY, FEBRUARY 16.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (2).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (5).—M. Beza: Nereids in Roumanian Folklore (2).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. K. Sibley: Seborrhœa and Psoriasis (Chesterfield Lecture).

FRIDAY, FEBRUARY 17.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (5).

KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (2).

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (4).

SATURDAY, FEBRUARY 18.

ROYAL SOCIETY OF ARTS, at 10.30 a.m.—Prof. J. A. Thomson: The Migration of Birds (Lectures for Teachers).

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (5).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: A Botanist in South Africa.

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