NATURE

SATURDAY, FEBRUARY 19, 1927.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2990, Vol. 119]

The Preservation of Nature.

PUBLIC opinion is inclined to look upon the scenery and great natural monuments of a country as of the order that lasts for aye, and to imagine that their survival through many millennia betokens an infinite future. It little realises that in this and other civilised countries, human progress is constantly nibbling at the works of Nature, and that greatly as the rate of consumption has grown in recent years, the threat will undoubtedly be magnified in the years to come. The need of water-supplies for the centres of population has altered lakes and swamped valleys; the demands of industry have changed rivers and harnessed waterfalls; the vast requirements of the modern metalling of roads are cutting into the 'everlasting' hills; and the desire for speedy transport has driven and threatened to drive bleak roads through some of the select scenery of the land.

With all this there has been, of course, immense economic gain, but there has also been loss. There has been a loss of beauty, a destruction of things of æsthetic and artistic appeal; and who knows what unconscious influence these may have had upon the minds of men? But there has also been a loss to science, sometimes material, more often of those historic-sentimental records, which, linking the achievements of the past with present-day knowledge, stir the imagination and stimulate the broad view. The haunts of a dwindling native flora and fauna are being disturbed: the driving of a road (abetted by the importunities of collectors) banished the Artaxerxes butterfly from its first discovered site in the King's Park, Edinburgh, which had "stocked the cabinets of Europe." Just as in Italy the Barma Cave, the richest and most interesting of the Grimaldi caves, which have added so greatly to the knowledge of palæolithic man, has been exploited for building stone, so the M'Arthur Cave at Oban, the first recognised habitation of Azilian man and, until the discoveries of last summer, the oldest known human dwelling in Scotland, has been entirely quarried away. The historic rock on Blackford Hill within Edinburgh, on the smoothed surface of which Agassiz first detected indubitable traces of an ice age, is threatened by the road-metal excavations of Midlothian County Council, and similar operations in Haddingtonshire will eat into Traprain Law, the site of extensive Celtic settlements and of the discovery of a unique silver hoard belonging to an early century of our era.

Here is a clash between 'business' on one hand

and æsthetics and science on the other. Obviously so disintegrating a warfare ought to be stopped, but how? Not by a simple attitude of protest, for the claims of 'business' cannot be lightly brushed aside, and the county council 'steam-roller' has an effective way of overriding objections. A burst of local effort endeavours to meet each new aggression, and occasionally a treasure is saved. Stybarrow and Glencoin Woods in Ullswater have thus been rescued within the last few weeks, and the *Times* of Feb. 5 announced that negotiations were understood to have reached a successful issue "whereby the land on the west side of the Borrowdale road, from Peterfield to the entrance to Stable Hills Farm, will be saved from all possibility of being built on, and the uninterrupted view over Derwent Water into the famous 'jaws' of Borrowdale and across to Cat Bells will be preserved intact for all time." In both cases appeal is made for public subscriptions of considerable amounts, necessary if successful negotiations are to be converted into the full goal of permanent preservation.

More often, however, the 'steam-roller,' if checked at all, is only temporarily checked and soon returns to complete its work. A year or two ago the danger seemed to have been turned from Traprain Law, but now preparations for extensive quarrying on part of the hill are in full swing. On the whole, local effort is too little organised, too spasmodic, too late in getting into action, too lacking in persistence and in authority to deal efficiently with such emergencies.

The needs of industrial progress are clamant and cannot be gainsaid by a point-blank negative, but is there no room for compromise? Compromise implies give and take on both sides; what has the æsthetic and scientific side to bargain with? As the law of Britain stands, it has nothing; for though more than twenty years ago France passed its first law towards the protection of 'sites pittoresques,' in Great Britain public opinion remains the only support. The matter seems to rest upon the nature of property in land; does purchase or possession imply for the possessor an absolute right to deal anyhow with the land he possesses? We act as if possession held this absolute right, and as if only by special appeal or through special favour may the right be waived; but ideas are changing and have changed. The absolute right no longer holds in the great cities, where an owner may not build upon his land except in accordance with the interests of the community as expressed by the Dean of Guild Court or some similar body.

The time will come when a natural monument, whether its message be æsthetic, historic, or scientific, will be reckoned of as much value as a garage, and its preservation or destruction a matter not for the individual but for the nation.

Other countries, recognising their value in the national life, have moved or are moving towards a general conservation of the natural sites and monuments of artistic, scientific, historic, and legendary interest. A vast body of evidence in this sense was submitted to the "Congrès international pour la Protection de la Nature" held in Paris in the summer of 1923, and appears in the "Rapports, vœux et réalisations" of the Congress published in 1925. In 1906 the *loi Beauquier*, which provided for the classification of picturesque sites, particularly forest areas, by a special commission in each department, and for the safeguarding of these places, set the ball rolling in France. Since then various measures of preservation have been applied to the colonies of France by decrees of the colonial minister. In Switzerland, Spain, Poland, Jugoslavia, Hungary, and Russia the movement is strongly supported. In Great Britain spasmodic efforts have become crystallised in the Royal Society for the Promotion of Nature Reserves in the British Isles, and it has already done good work. We trust, however, that the lack of faith in the efficacy of parliaments and governments as protectors of the beautiful and interesting, expressed at the Paris conference by the president, Viscount Ullswater, does not mean that this influential society will refrain from impressing upon the government of the day the desirability of safeguarding natural monuments, until parliamentary recognition gives a national sanction far more effective than that of any private organisation could be.

If, as we assume, a method of compromise between industrial needs and the demand for the picturesque or significant will ultimately replace the spasmodic and point-blank opposition of the present, who is to arrange the compromise? It must be a body with authority, with knowledge, and with sympathies broad enough to gain the confidence of both sides. Local authorities are already sufficiently burdened with duties, and their very proximity may be apt to obscure the broad view.

In France the Government appointed a special commission for the precise purpose, and this would seem to be the most satisfactory method. We need a Nature Monuments Commission, an advisory body attached to one of the great departments of

State, with the needful statutory backing. This body, with such local help as could be obtained, might draw up lists of Nature monuments and haunts of rare animals and plants deserving of preservation, but a chief function would be to receive from recognised local bodies complaints of threatened destruction, and to decide whether the particular needs of economic development were such as to demand the sacrifice of a national asset, or whether some adjustment might be arranged so that whole or part of the threatened natural monument might be preserved.

Until recent years the handiworks of prehistoric man and his successors existed in Great Britain unprotected from the elements or from the despoiler (except where private ownership bestirred itself), and, as a consequence, hundreds of stone circles of the bronze age and prehistoric sepulchral cairns, as well as buildings of Roman or later times, have been demolished and converted into stone dykes and insignificant barns, byres, and cottages. But the creation by government of an Ancient Monuments Commission has saved the situation, and invaluable work has been done by this body in scheduling and protecting the irreplaceable relics of the former inhabitants of Britain. Here is a precedent for the creation of a Nature Monuments Commission, and here in many ways is a model for its labours. JAMES RITCHIE.

The Chemistry of Rhythmic Actions.

The Problem of Physico-Chemical Periodicity. By Dr. E. S. Hedges and Dr. J. E. Myers. Pp. 95 + 2 plates. (London: Edward Arnold and Co., 1926.) 7*s*. 6*d*. net.

THE normal chemist is so well used to seeing his reagents pass away in a decently continuous fashion, that when he finds them attacking each other in a succession of recurrent spasms, he is a little apt to shy off. The thing is, perhaps, too nearly suggestive of heart-beats, of vital processes, and of human activities: domains into which chemists are warier of intruding than formerly, and which they prefer to leave to their bolder brethren, the physiologists and the historians. At all events, rhythmic, pulsating, or periodic reactions have seldom been systematically followed up in any general way by chemists. There have been, it is true, such detailed inquiries as Ostwald's on the periodic dissolution of a specimen of chromium in acid, as Bredig's on the pulsating decomposition of hydrogen peroxide by mercury, and as the numerous studies of the Liesegang effect in jellies; but Dr. Hedges and Dr. Myers have now worked their way to a more comprehensive survey than these, which they have summarised in a small monograph. The broad plan of this is, first to classify periodicities of various sorts, then to set forth the experimental factors that operate in each class, and to give in the end an indication of the views which the authors—themselves notable experimenters in the field—have formed as to underlying causes. The full and important bibliographic index contains about 300 references, of which about one-third centre in the Liesegang phenomenon. About twenty fall outside the last thirty years.

The kinds of periodicity discussed are shown by the authors' definition of the word: "the recurrence of some property or accentuation of a property at regular intervals of time, distance, or other quantity." The sub-atomic recurrences that give rise to periodicities such as Mendeléeff's are intentionally excluded. Three main classes may be distinguished. In one, the speed of a chemical reaction shows pulsations, time being here the variable; in another are the reactions or properties in which space is the variable, so that fixed space-patterns are formed, like the layers in an agate; and in another class the variable to which the pulses in properties are referred is not obviously time or space, but some adjustable condition such as degree of dilution or extent of mechanical stress.

One example of the third class is Holker's effect, in which a row of tubes of a colloid solution show alternating groups of 'thick and clear' when each tube is given a stronger dose of electrolyte than its left-hand neighbour had. Another example placed in this category (labelled "static periodicity") is found in the waxings and wanings of the mechanical and other qualities of some metals when subjected to continued cold-working.

The second class includes all the phenomena first studied thirty years ago by Liesegang: the stratification caused by the advance of a reagent into a jelly containing a second reagent. The valuable critical survey of the work in this class shows that although stratification is favoured by the presence of jellies, these are not essential to it. It can, for example, occur by the slow merging of gaseous ammonia and hydrogen chloride; yet even here it is to be noted that the smoke produced is a colloid, and so are the glass reaction-tubes. It is obvious, in all cases, that a prime necessity is that diffusion must be going on, and to that extent time-rates must come into the affair; but the authors say that there is nothing to suggest

that the reaction-time curve itself is periodic. They are inclined to correlate the formation of Liesegang striæ with Holker's effect, already mentioned. Though much diverse work has been done, there is evidently much still to do before a full understanding is reached of the Liesegang phenomenon and, with it, of many structures that concern mineralogists and biochemists. The authors' survey will be very helpful to workers in this field.

The account of the work on periodic reaction-speeds, together with that on pulsating electrode-potentials, covers very interesting ground. Here the authors, in their own investigations, met what they call "the bugbear of work on periodic phenomena"; namely, the operation of essential but unidentified factors. This has led many other workers into puzzles and controversy; but Drs. Hedges and Myers' happy gift of devising crucial experiments has often enabled them to exclude irrelevant factors and to study the phenomenon at its simplest. For example, aluminium dissolving in alkali gives off hydrogen in pulses; is this merely due to the formation and subsequent discharge of supersaturated solutions of the gas, either in the metal or in the liquid? They make the aluminium one electrode of a cell containing the alkali; when it is made the anode, it dissolves and the hydrogen comes off in pulses—but at the other electrode; and when the aluminium is made the cathode, so that it does not dissolve, hydrogen is evolved from it—but smoothly. Hence the question is negatived. Again, it was found that certain cases of dissolution owed their periodicity to something in the glass walls of the containing vessel; and when the glass eventually 'tired,' periodicity could be restored by minute traces of various colloids. Eventually, the very important conclusion next mentioned was reached.

The core of the book is this: the authors show fairly conclusively that intermittent pulsations in a reaction $A+B$ are due to the presence of some substance, C, which must be in a certain special physical condition. This substance may be foreign to the net reaction; for example, metallic mercury will cause the spasmodic decomposition of hydrogen peroxide; but alternatively it may be one of the reagents themselves, appropriately treated beforehand. To mention one case, the dissolution of copper in a suitable acid goes by pulses if certain freshly made colloids are present, or alternatively if the copper itself has first been submitted to mechanical stress. The soft crystalline metals like lead and tin are not able to be activated for periodicity by being strained; the authors connect this with the faculty for self-annealing. With metals which have been only mildly strained, the property is apt to fade. Liquid mercury needs no special treatment; it is active without it.

What clearly emerges is that the seat of pulsation in a heterogeneous action is at an interface. Further, there are good reasons for suspecting that, despite some seemingly contrary evidence, no pulsating reaction is other than heterogeneous.

Drs. Hedges and Myers accordingly seek to go further; and, tentatively but suggestively, they refer rhythmic reactions, and rhythmic structures also, to effects of varying surface tension. There is evidence that this property, which itself affects reaction-speeds in a solution, can be a periodic function of the strength of a solution; and a valuable step forward will have been made if pulses in surface tension can be correlated with reaction pulses on one hand and with the Holker effect (and through it with the Liesegang phenomenon) on the other.

It still remains to explain why periodicity of any sort should occur at these surfaces. The evident connexion with catalytic action is commented on by the authors; but they seem to think that rhythmic movements of energy may be intrinsic in 'metastable' surfaces. It is quite possible, they say, that all catalysis is periodic in character, though only rarely measurably so. Many readers will probably argue that the factors which must, in that event, be invoked to explain the suppression of rhythm in innumerable observed cases, might just as well be used instead to explain its presence in a few. That is, we would make rhythm a result of superposed velocities, rather than stop short at a 'principle of periodicity.' Thus the reaction velocity in a volume of dilute reagents subject to catalysis at fixed surfaces in it will show pulsations, provided that the catalytic activity of the surface gradually increases until it causes a local 'explosion,' *i.e.* a reaction speed that outstrips the rate at which reagents reach the catalysing surface. An example is seen in the lecture experiment, wherein a heated platinum wire is hung above warm ammonia solution through which oxygen passes; the rhythm of accelerating catalysis culminating in explosion, with local exhaustion of the reagents and the renewal of the cycle, can be watched recurring for a long time. The molecular film-patch mechanism of surface catalysis, worked out by Langmuir and others, seems capable of describing conditions for such cases.

At the same time it is attractive to look upon a pulse inductor as a kind of bank of energy, as the fly-wheel of an engine; for it does behave as if it stored up energy gained from the reaction, delivering it again so as to stimulate the adjacent reaction when this would otherwise have slowed down. In this light we may survey Drs. Hedges and Myers' conclusions as to the physical texture needful in a pulse inductor. Collating their facts as to cold-worked metals and colloids, they believe that a metastable, amorphous form is essential. They do not clearly differentiate metastability from amorphism; definitely crystalline, but metastable, allotropic forms of metals do not happen to be mentioned as pulse inductors; but the case of liquid mercury acting in this way shows that the potential energy, which characterises a metastable variety, need not have been implanted in the substance by previous treatment, but may be gained from the reagents into which it is put. The factor common to pulse inductors might be crudely described as the ability to produce atoms the valency-bonds of which stick out of the substance. Thus it can be said that a pulse inductor deals out to the adjacent molecules some of its internal energy, derived from external sources and set free by the return of its own atoms to a more stable orientation.

An illuminating example of this 'relaxation' is quoted on p. 65; cold-worked copper spontaneously 'breathes' oxygen in and out for a long time; whereas stable copper under the same conditions scarcely takes up oxygen at all. One may perhaps be allowed to picture this, however imperfectly, as a slow union of oxygen with areas of active or abnormal atoms of the copper; when the film of oxide molecules has spread to the edge of a patch of normal copper atoms, the transition sets in rapidly at the boundary, which thus quickly invades the oxide film and causes the expiration of oxygen, demanded by the smaller affinity between oxygen and normal copper. A moderately quick renewal, from within the copper, of areas of active atoms would then make the cycle set in again; such renewal requires that energy shall be supplied to the copper from outside, either by previous cold-working, or else by the storage of energy evolved from the stoppage and fixation of gaseous oxygen upon the active atoms. A fairly good analogue is that of a sink, filled by a slow tap and intermittently emptied by a quick-acting siphon; gravitational energy here takes the place of chemical energy. (It would be interesting to know whether the oxygen expired in pulses from copper is chemically active, as hydrogen escaping from palladium, and other molecules newly released from combination, appear to be.)

The storage of energy here ascribed to pulse inductors, as it were in a delay-action fuze, may be compared with the similar storage of radiated energy that is seen within silica or fluorite when these are heated after being exposed to high-frequency rays; or, a better parallel here, in the photographic plate between exposure and development. (In passing, the 'reversed image' of a photographic plate suggests a periodic action.) Thus the time of relaxation can be long in a solid aggregate of molecules while no reagent is attacking the aggregate. In homogeneous systems, on the other hand, it is known from fluorescence measurements that the time of relaxation of the isolated molecules is extremely short; they do not appreciably store up energy, and accordingly, as has been mentioned, measurably pulsating reactions in truly homogeneous systems are suspected by Drs. Hedges and Myers not to occur.

These reflections are offered merely as a footnote to a work which gives an admirable experimental survey and classification of facts, new and old, that were in much need of being marshalled and brought to our notice. The book is bound to meet with a well-deserved success; and not among chemists only; the authors remind their readers that periodic phenomena are of high importance biologically. Physiologists, no less than physical chemists, will find here much to think about, even though the book describes no biochemical or biophysical researches; for a good deal in the rhythmic behaviour of the fibres of living tissue is surely connected with the factors that Dr. Hedges and Dr. Myers have found significant in their studies of unorganised materials.

IRVINE MASSON.

The Physiology of Growth.

The Fundamentals of School Health. By Dr. James Kerr. Pp. xvi + 859. (London: George Allen and Unwin, Ltd., 1926.) 35*s*. net.

"LOCAL Education Authorities would be wise not only to facilitate and encourage investigation into local medical problems by members of their medical staff, but actually to expect and indeed require it. The problems are not only manifold but strangely significant and pregnant.

"For here is an expanding physiology, unexplored; here are the very beginnings of disease; here its cause may be searched with some hope; here it may often be prevented; here the physique

and education of a nation are in rudimentary form —and whatsoever here be found by searching or proved by experiment becomes forthwith of value to the child, to the community, and to the growth of human knowledge."

In these words Sir George Newman, in his eighteenth annual report as chief medical officer of the Board of Education, just issued, points out the immense field of research into the physiology of growth which is offered by the presence in the nation's schools of the whole of the population during the most interesting and important years of development. Although there is now completely established a school medical service throughout Great Britain, with one whole-time school medical officer to 8500 children, but little has been done even to explore this abundant field. Local Education Authorities, frankly, are not interested in the question of research. Their medical staffs are overburdened with difficult problems of administration, and mere doctoring more than absorbs the whole of their available time.

The appearance of Dr. Kerr's book on "The Fundamentals of School Health" is therefore especially to be welcomed. Dr. Kerr has been exceptionally situated. Appointed thirty years ago as medical adviser to the most progressive of the provincial education authorities, he was in 1902 appointed medical officer to the London School Board. He was the first medical man in England to appreciate the importance of the subject he deals with, and was the first doctor to make a practice of daily visiting the schools. In 1911 the London County Council, recognising his unique qualifications, created for him the post of Research Medical Officer and, to give him full scope and opportunity, relieved him of all administrative cares.

The result of the research of a lifetime is to be found in this very remarkable book, with which there is none other in the English tongue that can be compared. It stands alone, and must for many a day stand, as an incomparable authoritative work.

Roughly, the forty-three chapters can be grouped into six logical divisions. First come five chapters which deal with heredity and growth, then twelve chapters dealing with general physical defects of the child, followed by five chapters dealing with mental development and intelligence; then eleven chapters directed to the physiology of the special senses, next five chapters dealing chiefly with problems of administration; and, finally, five chapters on the school environmental conditions of the child, including ventilation, heating, and illumination. It is impossible to do justice in a review to the care and labour which have gone to the making of this book. It is safe to say that it includes everything that has hitherto been learnt in regard to the subject, and much is founded upon original work carried out by Dr. Kerr or under his direction.

Of especial value are the chapters on the physiology of vision, upon ventilation, and upon illumination, but perhaps the most interesting are the early chapters dealing with problems of growth. Every one will agree with Dr. Kerr's denunciation of the general practice of treating averages as standards. One feels, however, that the author rather stresses environmental at the expense of genetic influences. Most of us would place the standard of height, for example, "somewhere between the Polish Count and Giant O'Brien," and for girth, "somewhere between the *Anatomie Vivante* and Daniel Lambert." Not so, Dr. Kerr; he is for Giant O'Brien every time. For Anglo-Saxon standards he draws arbitrarily a curve which is higher than the average attained by any but very exceptional groups. "They would represent the ideal young Anglo-Saxon as 6 feet high and weighing 11½ to 12 stones." Any one of our race failing to reach this standard would be considered by the author as having been stunted by environmental conditions. He adduces in support the measurements of the rowing members of Oxford and Cambridge University boat crews. But surely a race is viewed as a congeries of genes, each of which, in respect to a character such as height, has its own maximum standard of attainment, and there must be innumerable Anglo-Saxon strains in which a height falling short of 6 feet by several inches is normal and not dependent upon environment. Do not they also serve who only sit and 'cox'?

Such criticism as this is not, however, to detract from the value of the book, but to point out the absorbing interest of the subject matter and its originality of presentment. The strong idealism of the author is shown in the tendency to stress environmental conditions. This idealism also causes him to leave the dusty road at frequent intervals in order to tilt at windmills—political, economic, and administrative. He returns, however, to the straight path after every such adventure with renewed zest and ardour. While these excursions do not advance the author's theme, they serve to make the work extraordinarily interesting to read, and to enliven a subject which might easily, by conventional presentation, have resulted in a dry-as-dust disquisition.

It remains to say that, as befits the subject matter

of the book, the type and format are unexceptionable, the illustrations and diagrams are numerous, and the tables clear and illuminative. While the work becomes immediately invaluable to all engaged in the problems of the care of the nation's childhood, it must remain to all time a classic.

Problems of Potato-Breeding.

Potato Varieties. By Dr. Redcliffe N. Salaman. Pp. xxii + 378 + 10 plates. (Cambridge: At the University Press, 1926.) 25*s.* net.

AS the author says, the title of this book is non-committal, but almost unreasonably so, for in addition to most exhaustive descriptions of all the commercial varieties, this treatise contains a very complete discussion of the various scientific problems connected with the origin, breeding, and cultivation of what the daily journalist delights in describing as the "comestible tuber."

Originally occupied in physiological research, Dr. Salaman has devoted the last twenty years to 'cultivating his garden' (and to some purpose), but the loss to medicine has proved a gain to agriculture. The diseases of the potato alone provide a fascinating subject for research, all the more seeing that the potato keeps up-to-date by falling a victim to virus diseases furnished with all the modern terrors of 'carriers' and environmental 'factors.' Of these diseases Dr. Salaman says: "By directly threatening one of the most important elements of the food of the people they become a question of national concern and their investigation a matter which no country can afford to neglect"—least of all, we may add, Scotland, for the trade in Scotch seed potatoes is one of the most important that the country enjoys. We are bound to notice the author's footnote. "The Ministry of Agriculture has devoted in all but a few hundred pounds to the elucidation of a disease the ravages of which are costing the country *at least five millions annually.*"

These insidious diseases, we learn, are known popularly by such names as 'curl,' 'crinkle,' 'mosaic'—epithets descriptive of characteristic appearances on the foliage. Their effect is to cause a progressive deterioration in yield, amounting, in the second year of infection, to 50 per cent. and more. Scotland, it appears, particularly north of the Grampians, enjoys a considerable immunity. The reason assigned is of much scientific interest. The guilty virus is ordinarily carried from one plant to another by insects—aphides are probably the worst offenders, and in the cool climate of the north of Great Britain 'green fly' is rarely found. Seed potatoes brought from Scotland may, consequently, be free from the disease. We have said 'may,' for Dr. Salaman has proved that the infection may be 'carried,' just as that of diphtheria and other human diseases may be. It is still unsettled in what degree the superiority of the Scotch seed potato is due to this tolerance, or to absolute freedom from the disease. Dr. Salaman does not go so far as some and state that the degeneration which attacks the tuber in the south is solely due to virus diseases: in his view it is still possible that there may be an environmental or physiological cause (such as immaturity) for the superiority of northern seed. There are many other unsolved problems, most of which our author notices; a bibliography of 177 items is evidence that he has cast his net widely.

When Dr. Salaman originally attacked the potato scientifically (under the inspiration, we believe, of the late Dr. Bateson) it was in the hope that the newly born science of genetics would give him useful results. It is somewhat sad to find the following passage under the heading of "The Application of Genetics to Variety Raising": "were we, however, to possess all the data we could desire we might still be wanting in the possession of that one essential gift, the eye of the fancier, the *flair* of the breeder. . . . Some of the best varieties have resulted from seed secured by impregnating some favourite but nameless variety with pollen recovered from several plants mixed together on the thumb nail before being applied to the expectant stigma." That is not the only discouraging feature to the geneticist. The potato, in common with so many varieties of cultivated fruits and vegetables in Britain, is genetically 'heterozygous,' and when 'pure lined' is likely to suffer a great loss of vigour. So much is this proving to be the case that it is doubtful whether—except in relation to plants which are normally homogamic, such as the cereals—the pure line will prove of much economic value.

Dr. Salaman is a thorough-paced Mendelian. To the presence of multiple genes he would attribute all the varying economic characteristics of the plant—yield, shape, cooking quality, and so forth. Of all the farm crops, none is more sensitive to environmental conditions such as soil, climate, and cultural treatment. Added to these there is the admitted variability due to the degree of infection by virus disease. On the figures adduced by the author, subject as they must be to these errors, it is permissible to question the existence of genuine

segregation: the facts, such as they are, might be equally well explained on the unfashionable hypotheses of blended characters, or inheritance of acquired characters.

The book is produced in the style which distinguishes all the publications of the Cambridge Press, and it certainly constitutes the best text-book extant on the scientific problems of potato-breeding. As such, it should prove a welcome addition to the library of the scientific worker and, especially in regard to varieties, to that of the enlightened agriculturist.

Science, Invention, and Industry.

Old Trades and New Knowledge: Six Lectures delivered before a 'Juvenile Auditory' at the Royal Institution, Christmas 1925. By Sir William Bragg. Pp. xii + 266 + 42 plates. (London: G. Bell and Sons, Ltd., 1926.) 8*s*. net.

THE publication of Sir William Bragg's lectures to a 'juvenile auditory' at Christmas 1925 will enable a much larger audience than could be accommodated in the historic Albemarle Street theatre to enjoy what he has to say on the application of modern scientific discovery to the study of practical problems. Our earliest inventors are known only by their works, but just as it is one of the aims of the archæologist to inform us of the social habits of past races, so the scientific investigator finds it worth while to attempt to explain the technique used in age-long industries. By so doing he not only shows us the why and wherefore of processes evolved by centuries of patient groping and accidental discoveries, but also at the same time lays bare the fundamental principles on which future improvements depend. Through the ages men have gradually learnt to smelt, cast, forge, harden, temper, spin, weave, dye, fashion, fire, and glaze, producing utensils, implements, tools, weapons, garments, and ornaments, but never before has it been possible to unfold the laws on which such operations depend for their success.

The lectures cover wide and interesting fields of human endeavour, ranging from the study of the work of those who go down to the sea in ships to that done in peaceful cottages where wool and flax were spun into yarn by hand, and again to the hazardous business of mining, in which water, gas, and dust worked such havoc. In nothing has science wrought a greater revolution than in sea transport. To a seaman of the days of Elizabeth, the speed, regularity, and certainty with which passengers and goods are carried overseas to-day might well appear magical. Even in 1741, as we are told, Anson, after rounding Cape Horn, was ten degrees out in his reckoning. But with the coming of the sextant, the chronometer, and the Nautical Almanac, the mariner could fix his position with ease. Never was a nation's money more profitably spent than when Flamsteed was made Astronomer Royal at £100 a year, or Harrison given the £20,000 for his years of labour on the chronometer. To the compass and the sextant have now been added the gyro-compass, wireless time signals, wireless direction finding, leader cables, echo sounding, and even microphones placed on the bottom of the sea far from land. With such appliances collisions are avoided, channels navigated, and harbours entered even in fog.

While improvements in navigation have been mainly due to science, the progress in textile manufacturing owes most to the work of mechanical inventors. Kay's flying shuttle, Hargreaves' spinning jenny, Arkwright's water frame, Crompton's mule, and Cartwright's power loom were all designed to replace hand labour by mechanical appliances, and no one could wish for a clearer description of the processes involved than that given in the lecture on the weaver. To these inventors might have been added Eli Whitney, whose cotton gin made many fortunes, but riveted the fetters of slavery and led to civil war. In the textile industry, however, are many problems for research, and to these Sir William Bragg referred. In mining, too, it was the practical inventions of Savery, Newcomen, and Watt which made deeper mines possible, but it has been the study of scientific principles which has rendered coal-mining a hundred times safer.

It is in the lectures on metals, clays, and dyes that the reader will see how the whole armoury of modern science is brought to bear on apparently simple yet really difficult problems. Chemical analysis, X-ray examination, the microscope, the theory of electrons, atoms, and molecules and internal structure are all used in the attack, and each lecture provides evidence of the value of research to industry. To the ordinary observer nothing could look less crystalline than the clay on the potter's wheel, yet even in the finest clays composed of the finest particles there is a crystalline structure, but "unfortunately, the information, while quite conclusive on this point, is not easy to interpret because our knowledge of the new X-ray methods is only in its first stages, and

some problems are too hard for us as yet." As it is with the work of the potter so it is with that of the dyer and the smith, and familiar operations carried out daily in villages all over the world are subjects for the highest studies. It is to be regretted that no such lectures as these are delivered to our working men, for after reading them it is easy to agree with the remark of J. A. Froude, who, addressing the students of St. Andrews, said "that every honest occupation to which a man sets his hand would raise him into a philosopher if he mastered all the knowledge that belonged to his craft." E. C. S.

A New Approach to Religion.

Reality: a New Correlation of Science and Religion. By the Rev. Canon Burnett Hillman Streeter. Pp. xiii+350. (London: Macmillan and Co., Ltd., 1926.) 8*s*. 6*d*. net.

THE old apologetic for religion used to treat it, and its evidences, as if it were a branch of natural or historical science. Its truth depended on the accuracy of its cosmogony, the historicity of its mythology, and so on. All this is now recognised to be beside the point. Science and religion are regarded as two complementary methods by which different aspects of reality can be apprehended. Any satisfactory correlation of science and religion must supply a theory of the mutual relations of these two methods of approaching reality. So far as men of science are concerned, they may be said of recent years to have examined their own methods and subject matter pretty thoroughly. On the side of religion, too, a good deal has been done by philosophers such as Prof. Höffding, Prof. Alexander, and others. But we still await the promulgation of a satisfactory philosophy of religion by a theologian. The book before us makes a genuine and sincere attempt to supply this want.

Canon Streeter approaches the problem by first drawing a contrast between science and art. Between these two there are differences not only of method but also of subject matter. To take the latter point first; whereas science is concerned with the quantitative, or metrical, aspects of existence, art is concerned with its qualitative, or non-metrical, aspects. As regards method, there are two important differences: (1) Science states definitely, while art suggests; and (2) science explains observed data by bringing individual cases under a general law, whereas art reveals an inner spirit by embodying it in a concrete instance.

These contrasts between the methods and material of science and art serve to illuminate the contrasts between science and religion. Religion, like art and unlike science, is concerned with the non-metrical or qualitative aspects of the world, though it is with ethical rather than with æsthetic values that it deals. With regard to method, religion, like art, suggests rather than states; and, again like art, religion isolates some individual event or circumstance, and makes it symbolic of the whole of reality, or of some dominant aspect of reality.

Canon Streeter holds strongly that not only science, but also art and religion, reveal to us genuine aspects of reality, though they are different aspects. The contrast between science and religion may be expressed by saying that "what science gives us is a *Representation* of Ultimate Reality, and that this Representation is one that may be likened not so much to a picture as to a diagram." Whereas "what religion gives is also a Representation of Ultimate Reality, but one that is of the nature *not of a diagram but of a picture*." So that science and religion each give a representation which without the other is incomplete. One is like the ground-plan of Venice in Baedeker's guide, the other like Turner's famous picture, "Sunrise in Venice." These are complementary, though more or less incommensurable.

Science, then, supplies us with abstract diagrams, whereas religion, using the methods of art (myth, drama, parable, hymn, etc.), presents us with the qualitative aspects of reality by making us *feel* these "beyond the limits of our own experience." Hence, to test the 'truth' of any particular religion, its myths, etc., must be cross-examined. These, rather than the intellectual constructions of its theologians, indicate the spirit of a religion. No doubt, the question of the 'objectivity' of the 'values' of a religion is, in the end, a philosophical question. Religion cannot dispense with philosophy, or even with science, which contributes data for philosophical constructions, but philosophy is always secondary.

Canon Streeter himself is far from avoiding the philosophical issue. He applies the tests indicated above to Christianity. He inquires the meaning of the Christian 'myth' (which, however, he regards as history), and then proceeds to ask whether the values enshrined or symbolised in the myth are actually inherent in reality. He discovers that they are. He reaches this conclusion,

not by the *a priori* reasonings by which theologians are accustomed to reach favourable results, but through a survey of scientific facts, largely from the biological sciences. Consequently, students of science will be able to follow this portion of the argument with patience, a thing they may often find difficult in this class of book. But in classing this volume with apologetic literature in general, we should not be acting fairly to Canon Streeter. It is a work of a very different type; one which all earnest students of the natural sciences would do well to read. J. C. H.

Our Bookshelf.

(1) *Man and Weather.* By Prof. Alexander McAdie. Pp. vi+99+18 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 8*s*. 6*d*. net.

(2) *Air Ministry: Meteorological Office, London. A Short Course in Elementary Meteorology.* By W. H. Pick. (Published by the Authority of the Meteorological Committee.) (M.O. 247.) Second edition, revised. Pp. 127+8 plates. (London: H.M. Stationery Office, 1926.) 1*s*. 6*d*. net.

(1) PROF. MCADIE'S little book is written in an entertaining style calculated to impress meteorological principles on the memory. It consists of six popular lectures originally delivered in the Lowell Institute, U.S.A., in December 1924: (1) The strategy of weather in war; (2) weather in peace; (3) the structure of the atmosphere; (4) clouds, fogs and water vapour; (5) lightning; and (6) droughts, floods, and forecasts. The book should be most successful in awakening an interest in the subject, but it is marred by a quite unintelligible table on p. 62 representing the balance of precipitation and evaporation by land and sea. The unfortunate reader led into this quagmire is offered no helping hand from the author, who ironically observes: "From the data given above it would seem that the total rainfall for the globe is much less than the evaporation." This is no paradox; it is surely a physical impossibility that precipitation, being the complementary process of evaporation, should in the long run be less over the whole globe.

(2) Mr. Pick's book, which contains an appreciative preface by Dr. Simpson, is couched in the more staid language of a British Government publication. It skilfully compresses the fundamental principles of meteorology into a small compass, but in a future edition the author would do well to revise various statements in the light of most recent knowledge. Why, on p. 26, should relative humidity be deemed a more important meteorological matter than absolute humidity? Both are fundamental matters in the physics of the atmosphere, and as regards physiological effects it is now realised that absolute humidity is the more important condition. If there is a defective chapter in a generally good book, it is that on "Weather Lore," inasmuch as too strict a regard is paid to the letter of weather rhymes and too little to the spirit thereof. The countryman's 'February fill-dyke' is a very real phenomenon in seasonal hydrology, and one is not justified in assuming, as Mr. Pick does, that this necessarily implies a belief in much rain in a month which rainfall statistics show on the average to have relatively little rain. There is no reference whatever to the fact that towards the end of winter, after the season of small evaporation and little absorption of water by vegetation, the water-table is highest, and the rivers and brooks are normally fullest, being ready to cause flooding with less rain than would suffice at the beginning of winter in November. Again, it may be doubtful whether any one really takes the forty-day prediction associated with St. Swithin's literally; yet the spirit of the saying has just this much climatic foundation: that if disturbed weather once sets in about the middle of July, or for that matter at any time in July, it is liable in England to be very persistent, with a long succession of battering rainstorms running into weeks. We all know that type of July and August, and the countryman has embodied such climatic experience in a proverb the literal terms of which are (as Mr. Pick observes) quite untrustworthy. The actual date has probably no significance whatever, being just a landmark, and before the rectification of the calendar it corresponded to July 26.

L. C. W. B.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 29, 1927. Pp. xvi+127+70+72 plates. (London: Percy Lund, Humphries and Co., Ltd., 1927.) 8*s*. net.

THIS volume fully maintains the reputation the previous members of the series have earned for the editor and publishers. The newest item in it is a description by Mr. Fishenden of the Pantone process, which Mr. Ronald Trist has now so far perfected that he no longer objects to publication of its details. "Planished plates of suitable metal are first coated with an electro deposit of copper to a thickness of, say, five one-thousandths of an inch, and then with a chromium deposit of two ten-thousandths of an inch." The plate is coated with a solution of fish-glue and bichromate, exposed, washed, and burned-in as usual in photo-engraving. It is then treated with hydrochloric acid, which dissolves the chromium where it is exposed, but as it does not attack the underlying copper it cannot etch too deeply. The plate is next dipped into a solution of a silver salt, and then a few drops of mercury are rubbed over it. Amalgamation takes place immediately except in those parts where the chromium surface remains, and the mercury surface repels the ink without the use of water. The plate is now ready for trimming and mounting. The advantages of the process are many. It saves much time, as underlaying, reproving, and fine etching are unnecessary. Fresh plates can be prepared as rapidly and cheaply as

electros. Chromium "is five times harder than steel," and a plate that has been printed from every day for months shows by microscopical examination that each chromium-topped dot retains its original perfection. An impression from a Pantone block made with a 175 to the inch screen printed simultaneously with type on a rough surfaced paper shows how perfect the dot formation is.

The editor gives his usual summary of the year's progress, in which he points out the great advances being made in rotogravure colour printing now that the process is thoroughly practical, and at the end of the volume adds his "Note Book," dealing chiefly and critically with apparatus. "The Work of the Private Presses, VI., Essex House Press, 1898–1909," is treated of by Mr. Chas. T. Jacobi, with examples. A new system of music printing, "The Isotonic Notation," which is claimed to be simpler to learn as well as simpler to print than the usual notation, is described by Dom John Stéphan. There are other articles of technical interest and importance, besides the usual batch of illustrations to demonstrate the present degree of perfection to which the modern reproductive processes have attained.

English Life in the Middle Ages. By L. F. Salzman. Pp. 287. (London: Oxford University Press, 1926.) 7*s.* 6*d.* net.

THIS is an attractive, sensible, and useful book. Mr. Salzman has already published a similar work on the industries of England in the Middle Ages, and in this second volume he takes up the wider subject and does it even better. It is full of interesting and significant facts, well selected and well presented, with such an abundance of excellent illustrations as we may expect from the Oxford University Press.

Mr. Salzman's book is an admirable and more popular companion to "The Legacy of the Middle Ages" which the Oxford Press also published a few months since. The keynote of the two volumes is similar and a welcome sign of the new spirit in history teaching. The new point is the constant realisation of the fact that history is important to us just in proportion as we understand that we are ourselves a part of it and that the past has made us what we are. Mr. Salzman has this truth in view throughout, and when he talks either of literature, education, warfare, or law and order, is at pains to show, both how the work of our forefathers seven hundred years ago laid the foundations of our present life, and in what respects it has altered in the interval.

The chapters on education and literature are particularly good in this respect. In the former, Mr. Salzman makes clear the reason for the puzzling difficulty in the early study of mathematics. Why was arithmetic, which we now regard as the foundation of all exact intellectual discipline, then relegated to the Quadrivium or second stage in education, and only attempted by the few? The answer is that the Arabic system of numeration had not yet made its way into the schools, itself a historic fact of high social and intellectual import.

In treating of language and literature Mr. Salzman brings out, with equal prominence and usefulness, the value of the contact of Anglo-Saxon and Norman French in the three centuries after the Conquest. To this we owe the simplification of English grammar, the wearing away of genders and inflexions, which has made our speech the universal and adaptable thing which it now is.

The illustrations have been ransacked from the libraries of western Europe, and are a striking proof of the wealth to be gained from the study of medieval illustrated manuscripts. F. S. M.

Transactions of the Institution of Chemical Engineers. Vol. 3, 1925. Pp. 137. (London: Institution of Chemical Engineers, 1926.)

THOSE holding the opinion that chemical engineering is as distinct and important a study as are the other better-known branches of engineering might well point to the contents of this volume in justification of their views. There is a series of papers on industrial water supply and steam pollution, an authoritative discussion of filtration, a description of the machines used in magnetic separation, and a couple of lectures on petroleum distillation and steam jets. The latest developments in steam generation are also considered, for the volume includes a good account of the Brunler internal-combustion boiler, which employs a flame burning continuously under water, and an interesting description of the Benson generator, in which water is converted into steam without ebullition by heating it under the critical conditions of temperature and pressure. These brief references will suffice to indicate the wide range of technological interest covered during the year. Of the papers themselves, it need only be stated that their general merit testifies to the vitality of this youthful Institution.

The Chemical Age Year Book, Diary and Directory, 1927. Pp. 155 + Diary. (London: Benn Bros., Ltd., 1927.) 10*s.* 6*d.* net.

IN addition to a very convenient diary, this book contains information of special interest to the chemist. Short notices are given of such subjects as research organisations, chemical and allied societies, patenting of invention, use of industrial chemicals, trade name of dye-stuff intermediates, certain stock-exchange prices, etc. Various tables of constants and chemical data are included. A chemical directory and a number of trade advertisements form a large part of the volume. At the present time there are so many excellent collections of physical and chemical constants available that the advisability of including such information, especially in an abridged form as in this diary, may be doubted. On the whole, however, the material selected for inclusion takes up only a small portion of the book, and the data may have definite value in special circumstances. The binding and general appearance of the book are excellent. This may partly justify the price, which is rather high compared with that of diaries generally. J. REILLY.

Letters to the Editor.

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

Stresses involved in Tests of Hardness, and a Table of the Comparative Hardness of Certain Metallic Elements.

IN NATURE of Jan. 23, 1926 (vol. 117, p. 117), I gave a description of a method of determining 'Hardness,' in which a cone of the material to be tested was pressed against a hard surface (sapphire), and the area of the flat thus formed at the point of the cone by the application of a known force was measured, the hardness being defined as applied force ÷ area of flat, that is, as the greatest stress which the material can sustain.

In all forms of tests in which hardness is determined by the effects of a crushing force (whether by the indentation caused by a hard ball or the flattening of a point or ridge) the stresses involved can be expressed as a volume-compressive combined with two shearing stresses, and the principal points of interest can be illustrated by a simple example. Consider a cube the edges of which are the axes x, y, z (Fig. 1), and let a compressive force F parallel to z act on the x, y faces, while the other x, z and y, z faces are free from any external force. These are the conditions for crushing and they can be satisfied by supposing that a volume compression $F/3$ acts on all the faces, while the shears the components of which, each equal to $F/3$ parallel to z and x and z and y, act to increase the pressure on the x, y faces and to neutralise that on the faces x, z and y, z.

If k and n are the coefficients of volume compressibility and rigidity respectively, the result of the application of F is that the distance between the x, y faces is diminished by $\frac{F}{3}\left(\frac{1}{3k}+\frac{2}{n}\right)$, while between the x, z and y, z faces the distance is increased by $\frac{F}{3}\left(\frac{1}{n}-\frac{1}{3k}\right)$, and the maximum value which can be given to F in

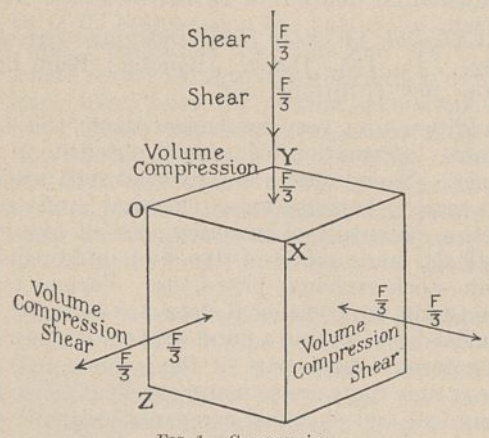

FIG. 1.—Compression.

this expression may be taken as defining the hardness of the material.

In all solids there are two distinct limits to the strains which they can withstand, namely, increase of volume and shearing strain. There is no known limit to the volume compression which can be borne by a solid; in fact, k increases continuously with the pressure, and hence when fracture is produced by crushing, the cause is to be found in its inability to resist shear.

Whether the coexistence of volume compression with shearing stress alters the limits of strain for the latter is not known: it seems probable, however, that it does, or at any rate may, do so: but assuming for the moment that k and n are independent, the hardness of a solid is three times the force required to cause it to shear.

In addition to the stresses just mentioned, reference must be made to the friction between the surface of the test piece and the harder substance by which the

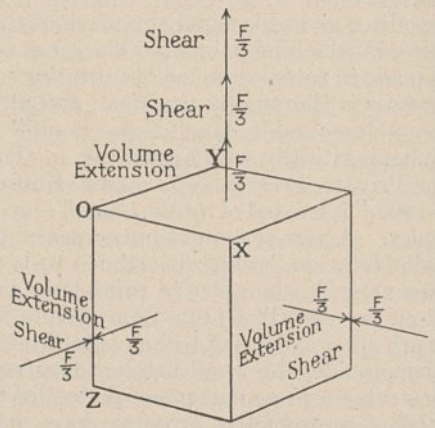

FIG. 2.—Extension.

crushing force is applied. This effect, which depends on the coefficient of friction, differs for each material, but in general adds to the apparent 'hardness' by opposing sliding motion which occurs at the area of contact.

In tensile tests the character of the stresses is inverted: volume compression is replaced by volume extension and the direction of the shear forces is reversed (Fig. 2).

In such tests rupture may occur either because the substance cannot bear the requisite volume extension or the requisite shear, and the nature of the break depends on which of the limits is the greater. When the limit of volume extension is small the material may be malleable although not ductile, but if it is ductile it is necessarily also malleable.

The accompanying table gives a list of 24 metallic elements arranged in order of their hardness. For

TABLE OF 24 METALLIC ELEMENTS ARRANGED IN ORDER OF HARDNESS.

Hardness stated in tons/square inch.

	Metal.	Hardness.	Remarks.
1	Iridium	240	*M.*
2	Molybdenum	158	*M.* Wire.
3	Tungsten	144	Thin plate, slaty fracture.
4	Rhodium	128	*M.* Wire.
5	Nickel	112	*M.* Wire.
6	Chromium	109	Cast: Crystalline aggregate.
7	Cobalt	99	*M.* Cast.
8	Titanium	77	Plate, slaty fracture. Brittle.
9	Manganese	60	Cast: Crystalline aggregate.
10	Iron	56	*M.* From ingot made by Merriot process. Pure.
11	Copper	50	*M.* Wire.
12	Aluminium	29	*M.* Wire.
13	Vanadium	28	Crystalline aggregate. Brittle.
14	Palladium	28	*M.* Wire.
15	Silver	25	*M.* Cast.
16	Magnesium	22	*M.* Cast.
17	Zinc	21	*M.* Cast.
18	Gold	20	*M.* Cast.
19	Calcium	17·5	Crystalline aggregate. Brittle.
20	Cadmium	12	*M.* Cast.
21	Bismuth	8	Large, crystal.
22	Tin	7	*M.* Cast.
23	Lead	3	*M.* Cast.
24	Thallium	1·4	*M.* Cast.

most of these the hardness is of little practical importance, but the table does show how capricious this quality is and how apparently unrelated either to density, atomic weight, or position in the periodic classification.

Much depends on the condition of each specimen and on the treatment to which it has been subjected, as, for example, whether it is cast, forged, rolled, or drawn. In the cast state some of the metals consist of an aggregate of small crystals which separate comparatively easily, and in these cases the value found for their hardness relates to the junctions of the crystals and not to the crystals themselves.

Only those metals which are, to some extent at least, malleable, give a true measure of hardness in this form of test. (These are marked *M* in the table.) The others show the apparent hardness of the particular specimen used, depending, in part, on the closeness of the aggregation of small crystals, or on the relation of the crystallographic axes to the direction of the crushing force.

Many alloys have been tested. Various kinds of steel range from 700 tons/square inch for hardened carbon steel down to 56 tons/square inch for pure iron, and it is worth while to notice that none of the reputedly hard metals such as iridium approach the former figure.

A. MALLOCK.

9 Baring Crescent, Exeter.

Is Darwinism Dead?

THE review in NATURE of Jan. 15 of my criticism on Mr. Wells's somewhat antiquated biology has only just been shown to me, hence the delay in my sending this letter. I will make it as brief as possible, for I am only concerned with showing that the distinguished reviewer, Sir Arthur Keith, though he has doubtless been given a few sentences from my book for purposes of quotation, has not read the book itself.

(1) He says: "So adroitly does Mr. Belloc cover his verbal tracks with a smoke screen" that he cannot determine whether I am a 'fundamentalist' or a 'Darwinian.' As a fact, I cannot conceive myself being either, but the point is that no one who had read my book could have imagined that 'Fundamentalism' was the issue. The only issue was whether natural selection were the process whereby the differentiation of species came about.

(2) He says that I give 'with approbation' St. Thomas's conclusion that the creation of man was (in scholastic language) 'immediate': that is, special and direct. Had the reviewer read my book he could never have sincerely written that. I quoted this *exceptional* conclusion on immediate human creation to show that St. Thomas probably thought the creation of animate beings other than man to be 'mediate': that is, evolutionary.

(3) The reviewer is "forced to the conclusion" that I have never read "The Origin of Species." If he had read my book he could not possibly have been 'forced' to so foolish a conclusion. All I say in it on this matter is written in direct relevance to that work—with its only original (and erroneous) thesis of natural selection as the machinery of differentiation.

(4) He says that "Mr. Belloc resuscitates this ancient misrepresentation of 'accidental' and 'single' variations," and follows the sentence up with a good deal of irrelevant abuse. Had he read my book he would have found that I know all about Darwin's retreat in this matter, *and* am careful to point out that it was a muddled retreat. For the mathematical argument against natural selection applies just as much to a thousand cases out of a million as to one out of a thousand.

(5) He so completely misunderstands the example I take from the growth of horns that he clearly has not read the original passage but is judging from a chance sentence put before him, and even that he fails to grasp. My point—clearly stated, emphasised, reiterated—was that multiple adaptation is mathematically incompatible with the blind mechanical action of natural selection. Multiple adaptation presupposes design. The citation of the hormone as a disproof of God is wildly off my point. One might as well say that the presence of glue in a piece of woodwork disproved the presence of a carpenter.

(6) I have kept to the last the most damning count in this indictment. The reviewer sets me down as owing my remarks entirely to Mivart, as having merely copied Mivart's work of more than half a century ago: implying my ignorance of all since. Had he read my book he would have seen that I quoted from authority after authority among the highest names in modern biology from the beginning of the discussion to works which appeared so recently as three years ago. I give their actual words, which prove with what increasing force the old-fashioned Darwinian theory of natural selection has been beaten down. I end by a list of no less than forty such names—I might easily have made it a hundred. No one who had read my book could possibly have missed this continued and repeated citation of authority from every side, which is the principal feature of this section.

I conclude, therefore, that the reviewer has not read my book; for I hope that not even the most violent religious animosity could lead him to deliberate misrepresentation.

H. BELLOC.

NOT only did I read Mr. Belloc's book with great care, but I also took the trouble of turning up the works of some of the authorities he cites. On p. 12 he mentions, with bated breath as it were, "the great work of Vialleton." This "great work" is a very good elementary treatise on embryology which Prof. L. Vialleton, of the University of Montpellier, wrote for his students, and it stands in much the same relationship to the works of Charles Darwin as do those of Mr. Belloc to Shakespeare's.

Mr. Belloc cites Vialleton as his authority for denying the possibility of birds having been evolved from reptiles. On searching Prof. Vialleton's "Éléments de morphologie des vertébrés"—published in 1911—I found on p. 611 that after citing what Huxley, Owen, Seely, Mivart, and Gadow had to say about the matter, Prof. Vialleton concludes thus: "L'origine des oiseaux reste donc dans le plus complet mystère," which is a very different thing from denying their origin from reptiles. I have collected many other errors of a like kind, enough to convince me that Mr. Belloc's references are untrustworthy. Many of the authorities he cites, such as my friend the late Prof. Dwight, of Harvard, belonged to the generation which never succeeded in assimilating the teachings of Darwin.

ARTHUR KEITH.

Radioactivity and the Heat of the Earth.

IN his presidential address to the Geological Society, abridged in NATURE of Jan. 1, Dr. J. W. Evans refers (page 15) to the above topic in the following words: "although the whole of the energy given out by radioactive elements, when isolated, is converted into heat, it is probable that a considerable proportion of the energy liberated by such elements, when they occur as rock-constituents, is used up in effecting physical, chemical, or atomic changes in the surrounding minerals.

"That much of the radioactive energy set free in the disintegration of radium and thorium is absorbed in other ways than in raising the temperature of the rocks is clearly shown by the formation in certain circumstances of 'pleochroic haloes' round radioactive minerals. This occurs especially in the case of zircon embedded in biotite mica. Such a halo is a sphere with a radius of about 30 microns, and has a minute zircon at the centre. It is of a darker and a deeper brown and far more pleochroic than the rest of the mica. The difference is usually assumed to be the result of ionisation by the radiations from uranium and thorium contained in the zircon. The possibility of atomic changes under the influence of the α-rays must, however, not be ignored.

"The formation of the haloes must involve a considerable absorption of energy, the magnitude of which will be realised when it is remembered that the mass of the halo may be some 15,000 times that of the zircon at its centre, and more than 300,000 times that of the uranium and thorium to which the halo owes its existence. Nor is it probable that this absorption is confined to the pleochroic haloes.

"It is, therefore, doubtful whether there is any considerable excess of radioactive energy available for raising the temperature of the earth."

In the absence of any experimental evidence in their support, such views as those expressed by Dr. Evans cannot be allowed to go unchallenged. They are liable to mislead, and to put unnecessary difficulties in the way of those who are interested in the trend of this aspect of geophysics, but are not sufficiently versed in the facts of radioactivity to form an independent judgment.

The occurrence of pleochroic haloes around radioactive inclusions in certain minerals certainly does show that *some* of the energy of the radiations emitted by the inclusions produces effects other than thermal ones; but before we are justified in stating that *much* of the energy is so expended, we must make an appeal to the available evidence, and this decides conclusively against Dr. Evans's view.

There is no evidence in favour of the view that an *appreciable* proportion of the energy liberated by the radio-elements, when they occur as rock constituents, is used up in producing changes of the kind suggested by Dr. Evans. In all determinations of the heat developed by radium, alone and with its disintegration products, the substance has been enclosed in a glass tube of sufficient thickness to absorb the α-rays completely, as well as more than thirty per cent. of the β-rays, and it is well known that the glass container rapidly becomes coloured by the action of the rays, the effects being quite analogous to those observed in minerals. Were Dr. Evans's views correct, we should expect that the heat development as determined experimentally would be considerably less than the value calculated from a knowledge of the number and energy of the rays involved; but this is far from being the case. Thus, for radium alone, that is, without disintegration products, the calculated heat development per gram of the element is 25·47 cal. per hour, whereas the measured value is 25·1 cal. per hour (Rutherford and Robinson) or 25·2 cal. per hour (Hess), and these experimental values probably require to be raised by 0·2 or 0·3 cal. per hour owing to incomplete absorption of the γ-rays from radium in the apparatus used (see NATURE, 116, p. 897, 1925).

Almost equal agreement is obtained between experiment and theory when we consider the total heat developed by 1 gram of radium together with its short-lived products. The results of experiment yield 135 cal. per hour (Rutherford and Robinson), and 137 cal. per hour (St. Meyer and Hess), both results probably being somewhat low owing to insufficient allowance for the effect of the γ-rays. On the assumption that all the energy of the rays is converted into heat, and with the latest data, the total heat production of radium and its short-lived products in equilibrium works out to be 137·7 cal. per hour per gram of the parent element (see *Phil. Mag.*, vol. 2, p. 1227, 1926). From the close analogy between the effects in glass and in minerals, it seems safe to conclude from these results that the energy of the radioactive rays expended in the manner suggested by Dr. Evans does not amount to one per cent. of the total energy, and is probably not more than about one-tenth of this value.

Determinations of the heat production in uranium and in thorium minerals have also been carried out experimentally. Here the effects are so small that the results cannot be expected to agree very closely with the calculated values. Nevertheless, the agreement is surprisingly good and gives additional support to the conclusion reached above.

Another aspect of the problem is worthy of mention. A rough calculation indicates that the energy of the α-particles emitted by the inclusion during the life of a representative pleochroic halo may amount to several hundred micro-calories. Were an appreciable fraction of this energy to be stored in the halo and liberated say by the application of heat, it is to be expected that the halo would attain a temperature reckoned in thousands of degrees. But nothing so violent occurs in practice. Glasses and minerals coloured by radioactive rays are restored practically to their original condition when their temperature is raised to from 200° to 400° C., and in the process they exhibit the phenomenon of thermo-luminescence with the emission of light of characteristic colour; but the energy so liberated does not produce catastrophic results, and is manifestly small.

The problem of the thermal history of the earth is unquestionably one of great difficulty, and in its elucidation much still remains to be done. But we cannot lightly dispose of the fact that radioactive processes must have exerted a profound and indeed a controlling influence in maintaining that youthful vigour which has characterised our planet throughout geological time. The effects of uranium, thorium, and potassium cannot be ignored in geothermal considerations, and in the absence of any experimental evidence to the contrary, we can continue to assert with confidence that practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur.

ROBERT W. LAWSON.

University of Sheffield.

Progressive Lightning.

IN NATURE of Nov. 20 last, Prof. C. V. Boys has an article on some attempts to photograph 'progressive lightning,' in which he refers to observations of 'multiple flashes'—that is, flashes succeeding each other along the same path.

There is no doubt of the reality of these *appearances* of multiple flashes, but I have very serious doubts of there being more than one flash in reality.

Córdoba is an excellent place for the observation of lightning, as the electrical displays are frequent during the summer months, and they are some of the strongest I have ever witnessed (in several parts of the world). The Observatory is well situated on the bluff overlooking the river, with a clear view over the pampas in almost all directions for many miles. Displays are often observed at distances of forty to fifty miles and many pass directly over us. Houses of the astronomers and other buildings have been

struck several times during my residence here, and one of the steel and concrete domes was struck once. In the early history of the Observatory one of the astronomers was killed in his room in the assistants' house.

Altogether I have observed many hundreds of brilliant flashes, as many close ones perhaps as distant ones. I have many times observed these 'multiple' flashes, usually two or three succeeding each other. They are strikingly clear and sharp and sometimes appear to vibrate. They certainly give the impression of there being distinct flashes, but I cannot conclude that this is a fact, because they are invariably seen only when the flashes are distant, usually too distant for there to be any sound. Now we have every reason to expect that just as many of this type of flash should occur near by as at a great distance if there are really several flashes instead of one. But in all my experience I have never seen a case near by; they are always at a great distance. One of the strongly marked characteristics of the near flashes, in appearance as in sound, is their sharpness and shortness—the nearer the shorter. Flashes within a hundred yards are sensibly instantaneous to both eye and ear, and *always single*.

From these facts I conclude that the 'multiple' flashes are due in some way to erratic refraction in the atmosphere.

It would not be without value perhaps for two observers, some twenty or thirty miles apart and in telephonic connexion, to test this matter by observing whether the flashes which appear multiple are observed to be so at both stations in cases where the flash is very close to one station and distant from the other.

C. D. PERRINE.

Observatorio Astronómico de la
Nación Argentina,
Córdoba, Dec. 19.

I HAVE to thank Dr. Perrine for his observations on my article on "Progressive Lightning." They are interesting as indicating some difference in the appearance of lightning in the Argentine, where the strokes are exceptionally strong, and that of lightning in Great Britain. Here without any question the appearance of the multiple flash is found when the distance is as little as a kilometre, and I certainly believe much less. In Cordoba Dr. Perrine only observes this when the flashes are so distant that thunder is barely heard. Such a distance here is from sixteen to twenty kilometres. I suppose here, with a flash near enough, even if it were multiple, the eye would be so dazzled by the primitive flash as not to be able to see those that follow, but it is difficult to account in this way for the great distance implied by the faint audibility of the thunder. I have seen a large number of photographs taken with an ordinary camera held in the hand, and not intentionally moved as Dr. Hoffert's was, but nevertheless not really fixed, which show the multiple flash, and the size of the flashes on the plates indicates that they must have been fairly near. At any distance such as sixteen kilometres the flash would occupy but a small portion of the plate.

I could have wished that Dr. Perrine had supplemented his eye observations with photographic records which would be easily obtained in so favourable a locality. It would appear that it is a suitable place for my proposed rocket experiment, that is, if the descent of the empty case and stick is not a danger as it is with me. I might add to my previous observations that the rocket, preferably of about three centimetres calibre, should be without a head but with one calibre extra of solid composition over the hollow left by the spindle, and that the usual proportion of coarse charcoal be retained, so that the whole length of the trail should contain live sparks to improve its conductivity. Such a rocket would attain perhaps double the usual height and move with immense speed.

If any question should arise as to the conductivity of the trail, this could be assured by allowing the rocket to carry up a hundred metres or more of fine copper wire arranged like a life-line so as not to kink. Owing, however, to the inconvenience of laying this in thunder rain I would first rely on the trail.

C. V. BOYS.

The Polishing of Surfaces.

IN NATURE of Sept. 4, 1926, Mr. J. M. Macaulay suggested that, in the process of polishing, surface layers were actually melted—the energy supplied being ample to produce melting, and the difficulty with regard to temperature disappearing if the heat, due to friction, was produced at points of contact rather than over large areas (the temperature at a *mathematical* point-source of heat being infinite). In NATURE of Jan. 29, Mr. N. K. Adam contends that "it does not seem necessary to suppose that actual liquefaction occurs," since "the polisher will tear away the surface particles of the glass" and "some of these particles will naturally be redeposited elsewhere at random, thus forming the amorphous layer." Now it is difficult to believe that particles of glass spread at random will have a polished surface, even although these particles be of molecular dimensions, since each particle will be covered by a surface layer of gas, or other substance, which will prevent cohesion at ordinary temperatures. It might be contended that in the polishing process the particles torn from the surface had no time to assume a surface layer, but that is surely a highly improbable assumption. It seems to me that Mr. Macaulay's letter gives the key to the rational explanation of surface polish.

JAMES MUIR.

The Royal Technical College,
Glasgow, C.1, Jan. 31.

PERHAPS my letter of Jan. 29 requires some further explanation. I did not suppose that the particles were redeposited as a dust on the surface, expecting them to coalesce spontaneously to a polished layer; this would of course be impossible. If, however, we examine what would happen to the *molecules* on the liquefaction hypothesis and on mine, it appears that mine is simpler and more probable. On the liquefaction hypothesis, the forces of adhesion between the moving polisher and the surface (constituting friction) are supposed to produce heat first; this heat then liquefies the surface layer. That means that the friction sets up irregular thermal vibrations in the surface molecules; it is then necessary to suppose that the energy of these vibrations is dissipated less rapidly than it accumulates, owing to the small thermal conductivity of the material; finally, the vibrations become so intense that the molecules can no longer stay in their positions in the solid, and 'melting' occurs. It must further be supposed that the surface layers remain liquid sufficiently long to flow to a plane surface, with whatever assistance may be given by the motion of the polisher.

My hypothesis states that the polisher adheres to the surface, dragging away small particles. In the same manner, at other localities, the adhesion of the surface to the polisher drags back some of the particles adhering to the polisher. Thus the polisher acts as

a temporary support on which many particles are removed from one point to another. Hardy's work on static friction shows that this tearing away occurs under quite light pressure, despite the possible presence of surface layers of gas. Clearly the random removal of particles, only some of which need be of molecular dimensions, from one point of the surface to another, must result in forming an amorphous layer, if continued long enough.

If there is energy enough to move the surface molecules as a result of intense thermal vibrations —which is all that melting amounts to—there must be ample energy for the mechanical transportation of my hypothesis. Thermal vibrations are a notoriously inefficient method of producing a specific mechanical result. The result required is the moving of molecules from an ordered space lattice to a disorderly, amorphous layer; and the motion of the polisher, picking up and redepositing particles elsewhere, seems admirably adapted to produce this.

I have some difficulty in accepting Mr. Macaulay's theory that the polisher only touches the surface at a point. This seems almost incredible, with a moving piece of flexible material such as wash-leather. Further, even supposing that the contact approximates to point contact in the first stages of polishing, through projections on the surface alone touching the polisher, one would expect that these points would be worn or melted away long before the completely polished, plane surface was attained, so that there would be contact over considerable areas in the later stages of polishing. I should expect heat to be lost from the area polished at nearly the normal rate of loss from a plane area the size of the apparent contact between polisher and surface.

N. K. ADAM.

The University,
Sheffield, Feb. 3.

Wheat in 3500 B.C.

A SHORT time ago I received from Prof. Poulton and Sir John Russell small samples of wheat grains found by Prof. Langdon, of Oxford, in a vase on the site of an ancient Sumerian house at Jamdet Nasr, seventeen miles north of Kish in Mesopotamia.

The wheat, which Prof. Langdon dates 3500 B.C., is of much interest, not only on account of its antiquity, but also because its grains are of a type associated with the more highly developed races of this cereal.

The identification of the races of wheat by their grains only is always difficult, and sometimes impossible. In this case, however, I conclude, from the features noted below, that they belong to a variety of Rivet wheat (*Triticum turgidum*), a wheat, so far as I am aware, unknown to the ancient Egyptians, and the first authentic ancient sample of this race which I have seen.

The characters of these grains, namely, large average size, blunt apex, very prominent dorsal hump, and asymmetry or lop-sidedness of some of the grains due to pressure of the flowering glume on one side, are all characters of *T. turgidum*, and the grains are matched exactly by several modern varieties, which we grow annually at the Agricultural Botanic Garden at Reading (see Fig. 1).

According to a letter from Prof. Langdon in the *Times* of Feb. 3, the opinion has been expressed that the grains are those of Bread wheat (*Triticum vulgare*) or of Club wheat (*T. compactum*), but the grounds upon which these conclusions are based are not given.

The view that they belong to *T. vulgare* may, I think, be neglected, for their prominent dorsal hump and the asymmetrical form of some of the grains are opposed to this identification. I am also unable to agree with the suggestion that they are grains of *T. compactum*. All known varieties of this race of wheat have been grown here and studied during the last thirty years, and the majority possess grains similar in form to those of *T. vulgare*, but smaller; a few uncommon representatives have the dorsal hump of *T. turgidum*, but the large size of Prof.

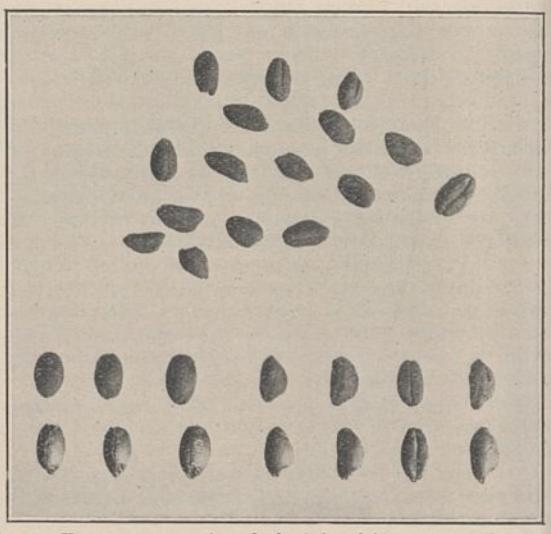

FIG. 1.—Upper group: grains of wheat found in a vase on the site of a Sumerian house (3500 B.C.). Two lower rows: grains of modern Rivet wheat (*Triticum turgidum*) for comparison. (Natural size.)

Langdon's grains is against their classification with these.

All trustworthy evidence we possess shows that Emmer (*T. dicoccum*) was the wheat first grown by the oldest civilised peoples, and I am of the opinion that these grains belong to the Emmer group of wheats; they leave us still without any clue to the origin of the Bread wheat series, but I hope that further discoveries in the region from which these have come will ultimately provide material for the solution of the problem.

Apart from its botanical interest, Prof. Langdon's discovery is of much importance, in that it has proved that the Sumerians were in possession of an advanced type of wheat at a very early date.

JOHN PERCIVAL.

The University, Reading,
Feb. 5.

The Length of Light Quanta.

AT the meeting of the American Physical Society in December last, Lawrence and Beams reported experiments showing that the length of light quanta is smaller than 3 cm. Experiments were made by me in the spring and summer of 1926 on the same subject with a similar result, though by a different method. While the experiments were begun, however, a theoretical consideration showed that a positive result would be very improbable, and so the results were not published. The reasoning was as follows:

It is well known that it is possible to obtain an oscillogram of a radio wave and that by a proper choice of apparatus (Dufour oscillograph) one can photograph the wave form for periods which are small fractions of a wave-length. No matter how small this fraction is, the photographic trace gives directly both the sine character of the wave and its frequency because it satisfies the differential equation $\frac{d^2y}{dt^2} + (2\pi\nu)^2 y = 0$. Therefore, every-day electrotechnical

measurements show that quanta of long wave-length have an effective length (in the sense of Lawrence and Beams) which is very much shorter than the wave-length of the radiation.

In my experiments a glass prism spectrograph and a photographic plate were used instead of a photo-electric cell. A Kerr cell with nitrobenzol as material was operated by means of sustained oscillations of 30 metres wave-length. Spectra of various sources were photographed with the cell operated as described above, and these spectra were compared with those obtained by applying a small direct field to the cell. This field was adjusted by trial so as to give the same intensity as the high-frequency alternating field. In all cases the spectra were identical.

It was expected that if light quanta should have a length corresponding to the mean life of an atom, then since for an opening time of $T = \frac{1}{2} \times 10^{-7}$ some lines are longer and some shorter than T, a change in the relative intensity of lines would be observed. No such effect was observed. Further, if the nicols were crossed well, the direct field which had to be applied was the root mean square value of the alternating.

The spectrograph was a low-dispersion, large-aperture Zeiss instrument kindly loaned by Dr. Meggers of the Bureau of Standards. It was naturally impossible to observe the theoretical broadening by means of it.

Needless to say, the experiments of Lawrence and Beams and those of the writer are a continuation of the experiments of G. P. Thomson with canal rays.

G. BREIT.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington.

A Polymorphic Oligochæte.

DURING a recent visit to North Wales an effort was made to increase our knowledge of its oligochæte fauna. The most interesting result was the discovery in three different localities of as many different forms of one worm, usually known as the Venetian worm (*Eisenia veneta* Rosa). In a rubbish heap near some gardens in Colwyn Bay I came across one specimen which closely resembles Rosa's type. Hitherto this has only been found at Kew, where it is probably an introduction. The Welsh specimen, however, has tubercula pubertatis on four segments on one side, while the normal two are on the other. This recalls the variety *zebra*. In a garden near by several specimens of a very different form occurred. In almost every British earthworm the girdle is much more fully developed dorsally than ventrally, but in these the conditions were exactly reversed. So characteristic is the appearance as to justify a distinguishing name, and this variety may be known as *tumida*. The third form was found under the bark of a tree along with several dendrobænic worms, and this closely resembles some of the other varieties which have been described.

We now have at least half a dozen well-marked varieties of this most unstable of all British worms, the list being as follows:

1. *Eisenia veneta* Rosa, *typica*. Kew Gardens, Sept. 1909. Colwyn Bay, Sept. 1926.
2. Var. *zebra* Mich. Ireland. Southern, 1909.
3. Var. *hibernica* Friend. Dublin, June 1892.
4. Var. *dendroidea* Friend. Malvern, 1909.
5. Var. *robusta* Friend. Kew, Oxford, Malvern and elsewhere, 1909.
6. Var. *tepidaria* Friend. Oxford, 1904.
7. Var. *tumida* Friend. N. Wales, 1926.

Some interesting problems present themselves in connexion with these facts, and a wide field for observation and investigation is opened up thereby.

HILDERIC FRIEND.

"Cathay," Solihull, Jan. 18.

Tuning-Forks with Parallel Prongs.

ATTENTION has been directed by Mr. Maxwell (NATURE, Jan. 22, p. 124) to an apparently extraneous overtone heard in tuning-forks, the pitch of which is one octave above the fundamental tone of the fork.

An explanation of the presence of this tone was supplied by the late Lord Rayleigh, who ascribed it to the action of unbalanced centrifugal force set up by the motion of the ends of the prongs in curved paths ("Collected Papers," vol. 1, p. 318).

A state of oscillatory tension thus comes into existence within each vibrating prong, and the frequency of this oscillation is double that of the transverse vibrations of the prongs themselves. The same holds for the bases of vibrating reeds and the ends of a vibrating wire.

Rayleigh obtained the octave tone by using a 256 fork on the box of a 512 fork. It may also be brought out by means of a Helmholtz or other resonator.

As Mr. Maxwell remarks, it is also heard when the butt end of the vibrating fork is placed on a table. With gentle pressure, the fundamental alone is heard, but with increased pressure, the octave above becomes audible, the pressure having to be increased as the amplitude of the prongs diminishes. By using a domestic spring-balance it may be found that the pressure required to bring out the octave of, say, a 512 fork with parallel prongs rises from 1 or 2 ounces to 6 or 7 ounces while the octave remains audible.

When the prongs are inclined to the stem, a component of the centrifugal force is not transmitted to the stem, and the vibration of the butt end due to this cause is of smaller amplitude. G. E. ALLAN.

Department of Applied Physics,
University of Glasgow.

[Mr. W. Anderson, College of Technology, Manchester, writes to point out that the effect described by Mr. Maxwell is also referred to by Lord Rayleigh in his "Theory of Sound," vol. 2, p. 463.—EDITOR, NATURE.]

Adsorption of Dyes to Silver Halides: a Correction.

IN a letter on this subject (NATURE, Dec. 25, p. 913), the number of dye molecules adsorbed at saturation to the surface ions of silver bromide crystal was given as about 1 dye molecule to 20 ions at *p*H 5·5. An error in the calculations has been found, which shows that the adsorption should be just ten times as great, namely, 1 dye molecule to about 2 ions of the lattice surface. Inasmuch as the dye adsorption increases with increased *p*H, it is probable that the limiting adsorption density occurs at the formation of a complete monomolecular layer. It may be possible to test whether the maximum sensitising effect is reached before this layer is completed.

S. E. SHEPPARD.

Eastman Kodak Company,
Rochester, N.Y., Jan. 12.

George Henry Lewes.

I SHOULD esteem it a great favour if any one possessing a photograph, however small, of George Henry Lewes about 1875, would allow me to have it copied. E. SHARPEY-SCHAFER.

University New Buildings,
Edinburgh, Feb. 7.

The Electron as a Vector Wave.

By Prof. C. G. DARWIN, F.R.S.

THE spinning electron of Uhlenbeck and Goudsmit has brilliantly filled up a serious gap in atomic physics, but, while we cannot withhold our admiration from its successes, it is only fair to consider certain defects from which it suffers. When what is required is to double the number of states of the electron, it is at the least generous to introduce three extra degrees of freedom and then make an arbitrary (though not unnatural) assumption which cuts down the triple infinity to two. The electron is in fact given a complete outfit of Eulerian angles, even if it may not be necessary so to express the matter explicitly. Now we regard the electron as the most primitive thing in Nature, and it would therefore be much more satisfactory if the duality could be obtained without such great elaboration. The present communication is an attempt to do this; it is, I think, promising, though falling short of complete success, but as future stages would involve a very large amount of work, it seemed better to expose the theory to criticism at once, in case some serious objection can be made against the whole principle of it.

The above criticism of the spinning electron is perhaps partly aesthetic, but there are others. Thus though dynamical principles have been shown by both Thomas (NATURE, 117, 514) and Frenkel (*Zeit. f. Phys.*, 37, 243) to give doublet spectra correctly, yet neither of them has succeeded in casting the result in a rigorous Hamiltonian form, so that all the work on the spinning electron has a 'dressed-up' appearance, lacking in formalism. Again the wave mechanics (in this the matrix mechanics is better) definitely excludes half quantum numbers for the spin, and so would lead to triplets instead of doublets—1, 0, −1 instead of $\frac{1}{2}$, $-\frac{1}{2}$. It is perhaps also not unfair to argue that the quantum mechanics is largely guided by the principle that nothing unobservable is to be explained, so that a theory is to be regarded as suspect, which introduces a large number of higher quantum states of rotation, only to bar them later.

The advent of the wave mechanics must have suggested to many a way out of these difficulties by assimilating the electron to a transverse rather than a longitudinal wave, for this at once provides the number of states with the necessary factor 2. The idea involves difficulty when more than one electron is present; we shall discuss and tentatively meet this difficulty later, but a necessary preliminary is to obtain a system of equations for the single electron. In doing so we are endowing it with an intrinsic duality to which there is no direct analogue in dynamics, so that the only guidance we have is that the equations must be of the wave form (to conform to classical dynamics in the limit), and must be such as to give correctly the structure of doublet spectra. It is scarcely conceivable that the equations should not involve the Schrödinger functions, and this excludes, as a great many trials showed, any wave type built on lines like the electromagnetic equations, for the Schrödinger function will not tolerate a *divergence* relation of any kind. Moreover, such types of wave do not appear to exhibit those qualities of approximate degeneracy which are implied by the Paschen Back effect. It is, however, possible to construct by a much more inductive process a system of waves, of a vector character though not transverse, which completely reproduces the doublet spectra, and then to generalise from this.

The general character of doublet spectra is given by having two *dependent* variables, each of which nearly satisfies the same equation, say $Df=0$ where D, depending on x, y, z, t, is the operator in Schrödinger's equation. Let α, β, γ, δ be small perturbing operators in x, y, z, t, and solve the equations

$$\left.\begin{aligned} Df+\alpha f+\beta g=0 \\ Dg+\gamma f+\delta g=0 \end{aligned}\right\}, \quad . \quad . \quad . \quad (1)$$

Near any characteristic W_n of $Df=0$ there are then two solutions of (1) with just the right type of degeneracy. Our task is, therefore, to discover forms of $\alpha \ldots \delta$ which will give the observed values of W for doublet spectra, and this is not so hard as might appear at first sight.

The *terms* of a doublet spectrum are very conveniently epitomised as follows. We take $k=0$, 1, 2 . . . for s, p, d . . . and $-k\leq m\leq k$, m being integral. For all values of m solve the following equations for $\overline{W}$:

$$\left.\begin{aligned} a_m[\overline{W}-\rho m-\omega(m+1)]-b_{m+1}\rho(k+m+1)=0 \\ b_m[\overline{W}+\rho m-\omega(m-1)]-a_{m-1}\rho(k-m+1)=0 \end{aligned}\right\}, \quad (2)$$

where ρ, ω are the Landé constant for doublet separation and the normal Zeeman effect in energy units. It will be found that the solutions give $\overline{W}$ as the distances of all the Zeeman levels from the centre of gravity of the terms at all strengths of magnetic field. (The equations give two end solutions of different form from the others, and these give the two extra members for one component of the doublet.) The above equations were found by solving the complete problem of the spinning electron and then adjusting the constants by trial; a_m and b_m are then the coefficients of a spherical harmonic for the two directions of spin. We shall not further inquire into their meanings; when suitably normalised they will of course be connected with intensity, but we need feel little doubt that intensities will come right on practically any theory.

By trial with $k=1$ and 2 it is easy to construct the operators $\alpha \ldots \delta$ and these are then found to work for all cases. The equations (1) are:

$$\left.\begin{aligned} \left(D-\frac{2\pi eH}{ch}\right)f+\frac{1}{2}\frac{Ne^2}{mc^2}\frac{1}{r^3}(-iR_1g-R_2g+iR_3f)=0 \\ \left(D+\frac{2\pi eH}{ch}\right)g+\frac{1}{2}\frac{Ne^2}{mc^2}\frac{1}{r^3}(-iR_1f+R_2f-iR_3g)=0 \end{aligned}\right\}, \quad (3)$$

In these D is the Schrödinger operator, written in

the form of Dirac (*Proc. R. S.*, **112**, 661) with the view of relativity generalisation :

$$D=\nabla^2-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}-\left(\frac{2\pi mc}{h}\right)^2+2\cdot\frac{2\pi i}{c^2h}\frac{Ne^2}{r}\frac{\partial}{\partial t}+\frac{2\pi ieH}{ch}\left(x\frac{\partial}{\partial y}-y\frac{\partial}{\partial x}\right)+\left(\frac{2\pi Ne^2}{ch}\right)^2\frac{1}{r^2}$$

and

$$R_1=y\frac{\partial}{\partial z}-z\frac{\partial}{\partial y},\quad R_2=z\frac{\partial}{\partial x}-x\frac{\partial}{\partial z},\quad R_3=x\frac{\partial}{\partial y}-y\frac{\partial}{\partial x}.$$

N is the atomic number of the nucleus, and we have reversed Heisenberg's process of deriving Landé's doublet formula from the mean of $1/r^3$. As it will be needed later, we here note that with the present formulation the time occurs in f and g in the form $exp-i\frac{2\pi}{h}(mc^2+W)t$. In spite of their appearance the equations (3) are symmetrical in x, y, z, when $H=0$.

The presence of coefficients Nex/r^3, etc., is a strong invitation for us to generalise, since they are simply the electric forces. Moreover, this generalisation is required if we are to show that the anomalous Zeeman effect is the same phenomenon as the doublet effect. We first split the two equations into four. Multiply by arbitrary constants a, b and add. Then do the same with ia, $-ib$; $-b$, a ; ib, ia. We call the quantities $af+bg$, etc., X_1, X_2, X_3, X_4. (The process is nearly, but not quite, the same as taking real and imaginary parts of (3).) The equations then become :

$$\left.\begin{aligned}DX_1-U_1X_4-U_2X_3+U_3X_2=0\\DX_2-U_2X_4-U_3X_1+U_1X_3=0\\DX_3-U_3X_4-U_1X_2+U_2X_1=0\\DX_4+U_1X_1+U_2X_2+U_3X_3=0\end{aligned}\right\},\qquad(4)$$

where

$$U_1=\frac{1}{2}\frac{e}{mc^2}\left(E_y\frac{\partial}{\partial z}-E_z\frac{\partial}{\partial y}\right),$$

$$U_3=\frac{1}{2}\frac{e}{mc^2}\left(E_x\frac{\partial}{\partial y}-E_y\frac{\partial}{\partial x}\right)+i\frac{2\pi e}{ch}H_z.$$

These equations, which are really only two, are now in vector form for space transformations, regarding X_4 as a scalar and X_1, X_2, X_3 as a vector. We can therefore take the magnetic force in any direction by adding on to U_1, U_2 terms like the last in U_3. It remains to apply the relativity transformation. The first point to observe is that (4) is not in space-*time* tensor form. To make it so we must use the fact that with sufficient approximation $-i\frac{2\pi}{h}mc^2=\frac{\partial}{\partial t}$. Remembering that E_x is the 14 component of the force tensor, this shows that the equations must be put in the form

$$\frac{\partial}{\partial t}DX_1-V_1X_4-V_2X_3+V_3X_2=0,\text{ etc.}$$

where

$$V_1=-i\frac{\pi e}{h}\left(E_y\frac{\partial}{\partial z}-E_z\frac{\partial}{\partial y}\right)+i\frac{2\pi e}{ch}H_x\frac{\partial}{\partial t},\text{ etc.,}$$

This is now *dimensionally* a possible tensor equation, but is not in fact covariant for space-time transformations. It is necessary to take the electric terms in V to be twice as large as they really are ; this is exactly the trouble of Uhlenbeck and Goudsmit. We shall discuss it later, for the present simply doubling the first factor in V_1, etc. Now write $x_1x_2x_3x_4$ for x, y, z, ict, and ϕ_1, ϕ_2, ϕ_3, $-i\phi_4$ for the vector and static potentials ; also for the six forces put $F_{12}=\frac{\partial\phi_2}{\partial x_1}-\frac{\partial\phi_1}{\partial x_2}$, etc. Remembering that $\partial/\partial x_4$ is much larger than $\partial/\partial x_1$, etc., and that H is much smaller than E, we add on certain insensible terms and obtain as our final equations

$$\left.\begin{aligned}T_4X_1-T_1X_4-T_2X_3+T_3X_2=0\\T_4X_2-T_2X_4-T_3X_1+T_1X_3=0\\T_4X_3-T_3X_4-T_1X_2+T_2X_1=0\\T_4X_4+T_1X_1+T_2X_2+T_3X_3=0\end{aligned}\right\},\qquad(5)$$

where

$$T_1=\frac{\partial}{\partial x_1}\left\{\sum_\alpha\left(\frac{\partial}{\partial x_\alpha}+i\frac{2\pi e}{ch}\phi_\alpha\right)^2-\left(\frac{2\pi mc}{h}\right)^2\right\}+i\frac{2\pi e}{ch}\left(F_{23}\frac{\partial}{\partial x_4}+F_{34}\frac{\partial}{\partial x_2}+F_{42}\frac{\partial}{\partial x_3}\right).$$

On the present view, apart from the introduced factor 2, these equations constitute the ultimate dynamics of a single electron. It will not alter the observed values, and will perhaps fit better with future generalisations if throughout (5) the operators $\partial/\partial x_1$, etc., are replaced by $\frac{\partial}{\partial x_1}+i\frac{2\pi e}{ch}\phi_1$, etc., as they are in D.

The first three equations of (5) are antisymmetric tensors of the second rank and the last is scalar, but the variables can be permuted according to the following scheme, so that any one of the four equations is the scalar :

$$\begin{matrix}X_1\\X_2\\X_3\\X_4\end{matrix}\rightarrow\begin{Bmatrix}X_4\\X_3\\-X_2\\-X_1\end{Bmatrix}\rightarrow\begin{Bmatrix}-X_3\\X_4\\X_1\\-X_2\end{Bmatrix}\rightarrow\begin{Bmatrix}X_2\\-X_1\\X_4\\-X_3\end{Bmatrix},\qquad(6)$$

The existence of these permutations means that to regard the X's as a vector is an unnecessary restriction, to which it may not always be convenient to submit. For example, by allowing a different rule of transformation the theory could be put in terms of four purely real quantities.

We must next consider how the solution will go when more than one electron is present. This is a most important matter, for the replacement of independent by dependent variables might entirely alter the counting of the number of solutions. We shall omit relativity considerations and so may use (4) instead of (5). At first sight the most natural extension would be to regard X_1, etc., as functions of two sets of x, y, z ; thus the first equation of (4) would become

$$(D+D')X_1-(U_1+U'_1)X_4-(U_2+U'_2)X_3+(U_3+U'_3)X_2=0.$$

The effect would be to double the number of

solutions, but it would seem that they would sort out as 2+2, not 3+1 as is required. We need a process which will give 4+4 solutions, reduced to 3+1 by Heisenberg's resonance principle (*Zeit. f. Phys.*, **38**, 411). This could probably not be done for most vector waves, but the permutations (6) suggest a way out; for in combining the two sets of variables there is no particular reason to select the same permutation of both. The actual number of possible selections is easiest seen from (3), where in adding the effects together we can interchange the meanings of f and g. We shall in this way get two systems of equations each with four solutions, just the number required. The question of two or more electrons is, I think, the most serious difficulty for the present theory, and this is only intended as an incomplete and tentative suggestion as to how it may be met.

Finally, we must consider the factor 2 which had to be introduced to obtain the tensor form. This is evidently the original difficulty of Uhlenbeck and Goudsmit. It was removed by Thomas, who showed that a rigid body when accelerating exhibits a sort of rotation on account of the kinematics of relativity. This brilliant explanation resolves the disagreement, but it really imports a foreign idea into mechanics; indeed relativity and rotation do not take at all kindly to one another, and it is not surprising that no formal Hamiltonian method has been found to cover what is really a blemish in geometry rather than dynamics. As we here have nothing corresponding very exactly to velocity, we cannot use the same type of argument. But regarding the matter from a more abstract point of view, may we not perhaps draw an inference from the fact that our work has forced us to have equations of the third degree? Relativity is essentially a point theory and is governed by a quadratic form. To a first approximation motion is controlled by this form, and the associated wave equations are of the second degree. Now we have seen that the actual wave equations, though approximately of the second degree, are more accurately of the third. Taking the analogy back, may we not conjecture that the quadratic form of space-time wants amplifying in some way (I fear the idea is quite vague) by terms of the third degree, and that the reason why Thomas and Frenkel did not obtain a formal Hamiltonian is because 'quadratic' dynamics is only an approximation, which cannot be perfectly represented by importing into relativity theory the foreign idea of a rigid rotating body. But this speculation is too indeterminate to pursue further at present.

Nerves and Muscles: How we Feel and Move.

By Prof. A. V. HILL, F.R.S.

IT is not an easy task to give the Christmas Lectures at the Royal Institution, especially on a subject like physiology, in which experiments are much more difficult than in some others, at least when required to work without fail, to be intelligible and not to cause offence. The difficulty is increased by the fact that one's audience does not consist simply, in the words of the Royal Institution, "of juveniles between the ages of 10 and 16"; one finds oneself addressing distinguished adults in many walks of life, and not only these, but also through the publicity given to these lectures in the press, a considerable proportion of the people of Great Britain. One must reflect, however, in preparing them that they are intended for 'juveniles,' and that if others dare to come they do so at their own risk and will be assumed to be 'juveniles' for the purpose of the lectures. It is true, as a matter of fact, that most lecturers are apt to pitch their lectures at a level much too high for their audience, and that by attempting to make them interesting to a child of thirteen they may well succeed in absorbing the attention even of adults comparatively expert in the matter with which the lecture deals. We all like to have things put to us simply, and no lecturer to a juvenile auditory should pay any attention whatever to people above the age of sixteen.

The Christmas lectures at the Royal Institution are intended to include a considerable number of demonstrations and experiments, and without the use of live animals experiments on the functional working of the body are impossible. Two fortunate facts, however, make it practicable to give suitable phsyiological demonstrations at the Royal Institution: (1) that the isolated organs and tissues of dead cold-blooded animals will continue to function for considerable periods after removal from the animal; and (2) that in recent years a great variety of perfectly good physiological experiments, often of precise quantitative as well as qualitative significance, have become possible upon men; and if upon men, then also upon children.

The fact that isolated tissues of animals will function for a long time after removal, although a commonplace of phsyiology, is not generally realised, and in itself is a matter of entrancing interest to those who come upon it for the first time: it awakens all kinds of questions, scientific and philosophical, which not only a 'juvenile' but also an adult urgently desires to see answered. The beating of an isolated heart, which will continue for hours or days after removal from its previous owner, provided that it be properly treated, is an extraordinary eye-opener to most people previously ignorant of phsyiology. There are few physiologists who do not remember the astonishment and interest which was aroused in them by their first sight of this phenomenon, or of the reflex movements of a frog whose head has been cut off, or of the contraction of a muscle preserved, sometimes for days, in salt solution, or of the electric current produced by an isolated nerve, or of the many other strange things that happen to little bits of tissue removed from the ordinary environment which their previous owner supplied. It is such things that bring physiology first into the region where exact experiments can

be made, and allow the factors at work in living tissues to be examined carefully and at leisure in the laboratory. The astonishment which we, as physiologists, have felt at intervals at such things, and which, if we have not grown too old, we still remember, is one thing we can and should communicate to our listeners, not only perhaps at the Royal Institution, but also at our classes in universities. The experience of the lecturer himself, at such a course of lectures as these, is valuable as showing him the kind of thing that appeals to intelligent, keen, unsophisticated, and natural people. There was no doubt from their applause that the audience approved of experiments in which the functions of organs were revealed by such experiments on isolated tissues.

Even more, however, than experiments on surviving portions of dead animals did the audience appreciate the fact, which I am sure many of them had never realised before, that experiments of all kinds on the mechanism of the body can be performed on man, or in this case on children, without discomfort or danger. How many are the things which, when we were young, we wanted to know about the machinery inside which we live—and nobody told us. Gradually, perhaps, we thought that these things were not to be known, or were unknowable; gradually, perhaps, we reached the state, in which I fear a good many adults exist, of regarding the machinery of the body as something unwholesome or 'nasty.' If my audience had been simply one of adults, I might perhaps have been afraid of shocking them in taking a life-like model of a man to bits and trying to fit it together again, after describing its various parts. In the case of children no such fear is necessary. As I have already said, there are very few small boys and not many grown men who do not want to take machinery to bits to see how it works; and children are quite ready to realise that they live inside a mass of complex and beautiful machinery, and are only too glad to be given the chance of taking it to bits, at any rate scientifically speaking, and examining its parts.

To a child there is nothing 'gruesome' about seeing the heart beating in a live man, or in watching the food (by means of X-rays) travel along his inside; nor are they inclined to faint, as some adults are, if one amplifies the sounds made by a human heart, or shows a kinematograph film of the blood corpuscles swarming through the capillaries of the lungs. The advantage of the audience at the Royal Institution is that they are natural people without any obsessions, so one can speak to them as one natural human being talking to another. Possibly some adults may have thought that the children *ought* to have been shocked by some of the experiments we performed; I am sure, however, that very few of the children themselves lived up to such an expectation. It is only by continually suppressing one's desire to know more about, and to understand, the body in which one has to make a home for so long, that one gradually develops an obsession that there is something unnatural, unclean, or 'gruesome' about it.

It was most instructive to note which of the demonstrations, and which of the lantern slides, appealed most to the audience. Of the slides the one that seemed to please the audience best was a simple little diagram, taken from Cannon, showing how the food is propelled along the alimentary canal by a peristaltic wave, consisting of a contraction behind and a relaxation in front of the portion of food to be moved. This little diagram evoked prolonged clapping. I suppose many of the audience had long wondered how the food moved along their insides, especially perhaps at Christmas time, and maybe had wanted to ask but had found nobody to tell them. Another slide they obviously admired was a simple diagram of the central nervous system, taken from Prof. Pear's book, "Skill in Work and Play," by which I described how they themselves, sitting up aloft in the cortex of the brain, were able to carry out all kinds of automatic, or semi-automatic, activity by means of the 'telephone exchanges' existing in the cord below, and were able to appreciate muscular movement by the messages from muscles, tendons, and joints which pass up along the afferent nerves and into the different levels of the nervous system. Another slide which evoked obvious approval was a simple piece of arithmetic by which I explained how the greater the length of a race the slower one had to go. This is a fact of which we are all aware, but only recent progress in physiology has made clear what are the factors which determine it. The body has a certain 'income' of oxygen and a certain 'credit' upon which it can draw. If the 'credit' has to spread out over a longer period, less of it can be spent per minute, the effort must be smaller, and the speed lower. The fact that they obviously approved of this simple arithmetic, which certainly contained nothing sensational or dramatic, is a tribute to the intellectual level of the audience.

The first lecture dealt with "Nerves and the Messages they Carry." Isolated nerves and muscles were shown working, the electric current produced by an excited nerve was demonstrated, and an experiment was made on the stimulation of the ulnar nerve of a child. The messages coming along nerves were described, and the central nervous system was likened to an automatic telephone exchange.

The second lecture dealt with "Muscles and How they Move." In this, isolated muscles were stimulated, and a competition was organised between the muscle-nerve preparation of a frog and the muscles of a child stimulated through the ulnar nerve. The child won easily, because his circulation was able to supply his muscles with the oxygen they required in order to do the work, while physical diffusion alone was unable to bring oxygen rapidly enough to the frog's isolated muscle, which therefore rapidly fatigued. The electric change of the human heart was shown, and the physical and chemical basis of fatigue was discussed.

The third lecture dealt with "The Heart and Some other Muscles," chiefly with the heart. X-ray pictures of the alimentary canal after an opaque

meal were followed later by a demonstration, kindly organised by Messrs. Watson and Sons (Electro-Medical) Ltd., in which a subject drank an opaque meal, which could be observed passing down into his stomach. Following this was an X-ray demonstration of the heart of the lecturer and others. The lecture had been started by a demonstration, organised by the Marconiphone Company, Ltd., in which the sounds made by the heart of a child were rendered audible throughout the hall. In the fourth lecture I dealt with "The Lungs and Blood: How the Muscles get Air and Fuel," in which perhaps the chief demonstration was that of a wonderful kinematograph film by Prof. Krogh, of Copenhagen, in which the blood corpuscles are seen circulating in the tissues of a frog. There is no means of which I am aware so good as this film of showing what the circulation of the blood really means. We discussed the energy derived from the fuel burnt in the muscles, and we saw experimentally how the oxygen consumed by man can be measured.

In the fifth lecture, "Nerves and Muscles Working Together," I discussed the basis of organised muscular movement, the nature of muscular skill and of muscular sensation, and all those automatic, or semi-automatic, actions of which a large part of our being is composed. A slow motion kinematograph film of a dancer, and another of a falling cat, were employed to emphasise the wonder of muscular skill, while a demonstration of the 'psycho-galvanic reflex' showed how our emotions cannot be hidden from certain quite simple physical apparatus. The sixth lecture, "Speed, Strength, and Endurance," dealt with an application of some of these matters to such things as mountain climbing and athletics; the importance of an adequate supply of oxygen was demonstrated by an experiment on a boy who pedalled a bicycle, breathing oxygen at only two-thirds of the ordinary atmospheric pressure, until very tired, and was almost immediately relieved—and pedalled with renewed vigour—when given oxygen in high concentration. Finally, it was emphasised how a capacity for severe muscular effort depends mainly on simple considerations of energy, and of skill in the economy of energy, and how certain predictions can be made of a man's athletic capacity by means of physiological measurements.

As I said in my first lecture, many people who own motor-cars know very little about the insides of them and how they work, which is distressing enough, especially when they go wrong. How many more who own perfectly good bodies have only the vaguest idea of their machinery, or of the meaning and importance of the various parts. In these lectures I tried to give my audience some idea of the working of two of the most important parts of the body. One cannot hope yet to understand our living machinery in full, but even the little we know already can add delight to physical exertion, and can make us realise the complexity of muscular skill and the nature of strength and endurance. The effort to understand will help us to appreciate the beauty and wonder of the devices with which our bodies are endowed; and when we begin to understand a little we shall soon want to understand much more.

Obituary.

DR. EUGEN HULTZSCH.

BY the death at Halle on Jan. 16, in his seventieth year, of Eugen Hultzsch, the study of Indian epigraphy loses one of its most ardent and painstaking followers. Born in Dresden, he was educated at Leipzig and Bonn, studying under Aufrecht, the famous Sanskritist. From 1882 until 1886 he was assistant professor of Sanskrit at Vienna. He was then appointed epigraphist to the Indian Government, remaining in the Service until 1903, when he retired and accepted the chair of Sanskrit at Halle. This he held until his retirement some time after the War. During the greater part of his service in India, Hultzsch edited *Epigraphia Indica*, to which he contributed many valuable articles. His own researches were very largely devoted to the inscriptions of the Presidency of Madras. His "South Indian Inscriptions," published between 1890 and 1893, gave in three volumes critical texts and translations of between three and four hundred inscriptions, mostly from the Tamil country. His reports on Sanskrit manuscripts in southern India were published in three massive parts between 1893 and 1905. His reputation as a scholar, however, will rest mainly on his edition of the edicts of Asoka—a subject on which he was the acknowledged authority. The publication of this standard work was delayed by the War, but it has recently been issued by the Indian Government on behalf of the Archæological Survey. In it the whole of the previous literature of the subject is critically examined, and each text is given in the original with an English translation. Hultzsch was a contributor to the *Journal of the Royal Asiatic Society* and to that Society's prize publications, as well as to other orientalist periodicals, while in recent years he took a prominent part in the work of the German Oriental Society. Orientalists in Britain are particularly indebted to him for, first, the valuable collection of Sanskrit and other manuscripts made during his stay in India which is now in the Bodleian Library at Oxford, and, secondly, for his exertions in securing the return to the India Office and the Royal Asiatic Society of the valuable manuscripts and books on loan at the Leipzig exhibition when the War broke out.

WE regret to announce the following deaths:

Sir George Greenhill, F.R.S., formerly professor of mathematics in the Artillery College, Woolwich, on Feb. 10, aged seventy-nine years.

Dr. C. D. Walcott, secretary of the Smithsonian Institution of Washington, D.C., since 1907 and formerly director of the U.S. Geological Survey, on Feb. 8, aged seventy-six years.

News and Views.

GREEK philosophers twenty-five centuries ago held that the gods work by geometry and by arithmetic: mathematics is the corner-stone of the temple of science. During the past two years a remarkable development has taken place in theoretical physics through the application of mathematical methods to the problems of the quantum. The introduction of the new quantum mechanics associated with the names of Heisenberg and of Schrödinger, and the revival of interest in the spinning electron, bid fair to initiate a new era in quantum theory. It is a striking testimony to the powers of generalisation inherent in mathematics that the method of matrices, due originally to Cayley, has proved a useful weapon of attack in the hands of Born and Jordan. After a prolonged discussion of the relative merits of language and mathematics as elementary disciplines, Willard Gibbs is reported to have said: "Mathematics is a language." Unfortunately it is too frequently "a tongue not understanded of the people," and for that reason it is not now our usual custom to publish in NATURE articles involving advanced and unfamiliar mathematical methods. The present stage of development is, however, exceptional, and as many of our readers are deeply interested in the new ideas, we have to some extent departed from precedent and are publishing certain articles by eminent authorities in which mathematical treatment is a necessity.

IN our present issue Prof. C. G. Darwin discusses the nature of the electron; after pointing out certain difficulties which arise on the hypothesis of the spinning electron, he suggests that the electron should be regarded as a system of waves of a vector character though not transverse. In treating the electron as a vector wave, he finds himself faced with a difficulty which arose also in the work on the spinning electron. A factor 2 has to be introduced to obtain the requisite results, and Prof. Darwin suggests that the quadratic form of space-time wants amplifying in some way by terms of the third degree. Perhaps a guess may be hazarded that the difficulty arises from insufficient attention being paid to the possible existence of 'magnetism' as essential to the constitution of the fundamental units of electric charge. But whatever may be the final reading of the riddle, our readers will welcome the attempts which are now being made to solve these and other fundamental problems in atomic physics.

THE Prince of Wales was the principal guest at the annual dinner of the Institution of Electrical Engineers on Feb. 10. In proposing the toast of the Institution he mentioned that after his presidential address to the British Association last year, Lord Balfour had expressed the hope that his year of office would be marked by some striking scientific achievement. This has now been accomplished. By the labours of the experts in Great Britain and the United States, the Atlantic has been finally bridged by radio telephony, and to-day anybody in Great Britain can—at a price—call up anybody in America whenever he cares. The Prince reminded his hearers that the scientific machine is always running quietly in the laboratory. Individual effort by itself will not keep this machine running smoothly. Were it not for the existence of our various scientific and technical institutions it might even come to a standstill. The Institution of Electrical Engineers bridges the great gulf between pure science and practical science. Electricians have given to the community electric light, power, and radio. Their inventions are known throughout the world and in every home at the present time. Great Britain would be in a very bad way if it did not back up inventions. We are perhaps a little too apt to be afraid of new things. Dr. Eccles, the president of the Institution, in replying, said that the Institution numbers nearly 13,000 members, and is in close touch with every electrical activity in the country. The signals from the radio station at Rugby are received all over the globe, and measurements show that they are the most powerful signals in the world. The Rugby station and the beam stations in Britain are in advance of foreign practice. Last year Englishmen laid in the Pacific the longest submarine cable in the world constructed with all the latest improvements. Col. Wilfred Ashley, the Minister of Transport, said that the Electricity Act caused members of the Government a good deal of trouble last year; one effect of the Act being before Parliament, however, is that the manufacturers of Great Britain exported £20,000,000 worth of goods overseas during its discussion.

THE gold medal of the Royal Astronomical Society has this year been awarded to Prof. F. Schlesinger for his work on stellar parallaxes and the determination of star places and proper motions by photography. Dr. J. H. Jeans devoted his presidential address to the Society on Friday last, Feb. 11, to a survey of this subject. Prof. Schlesinger's work on parallax began very early in the century. At that time only about eighty stellar parallaxes had been determined, and many of them were very uncertain. He published an article with several valuable suggestions for the improvement of photographic determinations. The two most important points were: (1) The light of the parallax star must be equalised with that of the comparison stars; this can be done either by placing a semi-transparent screen over the lighter image, or preferably by rotating a circular disc, from which a sector has been cut out, in front of it; (2) in order to eliminate differential refraction depending on colour, all plates must be taken close to the meridian, and the measures made in the direction of Right Ascension. Prof. Schlesinger carried out these principles first at the Yerkes Observatory, and later at Allegheny. He himself has obtained several hundreds of parallaxes, with probable errors in the neighbourhood of one-hundredth of a second

of arc; many observatories, including Greenwich, have followed in his footsteps, so that the number of known parallaxes runs into thousands.

ANOTHER line in which Prof. Schlesinger has done most useful work is the application of doublet lenses to stellar photography. He has shown that accurate stellar positions can be obtained on plates covering an area of $5° \times 5°$; in spite of the smaller scale, the precision of the measures is practically equal to that obtained with the astrographic telescopes, while the area of the plates is six times as great. He has already published catalogues for two complete zones, and the results are so successful that the Astronomische Gesellschaft has made arrangements to survey the whole of the northern heavens in a similar manner in the course of the next few years. Prof. Schlesinger is now director of the Yale Observatory; he is continuing work on the lines that he followed at Allegheny, and visited Johannesburg early in 1925 to inaugurate the work of the telescope that was sent there from Yale, which is in charge of Dr. Alden.

HOMAGE was rendered to the memory of the late Prof. Heike Kamerlingh Onnes on Feb. 10, when Prof. Ernst Cohen, of the University of Utrecht, delivered the Kamerlingh Onnes Memorial Lecture before the Chemical Society. The address was a panoramic survey of a fruitful life rather than an analysis of the theoretical and experimental achievements which entitle their author to be numbered among the *primi inter pares* for all time. Prof. Cohen first referred to the records of Kamerlingh Onnes' schooldays under Van Bemmelen, later professor of chemistry in the University of Leyden; to the award at eighteen years of age of a gold medal for an essay on "A critical investigation of the methods of determining the vapour density, and of the results obtained thereby, with respect to the relation of the nature of the chemical compounds and the density of their vapours"; to his sojourn at Heidelberg with Bunsen and Kirchhoff; and also to his sterling personal qualities. Onnes' doctorate thesis, presented at Groningen in July 1879, insisted on the closest correlation between theory and experiment, a programme to which he adhered to the end of his days. In Oct. 1882, when assistant in Bosscha's laboratory, he was appointed to succeed Ryke as professor of experimental physics at Leyden; simultaneously there commenced his triumphal progress through the realms of low temperatures.

OF Dewar and other workers in the same domain, "le gentleman du zéro absolu" with "Inferior!" as his watchword, continually spoke in appreciative recognition; neither did he neglect to acknowledge the part which his wife (Elisabeth Byleveld, whom he married in 1887) had played in his success by her care for her delicate husband. On Dec. 10, 1913, he received the Nobel Prize at the hands of the King of Sweden. In speaking of Onnes' character as a man and as an investigator, the lecturer referred to the report of the solidification of helium in March 1908, quickly followed by letters to NATURE in April (vol. 77, pp. 559 and 581) withdrawing the announcement and ascribing the observations to solution phenomena of solid hydrogen in gaseous helium; renewed experiments yielded liquid helium in the following July. In 1922 Onnes considered it safe to say that "the lowest temperature yet attained is some hundredths of a degree below 0·9° Abs." On Feb. 21, 1926, he passed away, leaving the last stage of his work on helium to be completed, but a few months afterwards, by Keesom. Prof. Cohen briefly referred to Onnes' services to the craft of instrument making, and concluded his tribute with words borrowed from Prof. Donnan: "He was a gentleman in every sense of the word, and one of the first gentlemen of European Science."

BELIEVERS in democratic institutions will watch with great interest the development of the Fundamentalist controversy in the United States, which is far from being the Gilbertian drama which it is sometimes taken for in England. The dictatorship of the uneducated and mentally undeveloped is a very real menace in the middle western and southern States of the Union. We have received a pamphlet, "Evolution and Intellectual Freedom," compiled by the Rev. Dr. Hay Watson Smith, pastor of the Second Presbyterian Church in Little Rock, Arkansas, in view of a threat to prohibit the teaching of the theory of evolution in the tax-supported schools of the State. The pamphlet contains a number of representative pronouncements of American and British men of science, as well as expressions of opinion by Theodore Roosevelt and Woodrow Wilson. In all probability these authoritative utterances will enliven the virulence of the anti-evolution fanatics; for if the doctrine is so well supported, there is all the more need to suppress it. How the fight will end it is impossible to say. Truth prevails, of course, but only with the intelligent, who must be in a very small minority in the State of Arkansas. We cordially admire the courage and vigour of Dr. Hay Watson Smith, and the ability displayed in this compilation of his. It is always so easy to fall in with the majority, and so difficult, in a country like America, where opinion is so much less free than in Europe, to take an independent line.

THAT Dr. Hay Watson Smith's pamphlet has not yet been effective is evident from a message in the *Times* of Feb. 11, in which its New York correspondent reports that the Arkansas House of Representatives has just passed a Bill prohibiting the teaching of evolution in any school supported by taxation. The Bill indeed passed by a narrow majority, 50 votes to 47, and had actually been defeated on a first roll-call. A similar Bill was 'killed' in committee by the New Hampshire legislation and by that of Missouri. In Louisiana, however, in spite of an adverse vote by the legislature, the Superintendent of Schools has, on his own authority, acting under pressure from religious associations, directed that evolution shall not be taught in State-supported schools. One wonders whether the science teachers are sufficiently well organised to resist this sort of dictation. Obviously, argument and appeals to reason are likely to be in

effective, and only co-operative action, whether by passive resistance or otherwise, can avail. Yet the Fundamentalists are one of the most powerful, as they are the most ignorant, sections of opinion in America. Science teachers and, indeed, all who desire progress, will, therefore, have to exert themselves very actively if they are to survive in this struggle for free intellectual existence.

IN his fourth Gifford lecture in the University of Edinburgh, delivered on Feb. 11, Prof. A. S. Eddington discussed the extension of the theory of relativity to non-uniform motion made by Einstein in 1915, ten years after the announcement of his earlier hypothesis. Prof. Eddington described the curious effects which would be observed when performing simple experiments within a freely falling lift, and the different views as to the results which observers inside and outside the lift respectively would record. Their experiences necessitate the re-formulation of the law of gravitation to include some conception of curvature. Space-time is now regarded as a four-dimensional manifold, and it requires twenty distinct measures at each point to specify it. Ten of these measures are more prominent than the rest, and Einstein's law of gravitation asserts that in empty space these ten principal measures of curvature are zero. A fundamental point in the theory is the relativity of acceleration.

MR. W. H. BROWN, Mill Hill School, London, N.W.7, recorded in last week's issue (p. 238) that two-way communication had been established between the School and the two Norwegian whalers *Sir James Clark Ross*, call-sign AQE, and the *C. A. Larsen*, call-sign ARDI. He now informs us that Mr. C. W. Goyder listened-in from the Mill Hill School station (2SZ) at 8.15 A.M. on Feb. 13, when he found that AQE was already in communication, in Norwegian, with LAIX (J. O. Berven, Stavanger). In reply to various questions, AQE reported to LAIX that signals were being received well, and that the ship had been in direct communication with LGN (the Bergen Radio Coast station) during the week. Mr. Goyder has heard another English station, 2LZ (F. A. Mayer, Stileman's, Wickford), in two-way communication with ARDI. It appears, therefore, that such communication with two ships in the Antarctic has now been established between two Norwegian and two English stations.

DR. E. F. ARMSTRONG, managing director of the British Dyestuffs Corporation, in his address before the Royal Society of Arts on Feb. 9 on "The Romance of the Organic Chemical Industry," selected the aliphatic alcohols as providing examples of chemical achievement of great industrial importance. Ethyl alcohol, used as a solvent and as an anti-freezing agent in the radiators of motor-cars, is made in large quantities from molasses. Its manufacture by an alternative method, the conversion of cellulose, for example, sawdust into fermentable sugar, Dr. Armstrong described as one of the prime problems of chemical industry to-day. By the synthetic production of methyl alcohol the cost has been reduced to about 20 per cent. of what it used to be. In due course the way is clear to cheaper formaldehyde and consequently cheaper indigo and synthetic resins. Butyl alcohol is being made in thousands of tons from grain or rice; but another process is also in use, based on acetylene. Yet another potential source is petroleum. In general, the tendency in the production of alcohols is to substitute methods based on coal or carbide for fermentation processes using food-stuffs. Dr. Armstrong concluded an interesting address with an appeal for more research directed to finding out how to accomplish new things, or even old things in a novel manner.

PROF. EDMUND GARDNER delivered a lecture on Feb. 8 on "Conceptions of the Cosmos, according to Dante," in continuation of the series which is being given at Bedford College for Women (University of London). He stated that Dante's cosmology is based ultimately on Aristotle, but as modified by Christian conceptions of the relationship of the universe to its First Cause. His individuality lies in his mystical interpretation of generally received theories. In Nature, "the Art of God," the soul may contemplate the working of the Divine Will. It has a threefold existence, in the mind of the First Mover, in the heavens, in the world of created things. The earth lies at the centre of the universe, disposed in nine concentric spheres revolving round it. Universal Nature originates in the ninth sphere, that of the First Mover, which by its motion regulates the motions of the other eight spheres. Enveloping the whole is the tenth sphere, or Empyrean, where there is neither time, space, nor natural law. The universe is brought into being by a process of double creation. The angels, the soul of man, the heavens are created immediately; secondarily, through the agency of Nature, there is a continuous process of generation by which potential matter becomes actual existence. The four elements, fire, air, water, earth, are disposed in concentric circles, earth being at the centre. But because universal Nature required a place where the elements could meet in order that things might come into specific being, portions of earth have been raised above the water. This, the inhabited earth, is confined to the northern hemisphere, and Jerusalem is its centre. At the antipodes lies the Mountain of Purgatory. The informative virtue of the heavens in the motion of the spheres superimposes form on the substratum of primal matter. The imperfect result is due not to the agent, but to a flaw in the material owing to the mysterious presence of evil. The whole creation is a single order through the working of a spiritual law of gravitation. An instinct is given to each thing to realise the degree of perfection of which it is capable, and to move to its own place where it is at rest. All causes are traceable to the First Cause; the universe is a unity.

EVERY one who has studied mechanics has a wholesome dread of high-speed machinery. In a 25,000 horse-power electric generator driven by a

water or steam turbine and running at 3000 revolutions per minute, the rotating part weighs about 20 tons and the kinetic energy is about 50,000 foot tons. In fact, the energy is approximately the same as that developed by a head-on crash between two fourteen coach six hundred ton trains each travelling at 35 miles per hour. The bursting of a rotor running at this speed might well cause a serious loss of life as well as great damage to property. In practice the stresses are all computed beforehand and a large factor of safety is allowed. Only the highest class material is used, and the greatest possible care is taken in manufacture. In addition, the completed machine is usually tested in an underground pit. The Metropolitan Vickers Electrical Co. of Manchester has recently designed and erected a new 'overspeed' test house in which 'rotors' up to 14 ft. 6 ins. in diameter and shafts up to 40 ft. in length can be tested. The walls are 9 ft. 6 ins. thick and are composed of wood, steel, bags of sand, air-cushioning space, and reinforced concrete. In arranging the materials, advantage was taken of the lessons learned during the War in the construction of shell-resisting structures: the door alone weighs 17 tons. A motor of 1800 horse-power is installed permanently, and by suitable gearing, speeds ranging from 350 rev. to 7200 rev. per min. can be attained. Special arrangements can also be made to attain much higher speeds. When the rotor to be tested is fixed in position, the door of the test-house is closed and complete control is obtained by electrical means. Vibrographs, oscilloscopes, and high-speed cameras are employed and elaborate records are made. In addition, a hole is bored right through the centre of the shaft and the internal surface is carefully inspected by a specially designed telescope.

DURING the oceanographical expedition of the *Arcturus* in July 1925, a Petersen trawl was worked on the edge of the Challenger Bank (about 10 miles south-west from Bermuda), and at a depth of about 506 fathoms, in a region where the sea bottom rapidly slopes down to more than 2000 fathoms. In the catch made were four eggs of about 3·3 mm. in diameter. Their appearance was that of the eggs of eel-fishes that are known, but there was only one way of identifying the species to which they belonged—that of hatching them out. Fortunately this was successfully done, and in a preliminary note (*Science*, Nov. 5, 1926) Marie Poland Fish describes the larvæ that were so obtained. There seems to be little doubt that they are leptocephali of the American eel, *Anguilla rostrata*. Pelagic nets were being worked both at the surface and at various depths, while the Petersen trawl was at the bottom, but only in the latter instrument were eel-eggs obtained. It is suggested by the author that the observations favour the previous theory of deep fertilisation. The catch was made within the boundary of the region regarded by Johs. Schmidt as the breeding ground of the American and European eels. Few observations will give naturalists so much pleasure as this: since 1904, Dr. Schmidt has carried on his intensive study of the life-history of the eel, and a year ago the only essential observation that had still to be made was that of finding the eggs. Details are yet to be worked out, but with this record there ends a mystery that has perplexed naturalists since the time of Aristotle, and a word of congratulation to Marie Fish and Johs. Schmidt is not inappropriate.

THE sixth annual report of the British Electrical and Allied Industries Research Association, presented at the meeting on Feb. 11, is of interest, as it shows that electrical manufacturers are keenly alive to the importance of scientific research. As a rule the research work undertaken by private firms is confined to that which yields immediate results commercially. But there is a large section of the work which demands intensive co-operative effort on the part of all sections of the industry, and in this direction research associations can do useful work. During the past year an attempt has been made to unravel the complicated physical phenomena which cause the breakdown of electrical insulation. Considerable progress has been made in explaining the phenomena as shown by gases, and it is hoped that the vexed questions of the breakdowns in liquids and solids will soon be satisfactorily answered. In particular a study of the corona phenomena in liquids is furnishing data of importance to designers. Working pressures are still on the upward grade and accurate and simple methods of measurement are required. A useful critical résumé of recent work on dielectrics has been prepared by Mr. L. Hartshorn of the National Physical Laboratory. Enlarged tables have been issued during the year based on the experimental work previously completed by Prof. H. L. Callendar. The work has been extended to higher temperatures and pressures and the apparatus constructed is expected to give results up to a temperature of about 850° F. and steam pressures of about 3000 lb. per square inch. The results given have proved useful to the designer and form a trustworthy basis for the rating of turbines.

THE formation of Imperial Chemical Industries, Ltd., a combination of four of the most important chemical concerns in Great Britain, namely, Brunner Mond and Co., Ltd., Nobel Industries, Ltd., British Dyestuffs Corporation, and United Alkali Co., Ltd., is of high significance in its bearing upon chemical research in Great Britain. The larger an industrial corporation grows, the more time can it afford to spend on research of an academic nature, because its results are available to a larger public. It is common knowledge that some of the constituent firms of the above combination have already made substantial contributions towards the discovery of new knowledge of a general type, and the advances made in this direction are an earnest of substantial contributions from industry to science to be expected in the future. Most research work in chemistry carried on at universities and similar institutions is limited to conditions of easily obtainable temperatures and pressures, on account of lack of money, lack of continuity of research staff, and the necessity of doing research which will 'come out' in a reasonable time.

A GREAT combine such as Imperial Chemical Industries, however, has great advantages: it is endowed with ample funds, has plenty of time and a continuity of staff, and is therefore able to attack problems which are beyond the scope of most universities. Whether the results of such work will be suitable for publication, and whether it will be published, remains to be seen. Much scientific research of this kind is concerned with the determination of as many physical constants as possible, because they can be applied later to other problems. That these determinations will be carried out with the greatest accuracy possible is also certain, in order to make the work permanent and of real capital value. We may be sure, therefore, that the well-known research tendencies of some of the constituent companies will be intensified in the allied group. The effect of this on academic life will be all to the good, and the study of the theoretical sides of somewhat neglected branches of science will be promoted. In short, it is not too much to hope that the effect of the research policy and publications of the new combine will give to academic chemistry a healthy stimulus and direction which should be of benefit to both science and industry.

IT is some twenty years since the New Zealand government began its policy of acquiring lands for the sake of preserving natural scenery. From a small beginning the area of scenic reservations in the Dominion has now grown to 454,000 acres. The recent annual report of the Department of Lands and Survey on scenery preservation records the addition during 1925–26 of 3067 acres. These include an area surrounding the Wairoa Falls which will ensure the safety of the falls and a stretch of native bush; a kauri forest of 652 acres on the Waitakerei ranges, where bird life is abundant; an area of 19 acres of the limestone rocks of Waro; and several other areas valuable on account of their wild life or proximity to well-settled districts. Part of Motuanaura Island on Queen Charlotte Sound was reserved on account of its historic interest, since it was there that Captain Cook in 1770 proclaimed British sovereignty over the South Island.

THE Smithsonian Institution, Washington, has just received from M. Ferdinand Canu, of Versailles, a leading authority on fossil micro-organisms, his collection of fossil invertebrates from France, and particularly the Paris basin, that he has spent fifty years in gathering together. The collection is accurately labelled as to the localities and geological horizons whence the specimens came. M. Canu chose the Smithsonian as the depository of his collection to secure its preservation and to insure its immediate use in connexion with the recently discovered relationship between fossil micro-organisms and oil deposits, a field in which associates of the Smithsonian Institution were among the pioneers. M. Canu made the gift through Dr. R. S. Bassler, palæontologist of the National Museum under the Smithsonian, with whom he has collaborated extensively since 1910 in working out geological horizons for the Atlantic and Gulf States. This work was undertaken by Dr. Bassler and M. Canu at the request of the U.S. Geological Survey. In 1924 M. Canu received the Elliot medal, one of the highest honours in American science, from the National Academy of Sciences for his work in palæontology.

WITH the December number our Norwegian contemporary *Naturen* completed its fiftieth year. A retrospect of the valuable popularising work it has accomplished since its foundation in 1876 by the geologist, Dr. Hans Reusch, is given by Dr. W. C. Brøgger. The number also contains an article by Lektor O. Valeur on the theory of relativity and its effect on our conception of the universe. Continuing his articles on the food of the East, Dr. Sopp here describes *ching-tong*, a Chinese malt-extract prepared from rice and used for many dietetic purposes. A note on lemming, by J. Grieg, and other small notes complete the number. We offer our congratulations and best wishes for the future to the present editorial staff.

THE Report of the Bristol Museum for the year ending Sept. 30, 1926, records the gift by Lord Ducie of the collections formed at Tortworth Court by the third Earl of Ducie. These include a unique fauna from the Llandovery and Wenlock rocks of Tortworth, with good series from the older rocks of South Wales and the Carboniferous Limestone of Belgium, also more than two thousand stone implements from the British Isles and Europe, and ethnological specimens from New Guinea and North America. Another important accession is the collection of birds and mammals obtained by Sir J. H. Greville Smyth, Bart., preserved at Ashton Court and in the Bungalow, Ashton Park, and now presented by the Hon. Mrs. Esmé Smyth. It is expected that the extension of the Museum and Art Gallery, provided for by the generosity of Sir George A. Wills, Bart., will be completed in two years.

IN the Report of the Executive Committee of the Empire Cotton Growing Corporation, submitted on Jan. 13, mention is made of the Report of the Research Sub-Committee set up by the Imperial Conference, which, after referring in eulogistic terms to the work of the Corporation, recommended the Conference to pass a resolution commending to the various Governments the work of the Corporation in the promotion of Empire cotton-growing. It also recommended periodical agricultural conferences, the first to be in London in 1927, and invited all the Governments concerned to send representatives. The Director of the Corporation is about to start upon a visit to South Africa, where, under plantation conditions, the present low price of cotton is a serious handicap. Rain-grown cotton is being successfully extended in the Sudan, and notice is taken of successful work going on in many parts of Africa, especially of Mr. Sampson's activities in work upon rotation of crops, a thing which is eminently desirable in connexion with Empire cotton.

THE Société de Biogéographie, Paris (61 rue de Buffon), is now entering into the fourth year of its

existence and we are asked to invite the attention of all botanists, biologists, ethnologists, geologists and zoologists, whose aim is the study of the distribution of living and fossil organisms over the surface of the globe, to this association. The society meets every month, and useful and interesting discussions on various subjects are held. In addition, at fixed intervals it institutes fundamental investigations on subjects selected as of importance to biogeographers, the solutions of which may require the collaboration of specialists in various branches of knowledge; for example, a series of memoirs forming a volume of 250 pages has lately been prepared on the "Histoire du Peuplement de la Corse"; a new volume on "Le Peuplement des Montagnes" is in preparation. The number of the members of the society is limited; but its reports (*Compte rendu Sommaire des Séances de la Société de Biogéographie*) for the years 1924–26 are on sale; current reports can be subscribed for (15 francs a year for France and 18 francs for abroad).

THE new journal *Protoplasma* or the *International Journal of the Physical Chemistry of Protoplasm*, which has recently been founded in Austria under the editorship of Prof. Weber of Graz and Prof. Spek of Heidelberg, seems to be thoroughly justifying its existence. There has certainly not been, up to the present time, any journal devoted to the physics and chemistry of the cell-interior—to physico-chemical cytology. In the first number, W. Seifriz investigates the protoplasmic papillæ on the surface of the immature sea-urchin egg and discusses their colloidal nature. E. Küster writes on plasmolysis and gives details of his experiments on *Vakuolenzerkluftung*, and much the same subject is treated by W. Beck, who deals with sucrose and nitric acid as plasmolysing agents. B. Ephrussi has a very interesting paper on the temperature coefficients of the different phases of the mitosis of the sea-urchin egg, which he compares with others previously determined for the cleavage of Ascaris eggs. J. Gicklhorn's review deals with the importance of the dielectric constant in microbiology. Two bibliographies are given, one on recent work with ray effects on protoplasm, and the other with the viscosity of protoplasm, and the number is very well illustrated. The second number contains papers by F. Vonwiller on microscopical technique, G. W. Scarth on permeability in Spirogyra, and M. M. Brooks, also on cell-permeability. A. Rumjantzeff and B. Kedroffski contribute a paper with some beautiful plates on vital staining in protozoa, Y. Kuwada and T. Sakamura another on the colloidal chemistry of chromosomes, and G. Ettisch and A. Szegvari a third on the structure of connective tissue fibrils. Finally, there is a review by J. Needham and D. M. Needham on the oxidation-reduction potential of the cell-interior. In both issues there are a valuable series of reviews of books, and abstracts of the more important current original investigations. Without a doubt the new journal will fill a distinct gap in scientific periodical literature.

AT the annual general meeting of the Royal Astronomical Society, held on Feb. 11, the following officers were elected: *President*, Rev. T. E. R. Phillips; *Vice-Presidents*, Sir Frank Dyson, Prof. A. S. Eddington, Prof. A. Fowler, and Lieut.-Col. F. J. M. Stratton; *Treasurer*, Mr. P. H. Hepburn; *Secretaries*, Dr. J. Jackson and Dr. H. Knox-Shaw; *Foreign Secretary*, Prof. H. H. Turner.

AT the meeting of the Royal Microscopical Society held on Jan. 19, the following officers were elected: *President*, Dr. J. A. Murray; *Vice-Presidents*, Mr. A. Chaston Chapman, Dr. C. Da Fano, Dr. J. W. H. Eyre, The Hon. Sir Charles Parsons; *Treasurer*, Mr. C. F. Hill; *Secretaries*, Mr. J. E. Barnard, Dr. Clarence Tierney; *New Members of Council*, Mr. J. G. Bradbury, Dr. W. E. Cooke, Mr. M. T. Denne, Dr. J. C. Mottram; *Librarian*, Mr. S. C. Akehurst; *Curator of Instruments*, Mr. W. E. Watson Baker; *Curator of Slides*, Mr. E. J. Sheppard.

THE annual general meeting of the Institute of Metals will be held on Mar. 9 and 10 in the hall of the Institution of Mechanical Engineers. The first morning will be devoted to papers on the effect of arsenic and bismuth on the properties of copper, and the afternoon to a paper on electric furnaces in non-ferrous metallurgy; the papers for the morning of Mar. 10 deal with the penetration of solders and the study of eutectic alloys, and those for the afternoon with magnesium, aluminium, and other alloys, and early brass and lead. The annual dinner will be held on the evening of Mar. 9.

A USEFUL adjunct to the botanical teaching in the schools of Reading has been provided by Dr. J. B. Hurry, who has presented a well-stocked economic botany collection, which has been organised as a department of the general museum of the borough. The specimens are classified into: miscellaneous food products, nuts, fibres, woods, gums and resins, medicines, and dyes. Pupils will thus be enabled to turn aside for a space from the more academic aspects of botany and study a branch of the subject too often neglected in schools—the origin and production of some of the common substances of domestic and industrial usefulness.

THE latest catalogue (No. 491) of Mr. F. Edwards, 83A Marylebone Road, W.1, should be of great interest to many readers. It gives the titles, and in some cases particulars, of upwards of 1600 works relating to the origin and history of man, classified under the headings of anthropology, etc., Buddha and Buddhism, folklore, freemasonry, gipsies, and witches and witchcraft. The catalogue can be obtained free upon application to the bookseller.

THE Section of Terrestrial Magnetism of the International Union for Geodesy and Geophysics has issued a "Preliminary Report on Subjects of Investigation." The matters discussed include comparisons of magnetic instruments (L. A. Bauer), magnetic characterisation of days (A. Crichton Mitchell), terminology in terrestrial magnetism and electricity (C. Maurain), the measurement of sudden commencements of magnetic storms (A. Tanakadate), the study of magnetic rocks *in situ* and in the laboratory (L. Palazzo), crucial phenomena of polar lights (C. Størmer), and thunderbolts (E. Mathias).

We have received "A Guide to British Spas and Climatic Health Resorts," 1927, which is published by Messrs. J. and A. Churchill, 7 Great Marlborough Street, W. (1*s.* net). Detailed information is given of the situation, climate, bath establishments, and characters of the waters of the British spas, and of the class of cases likely to be benefited thereby. Information is also given respecting the principal British health resorts other than spas. Lists of hotels, hydros, and other residential accommodation are included.

Applications are invited for the following appointments, on or before the dates mentioned :—A lecturer in building trades at the East London Technical College, Cape Province—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Feb. 21). A junior scientific officer under the Directorate of Scientific Research of the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Mar. 9, quoting A. 107). A director of cancer research in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (May 16). A research assistant, with qualifications in physical chemistry, at the Huddersfield Technical College—H. H. Gray, Department of Chemistry, Technical College, Huddersfield. An instrument maker, preferably with electrical and optical training—The Secretary, Experimental Department, Fine Cotton Spinners' and Doublers' Association, Ltd., Rock Bank, Bollington, nr. Macclesfield.

Erratum.—Prof. H. S. Allen points out that in his letter in Nature of Feb. 12, p. 237, on "Spinning Electrons and Protons," the late Prof. McLaren's initials, correctly given by him, were printed as "G. B." Prof. McLaren's Christian names were Samuel Bruce.

Our Astronomical Column.

The Comas Sola quickly moving Asteroid.—This object was at first reported as of doubtful nature, comet or asteroid. It is now assigned to the latter class, with designation 1927 AA.

Dr. A. C. D. Crommelin has obtained the following orbit from observations extending from Jan. 10 to Jan. 24:

$$T = 1926, \text{ Sept. } 21{\cdot}7559 \text{ U.T.}$$
$$\left.\begin{aligned} \omega &= 147^\circ\ 25'\ 14{\cdot}2'' \\ \Omega &= 279\ \ 4\ \ 15{\cdot}9 \\ i &= 24\ \ 47\ \ 58{\cdot}7 \end{aligned}\right\} 1927{\cdot}0$$
$$\phi = 16\ \ 8\ \ 18{\cdot}3$$
$$\log q = 0{\cdot}229249$$
$$\text{Period} = 3{\cdot}5977 \text{ years.}$$

The orbit is of the Aethra type. The inclination is high, but much less than that of Pallas. The planet is receding from earth and sun, so its light will diminish.

A similar but somewhat brighter object is reported by Mr. Oikawa of Tokyo. It is some 20° farther north than that of Prof. Comas Sola, but has the same daily motion, $-1^m\ 24^s$, south 17′. Its magnitude is 11.

The Planet Neptune.—Mr. M. E. J. Gheury de Bray writes: "Neptune is exceptionally well placed for observation now. Any one can pick it up readily with an opera-glass magnifying two or three times. Pointing the binoculars to α Leonis (Regulus), the next star in the field in order of brightness, on the right, is ν Leonis. The next object in the field in order of brightness after ν Leonis is a little above this star and on the right. This object is Neptune. A small telescope will show other stars which may lead astray the inexperienced person. An opera-glass will only show these three objects—Regulus, ν Leonis, and Neptune, the last being the faintest of the three, so that it can be picked up in this way with the greatest ease. It is moving west and will soon approach other stars, and will then be less easy to identify, so it should be looked for now."

Sunspot Frequencies and Terrestrial Phenomena.—An interesting paper (*Journal of the College of Science*, Imperial University, Tokyo, vol. 44, Art. 6) by Prof. T. Terada has recently been received which bears the title "On Some Remarkable Relations Between the Yearly Variations of Terrestrial Phenomena and Solar Activities." The association of earthquakes with spot frequencies in the north and south hemispheres of the sun, called N and S, is examined, and Terada finds that for some places in Japan and Jamaica, minima of earthquake frequency occur in years when $N - S$ is small, while for others, maxima occur under these conditions: some places show neither feature. Relationships with N and S are also found for the data of pressure and temperature for a network of stations over the world. The pressure associations resemble those for earthquakes; but the classification for temperature is more complex, and we have in addition one type in which maxima occur both with small and large values of $(N - S)/(N + S)$, minima occurring with intermediate values; while in another type maxima and minima have interchanged places. The paper contains much that is suggestive, and doubtless many of the results indicated are true. But there is no fixed criterion for a maximum or minimum, so that two workers may differ in their selection of these critical points; and, as Terada's statements of relationship have in most cases neither a diagram nor a numerical statement in the paper to support them, some readers will wish for the ordinary methods of correlation with their definite statement of results and their comparison with what can be expected from the working of pure chance. The idea that important geophysical phenomena depend on the difference of the sun's activities in the northern and southern hemispheres is so important that Prof. Terada's future papers will be awaited with much interest.

The Observer's Handbook for 1927 (Royal Astronomical Society of Canada).—This book contains much matter of use to observers. Besides the usual ephemerides there are maps showing the tracks of the planets among the stars. Both Jupiter and Uranus come to the north of the equator this year, after being south of it for 6 and 42 years respectively. They will be near each other in July. The period of Jupiter IX. is erroneously given as 3 years; it should be 745 days. There is a very useful table giving positions, magnitudes (apparent and absolute), spectral type, parallax, proper motion and radial velocity of a considerable number of stars.

Research Items.

ORIENTAL SEALS.—Mr. I. M. Casanowicz has issued, in vol. 69 of the *Proceedings of the U.S. National Museum*, an illustrated descriptive catalogue of a selection of the ancient oriental seals in the Museum. The collection consists of about 90 originals with flat plaster casts made from them and upwards of 200 casts of seals lent by private owners to the Museum for the purpose of making casts from them in the laboratories. The selection has been made with the view of showing a representative series of the artistic types and the mythological subjects of the seals. They come for the most part from Mesopotamia and Asia Minor and in date range from the early Babylonian to the Persian period.

PHYSICAL TYPES AND CULTURES IN AMERICA.—In Part 3, vol. 55, of the *Proceedings of the American Philosophical Society*, Dr. Aleš Hrdlička puts forward an answer to the problem, frequently propounded, of the relation of physical type to type of culture in America. The main pre-Columbian cultures are: The Moundbuilders and the Pueblos in the United States; the Toltecs, Aztecs, and Mayas in Mexico and Central America; and the Chibcha, Chimu, Nascas, Kechua, and Aymara in South America. There is no physical proof of the impact of accessions from outside which influenced any of these cultures. So far as is known, the peoples of these cultures were just Indian and nothing more. Any contact there may have been was so small as to leave no physical trace. Resemblances to other peoples, *e.g.* those accepted by Quatrefages, Ten Kate, Rivet, and Sullivan, which were held to point to Australian and Melanesian admixture, are either due to old basic relationship or individual variations which are no proof of racial admixture. The pre-Columbian Indians, however, were not all of one type. There were at least four main types: (1) Older dolichocephals—many of the tribes from South America to Mexico and California; (2) older brachycephals (Toltec type), Central America and Ecuador down the coasts of Peru to North Arica; (3) later dolichocephals—Algonkin and most Iroquois; (4) the later brachycephals—Athapascan tribes on the west coast from Alaska to North Mexico. Relating skull form to culture we find the Moundbuilders were partly Toltec, partly Algonkin; the Pueblos are mostly dolichoid, with here and there a strong dominant element of older brachycephals. The old Aztecs were a branch of the older dolichocephals, but the Aztecs of the Empire were a conglomerate; the Mayas were a pure sub-type of the older brachycephals. The Incas were also a conglomerate: the coast people were of Maya type; the mountain peoples old dolichoids. It appears that it is the older brachycephalic type which has developed the higher cultures; but the Aztecs, Aymara, most of the Pueblos, and the main element of the Kechua were of the older dolichoid type. The newer dolichoids give the Iroquois with their relatively high culture, and the newer brachycephals are responsible for some of the cultures of the north-west coast. There appears, then, no special connexion between the cultures and the physical type of the Indian.

COURTSHIP IN SPIDERS.—In three recent papers (*Ann. Mag. Nat. Hist.*, 9, 18, 113; *Proc. Zoo. Soc.*, 1926, part 2, p. 318, and part 4, p. 1125) Mr. W. S. Bristowe and Mr. G. H. Locket have made some contribution to our understanding of the process of courtship in spiders. The keen-eyed wolf-spiders, Lycosidæ, have been seen waving their decorated legs and palpi before the female. It is suggested that the males are made to begin their display by the scent of the females and that the scent organs are situated at the tips of the legs and palps. Crab-spiders, Thomisidæ, are less keen-sighted and caress the female by tickling her as they walk over her. Among web-spinning spiders courtship is carried out by vibration of threads of the web on which the male plays, and induces the female to come out from her retreat. Some species of female show no reluctance and this display is much reduced. Mr. Locket deals very ably with the popular ferocity of the female, and shows that while it may be the rule for some, with others a common life may occur. The authors see a dual purpose in these pre-coition activities, *recognition* and *stimulation*. The necessity of stimulating the female has long been pointed out by others, and to this is now added the necessity that the female shall recognise the male so as to distinguish him from edible prey. *Realisation* would be a better term than recognition, for a virgin female cannot recognise that of which she has no previous experience. Realisation may be produced by the same physiological changes which, continuing, result in eagerness or a state of stimulation, the 'two purposes' of courtship being, in fact, inseparable.

ANTARCTIC ECHINOIDEA.—The sea-urchins collected by the Australasian Antarctic Expedition (1911–1914) have now been reported on by Prof. R. Koehler. There are only 21 species and a variety, and they belong to 11 genera all previously known. The new forms are distributed in the following genera: Notocidaris, 1 species, 1 variety; Goniocidaris, 1 sp.; Sterechinus, 1 sp.; Echinosoma, 1 sp.; Pourtalesia, 2 spp.; Abatus, 1 sp.; Antipneustes, 4 spp. *Goniocidaris impressa* n., from Maria Id., *Notechinus novaezealandiae* Mortensen, from Macquarie Is., and *Echinosoma australe* n., from 35° S. 135° E., are not Antarctic. The discovery off Adélie Land of *Abatus cavernosus* (Philippi), *A. shackletoni* Koehler, and *Pseudabatus nimrodi* Koehler, considerably extends the known range of those species. Antipneustes is a name that replaces Amphipneustes Koehler 1901 to avoid confusion with the unknown Amphipneustea Wiegmann 1837; some of the species are remarkable for the size of the brood-pouches in the female. It is unfortunate that the young individuals contained in some of the pouches were not preserved well enough for study. Indeed the harvest of echinoids, especially among the more interesting but fragile heart-urchins, would have been much richer had it not been for careless packing. The report ends with a complete list of the eleutherozoic echinoderms found up till now in the antarctic and subantarctic regions.

MARINE CRUSTACEA OF THE ANTARCTIC.—The Commission dealing with the scientific results of the Belgian Antarctic Expedition has just issued a report on the Edriophthalma ("Rés. Voyage de la *Belgica* en 1897-99," Zoologie, Tanaidacés, Isopodes, et Amphipodes. Anvers, 1926). The determination of the species was entrusted to Bonnier on the return of the expedition, but the work was interrupted by his death, and not until now, more than twenty years later, has it been possible to complete the examination of the material. As M. Th. Monod, who undertook the task, justly remarks, owing to this long delay in working out the results many of the species brought back by the *Belgica* were rediscovered and described by the later expeditions to the Polar seas—by the *Southern Cross*, *Français*, *Pourquoi Pas?* *Discovery*, *Terra Nova*, and *Gauss* in the Antarctic, and by the *Ingolf* in the Arctic. But although the publication of these various reports has considerably

reduced the number of the *Belgica* species new to science, it has given M. Monod a unique opportunity of collating all the evidence on the geographical distribution of these polar forms. Taking the parallel of 60° S. as approximately the limit of the antarctic and subantarctic fauna, Monod enumerates 15 species of tanaids and 133 of isopods collected by the different expeditions, including the *Challenger*. 21 out of the 27 isopod species of the *Belgica* fall into this category, 8 of them taken by the *Belgica* alone—seven being new to science, and one, *Astacillœchus Ingolfi*, recorded also from the Arctic by Hansen. The isopods form the most important part of the collection. 2 tanaid species, 1 new, and 1 new amphipod are also recorded, together with 11 other species, including the ubiquitous *Jassa falcata* and *Leucothoe spinicarpa*. The new species are defined, and the paper is well illustrated throughout with careful detailed drawings.

MILK OF THE MONOTREME.—Milk obtained from an echidna (*E. aculeata*) has been examined by Mr. Hedley R. Marston (*Australian Jour. of Exper. Biology and Med. Science*, vol. 3, pt. 4, Dec. 1926, p. 225). The specific gravity was 1·023. The proteins consisted of a casein with albumin and globulin. Carbohydrate was present as lactose. The fat was pure triolein, and glycerides of soluble volatile fatty acids were absent. The figures obtained were (per cent.): Total solids, 36·75; casein, 8·4; albumin and globulin, 2·9; lactose, 2·81; fat, 19·62. Compared with cow's and human milk, the total protein and the fat are both very high and the fat is peculiar, but the figures are approached by those of rabbit's milk, which contains 12·0 and 13·5 per cent. of total protein and fat respectively. The author remarks that either the young echidna must store fat during the lactating period, or must be endowed with an extraordinary power of oxidation of fatty acids, otherwise extreme acidosis would follow consumption of a diet so rich in fat.

MOLLUSC AS AGENT IN THE SUGAR-CANE ROOT DISEASE.—Dr. Paul Bartsch and Mary E. Quick have been studying the small snail which, by penetrating worm-burrows and feeding on the root of the sugar-cane in Louisiana, admits infection with resulting decay of the root (*Jour. Agric. Res.*, vol. 32). The authors have successfully identified this snail with the well-known and widely distributed little *Zonitoides arboreus* (Say). This is demonstrated by means of careful comparison of its detailed anatomy with that of specimens of *Zonitoides arboreus* taken from their normal habitat under decaying bark, where their food consists largely of mycelial threads of fungi. The little animals appear to be largely nocturnal in their habits. Excellent figures of the animal, its shell, and its anatomy are given.

CONSTITUTION OF THE EARTH.—The latest issue (vol. 1, No. 8) of the *Geophysical Supplement* to the *Monthly Notices of the Royal Astronomical Society* is devoted entirely to seismology and geodynamics. One paper, by L. F. Richardson, is concerned with the design of vertical seismographs. H. H. Turner deals with the seismological observations of P and S for the five years 1918–1922, during which the times for P and S have been compared in the *International Seismological Summary* with the adopted tables of times; the comparisons are summarised and discussed for epicentral distances less than 120°. The paper raises several new questions which must be left for later investigation. The other two papers are by H. Jeffreys; in one he rediscusses the seismic disturbances which have been best observed at short distances, and concludes that the outer layers of the earth's crust consist of about 12 km. of granitic material above a basaltic layer about 25 km. thick. No further great change of material appears to occur down to a depth of about 1000 km. The velocities of compressional waves in the two outer layers are estimated at 5·6 km. and 6·2 km./sec., that in the sub-basic layer being 7·8 km./sec. His other paper deals with the viscosity of the earth; the lithosphere is shown to be practically non-plastic, while even in the rest of the rocky shell the time of relaxation is as high as two years. The forces tending to produce secular displacement of the earth's crust (chief among them being the equatorial drift) are incapable of causing important distortion of the lithosphere during geological time, but might give appreciable bodily displacement of the lithosphere over the interior. A region stripped of granitic material by the separation of the moon would probably persist. The viscosity found for the lower parts of the shell would not preclude convection currents.

MAGMATIC DIFFERENTIATION.—A paper on the Katmai magmatic province, by C. N. Fenner (which appears as a supplement to the *Journ. Geol.* for Oct.-Nov. 1926), is a most notable recent contribution on the origin of igneous rocks. A large number of analyses of Katmai rocks has been made, and the variation diagram indicates an almost linear variation of the oxides over a wide range of silica percentages. It is shown that differentiation by the separation of successive crystalline phases gives a broken and scattered diagram of very different and more complex form. Presumably, therefore, this process has not operated to any appreciable extent in the evolution of the Katmai rocks. There is, indeed, no known process which is competent to provide a linear variation, though Dr. Fenner suggests that volatilisation as a transporting agent is more likely to fulfil the requirements than gravitational sinking of crystals or squeezing out of residual fluids. In the course of the paper the origin of micropegmatite and graphic intergrowths is discussed; the field evidence for differentiation in different classical regions is surveyed; and many examples of the indubitable action of volatile fluxes are described. It is concluded that the operation of a variety of processes is indicated, and that Bowen's scheme of crystallisation differentiation cannot be accepted as having anything approaching the almost universal applicability that has been claimed for it in recent years.

THE FRACTURE OF QUARTZ BY HEAT.—We have received from Mr. Bernard W. Holman a copy of a paper read by him before the Institution of Mining and Metallurgy on Jan. 20, on "Heat-treatment as an Agent in Rock-breaking," together with further photographs illustrating the paper. An examination of Roman and other ancient fire-workings shows that the fragments of quartz are mostly in the form of a granular sand, and not of angular cracked fragments, as would be obtained if a fire were built against the face and water used for quenching. The granules are often cubical. Laboratory experiments show that disintegration at the transformation point, 575° C., gives granules and not splinters. Gentle pressure on a correctly heat-treated specimen gives thin laths of silky transparent quartz, often with finely toothed edges. Quartz from different sources gives varying results, and some specimens become fragile even when quenched from 300°. Only a few varieties will give the silky laths, which are the most friable form of quartz. A change in the dielectric constant is observed at as low a temperature as 340°, and the temperature at which disintegration begins varies over a range of 20°. It is suggested that the results may have a bearing on the nature of the allotropy of quartz.

It should be noticed, however, that disintegration in quartz may occur at low temperatures through the expansion of gases and vapours contained in the cavities, the extent of the cracking depending on the rate of heating, and this fact may account for some of Mr. Holman's results, without assuming any allotropic change other than the well-known transformation at 575°.

THE CREATION OF MATTER.—At the meeting of the Mathematics and Natural Philosophy Section of the Academy of Sciences of Vienna on Dec. 16, a communication was received from Dr. Arthur Haas on the increase of frequency of light quanta which impinge on swiftly moving particles of matter. The quantum and the particle are supposed to move in opposite directions and the quantum on impact has its direction of motion reversed. In these circumstances, when the speed of the particle is of the order of the speed of light, the frequency of the quantum may be so raised that the quantum is converted into a proton doublet with a wave-length of 0·013 tenth metres. As an example, the case of a particle moving with half the speed of light may be taken. The frequency of the quantum is then trebled by the impact. The author points out that the above leads to the possibility of a cosmical reconstruction of matter out of light quanta.

THE SCHOLES BOMB CALORIMETER.—A bomb calorimeter of the type originally introduced by Berthelot, embodying a number of new mechanical features, and suitable for the determination of the calorific power of solid and liquid fuels, has been placed on the market by Messrs. G. Cussons, Ltd., of Manchester. The bomb body, cover, and most of the details of the calorimeter are made of stainless steel and are machined from the solid billet. A small spanner is employed to screw the cover-nut home, and the body and base are screwed together by hand. The cover of the bomb forms the base on which the bomb stands, and the ignition rods (one of which acts as a support for the crucible cradle) are attached to the base. A form of self-sealing rubber ring, which is isolated from the combustion zone, and has been found to remain in perfect condition after more than 200 determinations of calorific power, prevents escape of oxygen or products of combustion. Oxygen enters the bomb through a spring-loaded non-return valve and is discharged through a screw-down valve. The device obviates the necessity for a gland and stuffing-box. Attachment of the ignition wire to the ignition rods is effected by insertion of the wire in slots, in which it is secured by movable sleeves. The chamfered edge of the sleeves acts as a wire cutter, effecting economy of the nichrome wire used in firing the charge.

RADIOGRAPHIC EXAMINATION OF COAL.—We have received a portable stereoscope and some stereoscopic X-ray photographs of coal, coke, and quartz, taken by Messrs. Kemp and Thomson, Technical Radiological Laboratory, 20 Laverockbank Road, Edinburgh. X-ray stereoscopy is, of course, very familiar in medical radiology, and its utilisation for the present purpose is of interest in providing another illustration of the uses of X-rays in industry. In the case of coal the photographs reveal the extent and distribution of the 'free' mineral ash of relatively high density. The authors have also applied X-ray methods to the study of the 'jig-washing' of coal, whereby the extraneous stony and shaly matter is mechanically separated out from the clean coal.

THE BURNING OF GASES IN NITROUS OXIDE.—The scanty chemical literature relating to the burning of gases in nitrous oxide is considerably extended by the recent communication to the Manchester Literary and Philosophical Society by Prof. H. B. Dixon and W. F. Higgins, of the results of their investigations of the burning of hydrogen, methane, ethylene, propylene, and acetylene in nitrous oxide. Davy's generalisation that combustible bodies require a higher temperature to ignite in nitrous oxide than they do in oxygen is not confirmed, all the gases tested having *lower* ignition points in the former gas than in either oxygen or in air. These ignition points correspond with temperatures below that at which the thermal decomposition of nitrous oxide is appreciable. The length of a hydrogen flame is increased about twelve-fold and its diameter about two-fold when the air in which the gas burns is replaced by nitrous oxide. The spectrum of the flame in nitrous oxide is continuous from red to violet with the 'steam' lines well marked. The red tinge in the flame at ordinary pressures is due to the formation of nitrogen peroxide. The paper contains tables of the respective ignition points of hydrogen in nitrous oxide at pressures between 150 mm. and 1000 mm. of mercury, and of ethylene and propylene in nitrous oxide and oxygen at 150 mm.–1000 mm. pressures.

THE SEPARATION OF RADIOACTIVE SUBSTANCES.—J. Kendall, E. R. Jette, and W. West have published details of the application of ionic migration methods to the separation of mesothorium-1 from barium, in the *Journal of the American Chemical Society* for Dec. 1926. The separation depends on the fact that the respective ions have different mobilities, and that during electrolysis the faster ion will gradually concentrate in front of the slower, an accumulation of radioactive material being shown by an increase in the activity per unit weight. By introducing other ions in suitable concentrations to keep the boundary sharp, and incorporating the greater part of the solution in agar gel, much more rapid and convenient separation is effected than by fractional crystallisation. Since mesothorium-1 is isotopic with radium, it is possible to apply exactly the same method to the separation of radium and barium, as it is known that isotopic ions have identical mobilities. The fact that the ions of mesothorium-1 and radium have greater mobilities than the barium ions shows that the increase in ionic mobility with atomic weight is continuous throughout the whole alkaline earth group.

THE VALUE OF TANK TESTING.—The value of the method of ship model testing in experimental tanks initiated by William Froude at Torquay in 1868 has been proved over and over again. Such testing gives the designer a mass of useful data and settles the form of hull and propeller to give the best results. But as Pepys said long ago, "It seems worthy of note how small things are sometimes found to mar or mend a ship's quality of sailing." The importance of minor details was really the theme of Mr. G. S. Baker's paper, "The Economy of Tank Testing of Ship Forms and Research in Ship Propulsion" read on Jan. 28 to the North-East Coast Institution of Engineers and Shipbuilders. The points dealt with included the form of the shaft webs and brackets; the bossing and direction of rotation of the propellers; the shape and section of the blades. At first, tank testing was confined to the determination of the factors which make up the resistance of war-ships in still water. It was extended to the study of propellers by R. E. Froude and to merchant ships by Messrs. Denny. In the National Tank, of which Mr. Baker is director, during the years 1924-26, no less than 80 designs were tested, and in an appendix to the paper are notes on the results.

Diet and Cancer.

THERE have been and are all sorts of statements about the relation of diet to the occurrence of cancer. We are told that eating raw carrots will prevent and even cure it; others attribute efficacy to onions, others to a salt-free diet; tomatoes, on the other hand, have been suspected of causing cancer. Particularly common is the suggestion, which appears at times to have crystallised into a belief, that vegetarians suffer from malignant disease less than ordinary people who take a fleshy diet.

None of these statements has been subjected to critical inquiry; and indeed such inquiry is by no means easy, for it is hard to find two bodies of persons, in other respects wholly comparable, who differ only in their enjoyment or rejection of meat. The vegetarians in Great Britain, for example, could not, without the strictest inquiry, be regarded as a sample of the population which differed from the normal only in their avoidance of meat; there are many grades and subclasses of vegetarians, but, taken as a whole, they form a group distinguished in many modes of life and thought besides their diet. In the world at large, vegetarianism, in short, is generally a character associated with other exceptional features of body and mind, and any advantage or disadvantage which vegetarians may show in the incidence of disease may be due to their general make-up as likely as to the nominal outward sign of it. The study of such associations in man is, indeed, difficult, and is liable to be extremely fallacious.

Particularly welcome, therefore, is the report on the incidence of cancer in certain religious orders by Dr. S. Monckton Copeman and Dr. Major Greenwood.[1] With the co-operation of the ecclesiastical authorities and with an amount of detailed inquiry which must have been even more troublesome than it seems, they have collected the necessary statistics in a number of religious houses in England and elsewhere. The monks, nuns, and lay brothers in these communities are all essentially vegetarians: but we can be pretty sure that vegetarianism is no more than an incidental circumstance, and that the nature of the diet has had no influence in determining the membership of these communities. Among the Carthusians and Cistercians the rules are especially strict, and a life which is spent in silence in a cell from which the monk comes out only for a nightly service, for a meal in the refectory on Sundays, and for a weekly walk, cannot be said to involve much of that hurry, luxury, and excess to which cancer and other sickness is so often ascribed. But the results of this minute inquiry into their mortality shows that, while perhaps as a whole the mortality is in some instances rather less than would be expected in persons of similar age and sex in the outside world, there is no evidence at all of any immunity to cancer. Thus in a Cistercian house in England, 427 people lived between 1800 and 1920: there were 104 deaths against an expectation of 82 in the general population, and of these 5 certainly, and 3 probably, died of cancer, as compared with 5 or 6 in non-monks. Cistercian nuns in England and a Belgian house of the same order give similar results, as do Benedictine and Carmelite communities in which the rules are not quite so strict. Taken separately or together, the figures lend no support to a proposition that cancer is either less or more common inside monasteries than among the contemporary comparable part of the population outside.

Finally, data are given which were collected less minutely and completely from 57 Cistercian houses in different parts of the world: the figures seem to show a singularly small number of deaths from cancer, but, as the authors point out, the calculations are subject in these instances to so many qualifications that one is once again reduced to the conclusion that there is no evidence of any difference either way. Any one who feels inclined to rush in and solve the problem of the causation of cancer by statistical methods should study carefully this admirable example of how such work should be done: it is much more difficult than some enthusiasts imagine.

[1] Ministry of Health. Reports on Public Health and Medical Subjects, No. 36: Diet and Cancer, with Special Reference to the Incidence of Cancer upon Members of certain Religious Orders. By Dr. S. Monckton Copeman and Major Greenwood. Pp. iv+33. (London: H.M. Stationery Office, 1926.) 9*d*. net.

Maori Navigation.

THE vessels used by the peoples of the Pacific in their migrations and colonisations are of primary importance in Oceanic ethnology. They have been described by various writers, but only partially, and generally from the technological side. Now, in an interesting *Bulletin of the Dominion Museum of New Zealand*,[1] Mr. Elsdon Best has collected all that is known or can be learned from native sources about Maori canoes. Every aspect of the subject is discussed and fully illustrated by copies of early prints or modern photographs.

Some types of Maori canoes have entirely disappeared. The double canoe, formed by two dug-outs united by a platform, survived until about 1830. The occurrence of the single canoe with one outrigger is denied by some writers, although it is said to have been seen by Captain Cook. The single canoe with double outrigger is said to be only mentioned in tradition. This becomes important when it is noted that Indo-Javan vessels twelve centuries ago had double outriggers.

The only native canoe now used is that without an outrigger. The generic name is *waka*. Varieties are distinguished as the *waka taua*, war canoe, *waka tete* used for fishing and travelling, and the *waka titai* and other small craft used in calm waters.

The building of the *waka taua* is fully described. The tree, of *totara*, *kauri*, or other timber, was reserved by clearing the bush around or by a taboo. A strip of bark might be peeled off one side to initiate decay and facilitate hollowing out. On an auspicious day, after fasting and ritual, the trunk was felled. Sometimes the lower part was scarfed, or the uncovered roots were burned, or an ingenious machine on the ballista principle was used. The trunk was charmed to prevent damage in falling. The hollowing was performed by burning and by the stone adze. Canoe makers wore only one garment, and their food, reserved for them alone, was cooked apart. It was etiquette for a visitor to throw his spear at the canoe. If it stuck, the omen was favourable. The hull was hauled to the water side by ropes, often for long distances, by many people. Charmed skids eased the canoe over rough ground. Sometimes the hull was composed of more than one piece.

The sides of the dug-out were heightened by an ornamental top strake, butted and lashed to its top edge by strings of flax, and caulked with fibre. The

[1] New Zealand, Dominion Museum. Bulletin No. 7: The Maori Canoe. By Elsdon Best. Published under the direction of the Board of Maori Ethnological Research, for the Dominion Museum. (Wellington, N.Z.: W. A. G. Skinner, 1925.)

join was covered by a batten. The ends of the top strake were drawn in by a tourniquet and the lashings tightened with a lever. The ends of the dug-out were fitted with figure-head and stern piece, coloured red and black and ornamented with feathers. The deck was a mere grating. The launch was carried out according to ritual and was followed by a ceremonial feast.

Mr. Best describes in less detail the fishing and river canoes, and also the canoes of the Chatham Islands. An account is also given of ceremonial observances in the use of canoes.

The common mode of propulsion was the paddle, but poling was often resorted to when ascending streams or in shallow water. Steering was effected by a long paddle at the stern or by directions to the paddlers. Mr. Best gives specimens of the songs sung while paddling. The sails formerly used were triangular, with the small end downward. They were made of matting or laced leaves. Generally only one sail was used, but large canoes might have two or three. Stones were used as anchors. They were used in the natural state or with grooves pecked round the middle to fit the rope, or in baskets. Baling was performed with carved balers having the handles projecting forward.

Mr. Best gives a summary account of canoes of the Pacific area, quoting from various authors. Gilbert and Loyalty Island canoes are included with the Polynesian, and only short notes are given on those of Melanesia, Micronesia, and Indonesia. At the end of this chapter Maori methods of navigation are described, and the Maori and Moriori compass points enumerated, without reference to other island names.

An interesting chapter is devoted to Maori traditions of the discovery and settlement of New Zealand by visitors from eastern Polynesia, from an island Hawaiki, which Mr. Best identifies with Tahiti. The first voyagers were Kupe and Ngahue. They circumnavigated New Zealand and named it Aotea-roa. They found no human inhabitants but reported on their return to Hawaiki that the most valuable products of Aotea-roa were the *moa* and *pounamu* (nephrite). Toi, a later visitor, found the islands inhabited by the Maruiwi or Mouriuri, a dark-skinned people with bushy hair. The voyage of Toi and that of his grandson Whatonga led to the colonisation of New Zealand, and voyages thereto became frequent. Mr. Best gives an account of Maori voyages and the historic canoes in which they were made.

With its list of Maori navigation terms, bibliography, and index, the work forms a valuable compendium and record of one group of Polynesian canoe builders and navigators, and Mr. Best has done real service to Oceanic ethnology by its compilation.

In some places the linguistic comparisons are weak. Tonga *hama*, Rotuma *sama*, Fiji *thama* are assumed to be derivatives of the Maori *ama* (outrigger). The Tonga *fohe* and Samoa *foe* are said to come from the Maori word *hoe* (paddle). The Fijian *wanka* (canoe and shrine) is said to be a Maori term. But the names as found in Tonga, Rotuma, and Fiji are older than in Maori. The original words were *semang* or *soman* (outrigger), as in the Moluccas and Batjan; *boseh*, *borsi*, or *bogsai* (paddle), as in Java, Sumatra, and the Philippines; and *banka* or *wanga* (canoe), as in the Philippines and Celebes. SIDNEY H. RAY.

Planets and Periodicities.

THE nineteenth century discarded horoscopy of the weather with the other appurtenances of astrology. Dr. Z. Kamerling[1] would have us reverse the verdict and employ the motions of the planets as the basis of long-range forecasting. His thesis is that widespread periodicities must have a cosmic origin, and sunspots having failed, there remain only the planets. Accordingly he investigates periodicities of the length of the 'synodic rotations,' that is, the intervals between the dates at which the various planets are nearest to the earth. (It appears that the theoretical basis of this planetary connexion has been given in a previous paper; one wonders what it can possibly be.) These give him in years: Venus 1·60, Mars 2·13, Jupiter 1·09, Saturn 1·035, Uranus 1·018. As material he has forty years of average monthly rainfall over east Java and over west Java, twenty years' rainfall at Pernambuco, and temperatures at Winnipeg, Königsberg, and Zwanenburg. The method is to write down the monthly data in sets corresponding with the 'synodic year,' so that, for example, all the months of perigee come in the same vertical column, and to plot the smoothed means of these columns. From his graphs Dr. Kamerling concludes that there are real periodicities corresponding with the synodic periods of each planet, giving maxima generally near perigee and secondary maxima near apogee.

Such a result would be of considerable importance if substantiated, as explaining the origin of a number of periodicities of a little more than a year which have been suggested from time to time, but unfortunately the author has not done all he might to prove his case. He does not express his periodicities as Fourier series, nor does he attempt to determine their exact length. The original data are given only for the east Java rainfall, and here inspection shows that the annual variation has not been completely eliminated. They show, in fact, a residual mean annual variation with a range of 16 mm., which is of the same order as the ranges of the planetary periods. The normal used apparently covers the first thirty-three years, so that the error is entirely concentrated in the last seven years, and falsifies any apparent periods up to 1·1 year. The supposed period for Uranus (1 year 4 days), with a range of 18 mm., is almost entirely due to this residual annual variation. The author does not give the standard deviations of the data which he uses, so that no test of reality can be made. The Venus period in east Java, which has by far the largest range of any, may be taken as a test case. The amplitude of the corresponding Fourier series is found to be 9 mm., and the standard deviation of the original 480 values is 63 mm. The amplitude is therefore 4·5 times the expectancy on a chance basis, and the period seems to be real. Its exact length, however, turns out to be 1·58 year, while the 'synodic year' of Venus is 1·60 year; this means that the maximum phase shifts by about 120° in forty calendar years, which seems too great, and the interpretation suggested is that there is a periodicity in the east Java rainfall which happens nearly, but not quite, to coincide with the Venus synodic year.

The curve for Mars shows very little trace of the whole period, but a well-marked half-period of 1·06 year, which may be due to the residual annual variation in the data. The present writer is not impressed by the supposed approximation of the maxima to perigee and apogee, since to him the graphs rather suggest a haphazard distribution of phase. Hence it seems necessary for the author to repeat his work, using more refined methods of analysis, and where possible longer series of data. The title of the paper is a misnomer, since the results would be of little use for forecasting purposes. C. E. P. B.

[1] "Grondslagen voor een Weervoorspelling op langen Termijn." Door Dr. Z. Kamerling. 1: Enkelvoudige Periodon van Wijziging der Weersgesteldheid. Pp. 30. (Leiden: A. W. Sijthoff, n.d.) n.p.

The Indian Lac Research Institute.

THE importance of lac in the markets of the world is well known to many; also the fact that at the present time India enjoys practically a world-wide monopoly of the lac industry. Owing to serious fluctuations in the price and output from time to time, speculation is rife and steps are being taken with the object of endeavouring to stabilise the trade. A Government inquiry was carried out by Messrs. H. A. F. Lindsay and C. M. Harlow, their report being published in 1921. An outcome of the report was the formation in the same year of the Indian Lac Association for Research. It was decided to build and equip a Lac Research Institute and to run in conjunction with it a small experimental plantation. The Association is managed by a committee of Europeans and Indians representing all branches of the trade. Funds are obtainable by a small cess imposed by the Government of India on all exports of lac, manufactured and unmanufactured. A report of the work of the four years (to Mar. 31, 1926) has been issued (Calcutta: Thacker, Spink and Co.).

The greater bulk of the lac produced comes from Central India, *i.e.* the Central Provinces and Chota Nagpur. This factor determined the selection of the site for the research institute. Ninety per cent. of the lac produced comes from a fairly compact area comprising Chota Nagpur, the Feudatory States of Orissa, a few adjoining districts of the Central Provinces, and a few adjacent areas in Bengal and the United Provinces. From this area Bihar and Orissa claim more than half the annual production of lac in India. Thus Ranchi, one of the capitals of this Province, was selected as the home of the future Institute. The local government provided a site of 110 acres a few miles out of the town on favourable terms, and construction work was commenced in 1924, the foundation-stone being laid by the Governor of the Province. The Institute building includes laboratories for biochemistry and entomology and was finished in August 1925. The research staff consists of (1) the director and biochemist appointed in Oct. 1923, (2) three assistants to the biochemist appointed in June 1925, (3) an entomologist and three assistants, all appointed in 1926. The biochemist, who is also director, is Mrs. Dorothy Norris, and she has been in charge since 1923.

Lac production in the past has been either undertaken by the officers of the Indian Forest Department or by local proprietors and others, the material being sold to middlemen for transmission to the big markets. A certain amount of research work has been carried out in recent years by officers of the Department in connexion with improvements in collection and out-turn, studying insect pests of the lac, and so forth.

The main objects of the Lac Association may be taken to be the establishment of the lac industry on such a sound commercial basis that competition need not be feared, owing to "(1) A synthetic product such as affected indigo and would have affected rubber but for the drop in price of the natural product. (2) The establishment in other countries of the lac insect itself as has been done in the case of silk."

The Forest Department in the Province is co-operating with the Institute by affording facilities for experimental work in selected areas of forest, thus supplementing the experiments which are being carried out with species, spacing, and so forth on the Institute's own land. The work of the Institute is being welcomed in the Province. As an example of a purely private and commercial undertaking, even though assisted by Government, its inauguration in India is a striking illustration of modern progress.

Women in Factories.

ON Jan. 28, Prof. Edward P. Cathcart lectured at the Royal Institution of Great Britain on "The Physique of Women Employed in Industry." He began his lecture by deploring the fact that while a large amount of work has been done on the anthropometry of man, little attention had been given to the determination of the physical measurements of women. He points out that a real necessity for such knowledge exists quite apart from the theoretical scientific value of the facts, for if, as is likely, legislative action is to be taken with regard to protection from overloading, then definite knowledge will be required.

The problem was studied along the following lines:

(1) The determination of the physical characters of the average woman engaged in industry.

(2) The determination in the laboratory of the optional load.

(3) The determination of loads actually carried in the course of ordinary work by women.

Details of the first section of the research were presented in the lecture. Some 3000 factory women were studied, and as controls a group of unemployed women and a group of women students. Records were obtained of the age, weight, height, lumbar pull, grip, and crush. The factories represented a variety of trades. The heaviest work done was in the chemical and brick trades, and Prof. Cathcart paid a tribute to the physical strength and grace of the women, although they were drawn from one of the worst districts of Glasgow.

A good correlation was found to exist between the various strength tests, indicating that there is, if the strength depends mainly on muscle development, a more or less uniform development of muscle in the different subjects, or, if the strength tests are indicative of more than muscle development, then the factor operative is uniform for all types of muscle activity.

A comparison of the unemployed and the employed showed that the unemployed were of poorer physique than the employed. This did not appear to be due to lack of nutrition or flabbiness of muscle through lack of use. The college women tested exceeded in height, weight, and strength the other two groups, and from the statistical evidence given, this did not appear to be due to bad sampling. Prof. Cathcart thinks the difference is probably due to the fact that the college women had already been selected by medical examination, that they received good physical training, and also that strength is not merely a function of the amount of muscle present but is also related to mental alertness that enables a subject to co-ordinate his powers more successfully when called upon to produce some extra effort. From a practical point of view, he thinks it would be well if women below a certain fitness factor were not employed in hard factory work; also that those employers who encourage physical training are doing work that is valuable both from the point of view of the worker and of the work.

We would also add that if Prof. Cathcart's findings as to a fitness factor can be substantiated, the knowledge will be of very great value to those engaged on vocational guidance. Careful studies such as this are of very great value and are applicable to a wide range of problems.

University and Educational Intelligence.

CAMBRIDGE.—The Council of the School of the Biological Sciences has been constituted as follows: Dr. Adrian, Prof. Barcroft, Mr. Bartlett, Mr. Blackman, Prof. Buxton, Mr. Forster Cooper, Prof. Dean, Sir F. G. Hopkins, Mr. Nicholas, Dr. Rideal, Prof. Seward, and Prof. J. T. Wilson.

The Faculty Board of Medicine has reported in favour of continuing the diplomas in public health, hygiene and tropical medicine, and hygiene until 1930, but for no longer unless the University otherwise determines at a later date. The foundation in 1922 of the London School of Hygiene and Tropical Medicine has altered the situation at Cambridge. When the new school is completed it should offer facilities for teaching and research with which Cambridge would be unable to compete. The Cambridge diploma in public health established in 1875 may be succeeded in due course by analogous diplomas at the new school.

The provision of facilities for special study and teaching in neurology and mental hygiene at the Maudsley Hospital, and the fact that only part of the course of study for the diploma in psychological medicine could be well provided at Cambridge, has led the Faculty Board to recommend that this diploma be discontinued as from October next. The Faculty Board recommends that the diploma in medical radiology and electrology should be continued for a further period of three years, with a fresh provision that before admission to the second part of the examination the candidate should have had a proper clinical experience of the subject.

READING.—Mr. Alfred Palmer, president of the council of the University, has been given the degree of Doctor of Science *honoris causa*. This is the first degree which has been awarded by the University.

FROM University College, London, we have received "These Hundred Years," the oration delivered by Sir Gregory Foster on the occasion of the thirtieth celebration by the College Union Society of the foundation of the College. The title of the address is a reminder that the College centenary is to be celebrated this year. The great transformation —religious, political, social, and educational—that has taken place in these hundred years is, as Sir Gregory Foster says, due largely to the progress of science. He quotes Sir John Herschel's scathing criticism of the state of the exact sciences at the beginning of the nineteenth century: "Mathematics was at its last gasp, astronomy was nearly so. . . . The chilling torpor of routine had spread itself over all those branches of science which wanted the excitement of experimental research." There was no place in England where chemistry was systematically taught, and there was no chemical laboratory until one was opened at University College in 1828. The important part played by the College in the astounding progress witnessed by the hundred years that followed is briefly touched on in the address and will doubtless be celebrated at length in due course. In accounts of the origin of the College (and of the University of London) its debt to the poet Thomas Campbell is commonly acknowledged, but it is not so commonly recognised that the great principle of freedom from religious rivalry which the poet so eagerly and successfully championed was by him imbibed from the University of Berlin, founded, under the guidance of Wilhelm von Humboldt, in 1809, "unattached to any particular creed or school of thought, and devoted only to the interests of science and learning."

Calendar of Discovery and Invention.

February 20, 1880.—In one of the notebooks of David Edward Hughes preserved at the British Museum is an entry dated Feb. 20, 1880: "Mr. Spottiswoode, President of the Royal Society, Prof. Stokes, and Prof. Huxley visited me to-day at half-past 3 P.M. and remained until 6 P.M. in order to witness my experiments with the extra current Thermopile, etc." Hughes was then making experiments in the transmission of signals across space by means of the radiation given off by what he called the 'extra current' from a small spark coil, using for reception a Bell telephone and battery connected to a separate receiving circuit including sometimes a microphone. Neither Hughes, however, nor his visitors had any conception that the effects obtained were due to electro-magnetic waves.

February 21, 1824.—While professor of chemistry at Jena, Johann Wolfgang Döbereiner in 1823 discovered that when platinum in a fine state of division, known as platinum black, is placed in oxygen, it absorbs many hundred times its own volume with a considerable rise in temperature. Spongy platinum he found acted in the same way, and on Feb. 21, 1824, he patented his lamp, in which a stream of hydrogen is ignited by being directed on to such platinum.

February 22, 1804.—Trevithick, the famous Cornish engineer, was a pioneer in the use of high-pressure steam and was the father of the locomotive. His first practical experiments with a railway locomotive were made at Merthyr Tydvill in 1803–4, and on Feb. 22, 1804, his engine conveyed 10 tons of ore, 70 men, and five wagons a distance of 9½ miles at about 5 miles an hour.

February 22, 1831.—The virtual founder of the British Association was Sir David Brewster. Johnston the chemist, in 1830, had written an account of the German Association of men of science. On Feb. 22, 1831, Brewster wrote to Prof. Phillips at York: "It is proposed to establish a British Association of men of science similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful sovereigns of that part of Europe. The arrangements for the first meeting are in progress; and it is contemplated that it shall be held in York, as the most central city for the three kingdoms." Murchison, Robison, J. D. Forbes, and Vernon Harcourt were among its chief promoters.

February 24, 1891.—The process for producing seamless steel tubes such as are used in modern boilers is due to Reinhard and Max Mannesmann, one of whose patents is dated Feb. 24, 1891. A heated round billet is spun at a high velocity by rollers which, being slightly inclined to one another, also give the billet an endwise motion. A flow of metal takes place from the interior outwards, a tube being formed the interior of which is smoothed by its being forced over a mandril.

February 24, 1896.—No discovery created more stir in scientific circles than that of the Röntgen rays, but no sooner had it been made known than a new field of investigation was opened up by Henri Becquerel, who, seeking to test whether such rays always accompanied the excitation of phosphorescent light, was led to the discovery of radioactivity. His experiments were made known to the Paris Academy of Sciences in his memoir, "Radiations émises par phosphorescence," read on Feb. 24, 1896.

February 26, 1788.—The Linnean Society was founded through the efforts of Sir James Edward Smith, the inaugural meeting being held on Feb. 26, 1788, at the Marlborough Coffee House. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 10.—C. D. Ellis and W. A. Wooster: The photographic action of β-rays. The β-ray spectra of radio-active bodies were recorded as usual on a photographic plate, but homogeneous beams separated by magnetic deflexion were used. The reciprocity law is found to hold, and the form of the blackening curve is independent of the time of development and of the velocity of the particles between $H\rho$ 1450 and $H\rho$ 5830. The blackening curve follows a simple empirical formula which is identical with that holding for the blackening by X-rays, the constants in the formula showing the same variation with velocity as holds for variation in frequency in the case of X-rays.

C. D. Ellis and W. A. Wooster: The relative intensities of the groups in the magnetic β-ray spectra of radium B and radium C. With the method used, the intensities of the groups in the two spectra are measured on the same scale and refer to equal numbers of disintegrating atoms. An interesting result is that the ratio of the intensities of the groups due to conversion of the same frequency γ-ray in the K and L levels is independent of the frequency and equal to that occurring in the ordinary external absorption of X-rays. Using Gurney's determination of the number of electrons in the strong groups of radium-B, the number of electrons in all the other groups are deduced. Hence the total number of secondary electrons emitted from these two bodies can be determined.

A. Müller: An X-ray investigation of certain long-chain compounds. The substances were in the form of well-developed single crystals. They contain straight carbon chains of identical or very nearly identical zigzag structure. The angle between two lines connecting the centres of three consecutive carbon atoms is little different from the tetrahedral angle (109° 30′). The chains can be represented by rods of elliptical cross-section. In the crystals these rods are packed in bundles or, in other words, with their axes parallel to a fixed direction in the crystal lattice. The density of packing of these rods is the same for all the substances. Comparisons between X-ray data and others obtained by Langmuir and Adam from measurements of mono-molecular films of long-chain compounds, suggest that the crystal structure and the structure of the compound film are very similar, if not identical.

G. H. Briggs: The straggling of α-particles from radium C. The variation in velocity is measured by the magnetic deflexion method when the rays passed through various thicknesses of mica. The deflected and undeflected bands produced on a photographic plate are analysed by a microphotometer. The distribution of energies on emergence is very approximately Gaussian in form. From the energy distribution, the straggling of the ranges can be calculated at any point in the region investigated; it is about 1·4 times that predicted by Bohr. Half the total straggling in range occurs in the first 2·4 cm. of the path. The discrepancy between theory and experiment would be explained if transfers of energy occur twice as often as theory indicates.

G. H. Briggs: The decrease in velocity of α-particles from radium C. For velocities less than $0{\cdot}55\,V_0$, the velocity decreased much more rapidly than was found by Marsden and Taylor, but is in agreement with the results near the end of the range found by indirect methods by Kapitza and by Curie. The ratio of the number of singly to doubly charged α-particles varied as $V^{-4\cdot3}$. Experiments to detect any lack of homogeneity in the initial velocities of the α-particles gave no evidence of velocities greater than the average by more than 1 in 3000. Velocities less than the maximum were present, due probably to absorption in the source.

L. H. Thomas: On the capture of electrons by swiftly moving electrified particles. The chance that a fast α-particle will capture an electron is calculated in two cases; for particles with velocity greater than 8×10^8 cm./sec. moving through hydrogen or helium, and for particles with velocity between 4×10^8 and 2×10^9 cm./sec. moving through heavy matter. The method is to split up the process into a close collision of the particle with an electron and a close collision of this electron with an atomic nucleus. The results are in agreement with those obtained experimentally.

Linnean Society, Jan. 20.—H. Graham Cannon and Miss S. M. Manton: Notes on the segmental excretory organs of Crustacea. The patterns of the maxillary gland efferent ducts of the Branchiopoda show a marked uniformity. The simplest type is that of Estheria. In Chirocephalus there is a divergence from this pattern, probably correlated with the absence of a shell-fold. In the maxillary gland of Anaspides the pattern of the duct is the same as that of Chirocephalus. The maxillary gland of each possesses a muscular sphincter controlling the exit of the efferent duct from the end sac. The entire gland is mesodermal. The Lophogastridæ represent primitive Peracarida, from which both the modern mysids and isopods could have evolved. The segmental excretory organs of the former are antennal glands and of the latter maxillary glands. Lophogaster possesses both antennal and maxillary glands.—R. R. Gates: The tundra vegetation of Russian Lapland. The plant-breeding station at Khibiny, in Russian Lapland, north of the Arctic Circle, in lat. 67° 44′ N., is on Lake Ymandra, and is partly surrounded by mountains which reach a height of nearly 4000 feet. The summer season begins about the middle of June, when the ice goes out of the lake, and ends about the end of August. During this short season most of the plants bloom twice, June and August. The snowfall is not heavy and the rainfall about 450 mm. In February the lowest temperature is about −36°·4 F., while in June—the warmest month—the mid-temperature is 53°·6 F. and the maximum 86° F. There is very little rain from May to August, but the winds are always very strong and have a marked effect on the vegetation. There are many kinds of tundra. The mountain rock tundra above the tree-line at Khibiny is very similar to the low rock tundra on the Arctic coast. Moor tundra is typical of Siberia, and but little of it is found in the Kola Peninsula. Cladonias and other lichens make up a conspicuous element and give a whitish character to the landscape. This may be free from trees (*chuna* tundra) or may be interspersed with pine. In the Ural Mountains is *Flecken* tundra, characterised by its patchy covering of vegetation with areas of bare yellow clay. In *Klotschkovataya*, or tufted tundra, in the Kola Peninsula, the surface of the ground is broken into polygonal areas, which may be thirty feet across and are covered with vegetation. Between these *Klotschy* are crevices which may be ten feet deep and six feet wide, with vegetation at the base. All these forms of tundra have many features in common, Cladonias and other lichens as well as heaths and woody creepers being conspicuous elements in the plant-covering. Tundra vegetation appears to be chiefly the result of a soil which is wet and frozen during much of the year, general low temperature, and continuous high winds. The continuous daylight during the greater part of the summer season favours

quick maturity in the flowering plants. Occasional summer fogs occur, but farther north on the Murmansk coast they are much more frequent and very dense.

Geological Society, Feb. 2.—V. C. Illing: The geology of the Naparima region of Trinidad (British West Indies). The area around San Fernando is covered almost entirely by a series of sands, clays, and marls of Lower and Middle Tertiary age, the marls being responsible for the black soils which have become the home of the sugar-cane industry. These Tertiary deposits have been formed in two separate basins, separated by an important zone of uplift extending from San Fernando in an east-north-easterly direction. The Upper Argiline, generally considered to be Cretaceous, is placed in the Upper Eocene on the evidence of the foraminifera, and is followed unconformably by a series of sands and silts, also of Upper Eocene age. The Oligocene is only partly represented, but the late Oligocene and early Miocene Periods show a thick series of clays, marls, and sands. The marl facies is almost completely restricted to the southern basin, and is merely a facies of the more widespread foraminiferal clays. The rocks of the area are moulded by a series of thrusting movements coming generally from the northward, the main trend of the folding being east-north-easterly. Associated with the movements which have clearly recurred at distinct periods in Tertiary times, there has been emergence of the central land-ridge and the formation of shallow-water beach-deposits at the maximum periods if uplift.—W. L. F. Nuttall: Tertiary Foraminifera from the Naparima district of Trinidad (British West Indies). The rocks of the Naparima district consist of an upper and a lower series, which rest upon one another unconformably. Foraminifera are abundant in these beds, and indicate that the upper series is of Miocene-Oligocene age and the lower series Upper Eocene. There are two distinct areas separated by a zone of over-thrust faulting. The stratigraphical sequence and foraminiferal faunas of these areas are dissimilar, and the explanation offered is that they were originally two separated basins of deposition.

EDINBURGH.

Royal Society, Jan. 24.—Henry Briggs: Rock-faulting from the engineering standpoint. The bearing of Mohr's theory of rupture on the angle of fracture of rocks of different degrees of brittleness is discussed, and the character of the three-dimensional stress-systems required to produce normal, transcurrent, and reversed faulting is ascertained. This carries the quantitative methods of the engineer into a branch of geology.—W. J. M'Callion: The geology of Gigha. Gigha is a small island off the western coast of Kintyre and about 5½ miles south-east of West Loch Tarbert. It is 6 miles in length from north-east to south-west, and has a greatest breadth of 2 miles. The rocks of the island are composed of quartzites, phyllites, and epidiorites belonging to the Erins Quartzite division of the Ardrishaig group which is so well developed in South Knapdale. Kainozoic crinanites and olivine dolerites are very abundant.—A. R. Normand, J. B. M. Ross, and E. Henderson: The distribution of intensity in the X-ray spectra of the normal saturated dicarboxylic acids, their diethyl and mono-ethyl esters. The intensity distribution among the several orders of reflection from the principal spacing planes was calculated by Shearer's method. The calculated and observed results on comparison showed good agreement, thus confirming the structures assigned by the authors to this series of compounds.

PARIS.

Academy of Sciences, Jan. 10.—The president announced the death of Antoine Balland, corresponding member for the Section of Rural Economy, and of Haton de la Goupillière, free member.—Emile Borel: Systems of linear forms with a left symmetrical determinant and the general theory of play.—Emile Borel: A problem of geometrical probabilities relating to the circle.—G. Ferrié and R. Jouaust: A free pendulum maintained by a photo-electric current and its application to the problem of time. The free pendulum, the mechanism of which has been described in an earlier paper, has been observed for more than twelve consecutive hours, and the interval of time between two successive records of beats has been constant to 0·001 sec., an order of accuracy higher than that hitherto attainable.—L. Gustave Du Pasquier: Groups of Hamiltonian quaternions.—Mme. M. Piazzolla-Beloch: Hyperelliptic surfaces of rank 2.—Tibor Radó: The area of curved surfaces.—Norbert Wiener: A generalisation of functions with limited variation.—André Weil: Functional spaces.—Stefan Kempisty: Integration of the regular differential.—Arnaldo Masotti: The composition of the movements of a perfect liquid parallel to a fixed plane.—R. Mazet: Flow through a circular orifice.—F. da Costa Lobo: Two interesting prominences. A description of observations made with the spectroheliograph at the astronomical observatory of the University of Coimbra on Aug. 5 and Oct. 7.—Th. Vautier: Velocity of waves [of explosions].—Paul Gabriel Girault: A mechanical image of hysteresis and the inconstancy of the Steinmetz exponent.—Louis de Broglie: The possibility of bringing into agreement the electromagnetic theory with the new undulatory mechanics.—Léon Brillouin: Is it possible to detect directly the magnetic moment of the electron? An experiment is conceived which might decide this question. The necessary conditions are difficult to realise, but do not appear to be impossible.—Albert Pérard: Quartz standards, checks of the metric unit. Results of the length measurements and of the indices.—S. Piña de Rubies: The arc spectrum of europium. Measurements made at the normal pressure between 3100 Å.U. and 2200 Å.U. A list of the wave-lengths and intensities of the lines is given, also a list of lines given by Exner-Haschek and by Eder, attributed to europium but considered by the author to be due to impurities.—C. Mihul: New researches on the structure of the spectrum of oxygen.—Andrieux: A method of high-temperature electrolysis of oxygen compounds. Application to the preparation of a certain number of metals and of borides. The electrolytic bath consists of a mixture of metallic oxide, boric acid or borax, and fluoride of an alkali or alkaline earth. Electrolysis with a high current density gives the metal (fused or crystalline); with low current density, borides are obtained.—W. Swietoslawski and S. Poznanski: The equilibrium constant of the esterification reaction in the gas phase.—Edmond Vellinger: The rotatory power of organic substances as a function of the pH; malic acid. The curve of rotation of malic acid as a function of the pH generally resembles that given by tartaric acid and can be calculated by the same formula.—Jean Thibaud: The polymorphism of the fatty acids.—Picon: The action of high temperatures on some metallic sulphides. Iron sulphide heated in a carbon tube *in vacuo* commences to dissociate into its elements at 1100° C., while manganese sulphide volatilises without decomposition at 1375° C. Chromium sulphide decomposes at about 1350° C.—Charles Dufraisse and Henri Moureu: A method of preparation of the α-diketones, starting with ketones of the type R . CO . CH = CH . R′.—Mme. Ramart-Lucas and F.

Salmon-Legagneur: The action of phenylmagnesium bromide on the trisubstituted acetonitriles. This reaction yields trisubstituted acetophenones. With the exception of trimethylacetophenone, all the ketones described are new.—Edgar Aubert de La Rüe: Some minerals from the Ivory Coast.—Léon Bertrand: The rôle of the Alpine Triassic spur of central Vésubie in the recent landslides of Rocquebillière, Belvédère and Lantosque.—W. Kopaczewski and A. de Moraes Sarmento: The extreme lability of certain mineral waters.—O. Munerati: Three generations of *Beta vulgaris* in the space of one year.—Abelous and Argaud: The different vicariant modalities in animals without the spleen. A discussion of the modes in which glands may be modified to perform some of the functions of the spleen when the latter has been experimentally removed.—J. Nageotte: Coagulation *in vitro* of collagen dissolved in a dilute acid.—A. Policard: The phenomena of reparation of fractures studied by the method of tissue culture.—C. Hosselet: The genesis of the myofibrils and the radiate structure in the myoblasts of the legs of *Culex annulatus*.—René Lambert and Georges Teissier: The theory of biological similitude.—L. Mercier and Raymond Poisson: Remarks on a case of macrophthalmia in an eel.—A. Astruc and M. Mousseron: The various soluble ferments contained in black mustard (*Brassica nigra*). Mustard seed is rich in ferments. Besides the well-known myrosine, there are also present invertine, amylase, maltase emulsin, and an anæroxydase.

SYDNEY.

Royal Society of New South Wales, Dec. 1.—W. G. Woolnough: The geology of the Flinders Ranges, South Australia, in the neighbourhood of Wooltana Station. The eastern escarpment of the Flinders Range, at Wooltana Station, some 400 miles north of Adelaide, is bounded by a very heavy fault throwing to the east. In the escarpment are exposed rocks of the Adelaide Series (Proterozoic), much better developed than in the type area near Adelaide; Sturtian Glacial Beds attain a thickness of about 1000 feet. They rest upon shallow water or terrestrial sediments, except in one place, where a well-preserved volcanic cone of Proterozoic age is seen. Tapley's Hill Slates (Varves) and Brighton Slates and Limestones follow the glacial series. The topmost beds in the series are red beds, with ripple-marks and sun-cracks, which may have been deposited under desert conditions.—Edgar H. Booth: (1) The microphone as a detector of small vibrations. Various military type microphones were examined as to their response to impressed impulses and simple harmonic motions, the detectors being employed with an Einthoven galvanometer. The relationship between thread movement and amplitude of impressed wave is linear for minute amplitudes, and the forms of reproduced and impressed waves practically identical, in the case of certain microphones. (2) Surface waves due to small artificial disturbances of the ground. Waves were produced by dropping a pile driver of mass 0·5 lb. through distances up to 30 cm., the nature and relative amplitude of the waves produced being examined at varying distances from the centre of disturbance by microphones and an Einthoven galvanometer. A value of damping effect for Rayleigh waves for a particular case is given.—Sir George Knibbs: Notes on the occurrence of triplets in multiple births. In a previous solution of the probabilities of triplets being produced from one ovum or from two or three ova, it was assumed that triplets were never produced from a single egg. It seems certain, however, that they are sometimes so produced. A probability-analysis, similar to that possible in the case of twins, is not possible in the case of triplets; the numbers produced from one egg must be a matter of observation. Tables are given, however, which show for various numbers of cases of triplets produced from one egg, what the numbers will be of those produced from two or three eggs out of the total of 1489 cases analysed, in which the numbers of males and females were distributed as follows, namely, three males, 343 cases; two males and one female, 390 cases; one male and two females, 395 cases; and three females, 361 cases. It is remarkable that the females are in excess instead of the males. The following illustrates the probable distribution in a total of 1489 cases:

Cases from—						
One egg	0	1	2	20	200	400
Two eggs	1327	1324	1321	1267	727	127
Three eggs	162	164	166	202	562	962

—A. R. Penfold: The essential oils of *Eriostemon Coxii* Mueller and *Phebalum dentalum* Smith. The first-named plant has been recorded from one locality only, Sugar Loaf Mountain, near Braidwood, New South Wales. The second is very plentiful in the Port Jackson district of New South Wales. The oils from both were of a pale yellow colour, and possessed a pleasant fruity odour closely resembling that of the passion fruit (*Passiflora edulis*). Their chemical and physical characters were determined.—M. B. Welch: An examination of defective New Zealand kauri (*Agathis australis*). New Zealand kauri milled from buried logs obtained from swamps is liable to become worthless due to seasoning defects, the tensile strength being practically equal to the compressive strength. The weakness is evidently caused by a reduction of the strength of the tracheid walls, with the result that they become spirally cracked by the elongation of the bordered pit openings, due to internal seasoning stresses. There is apparently no variation in the rate of absorption or loss of moisture and the ash content is normal.—F. A. Coombs, W. McGlynn, and M. B. Welch: Notes on wattle barks (Part 2). Analyses of barks stored for thirty years indicate that no loss of tannin has occurred, and there is no alteration in the solubility of the tannins. The loss found when solutions of wattle tannins, in contact with partially spent bark, are exposed to high temperatures, is probably due to an insoluble starch tannin combination. This starch tannin compound is soluble at temperatures approaching boiling-point, but separates out on cooling. The high temperatures necessary to overcome adsorption are responsible for the alteration in colour of the tannins.—W. R. Browne and H. P. White: On the hypersthene-andesite of Blair Duguid, near Allandale, N.S.W. This outcrop of andesite is about 1½ square miles in area and was formerly regarded as the stump of a volcano contemporaneous with the Lower Marine series of the Permo Carboniferous system. Reasons are given for considering it rather an inlier of Carboniferous lava. The rock has suffered considerable deuteric alteration in places involving albitisation, change of hypersthene into iddingsite, carbonation, etc. Comparison of chemical analyses of the fresh and altered rock indicates the addition of potash as well as soda during alteration.

Diary of Societies.

SATURDAY, FEBRUARY 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—L. F. H. Booth: Screening and Washing Plant at Deaf Hill Colliery.—W. Rawling: The Economic Working of Thick Seams in New South Wales.—Paper open for further discussion:—The Chemical Relations of the Principal Varieties of Coal. Prof. G. Hickling.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: The Supernatural in Fiction.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital Medical School), at 4. —Demonstrations:—Fœtal Respiration in the Goat, by A. St. G. Huggett; The Secretion of Bile and Pancreatic Juice following the Injection of Bile into the Small Intestine, by Prof. J. Mellanby.—E. P. Poulton: Tone in Plain Muscle.—J. Needham: Absorption, Combustion and Constitution in the Developing Avian Embryo.—E. M. Boock, J. H. Burn, and J. W. Trevan: The Accuracy of the Assay of Strophanthus and Squill by different Methods.—Prof. J. Mellanby: The Secretion of Bile.

BIRMINGHAM METALLURGICAL SOCIETY (at Girls' High School, Dudley), at 7.—R. P. Bethell: Blast Furnace Practice.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB, at 8.15.—Exhibition Meeting.

MONDAY, FEBRUARY 21.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Squadron-Leader P. J. Wiseman: Babylon in the Days of Hammurapi and Nebuchadnezzar.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. B. W. Williams: The Importance of Toxæmia due to Anaerobic Organisms in Intestinal Obstruction and Peritonitis.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. O. Kapp and others: Discussion on National Busbars of Central Europe.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. H. Reyner: Recent Developments in Radio Reception.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—F. C. Johansen: The Screw Propeller.

INSTITUTION OF AUTOMOBILE ENGINEERS (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—E. W. Sisman: The Straight-Eight Engine.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. A. Wolf: Some Aspects of the Philosophy of Spinoza.

ROYAL SOCIETY OF ARTS, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (2).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Flight-Lieut. G. N. Humphreys: New Routes on Ruwenzori.

MEDICAL SOCIETY OF LONDON, at 9.—D. Armour: The Surgery of the Spinal Cord and Membranes (Lettsomian Lectures) (1).

ROYAL SOCIETY OF MEDICINE (Social Evening).—P. Flemming: Topographical and Medical Notes on Harley Street.

CHEMICAL INDUSTRY CLUB.

TUESDAY, FEBRUARY 22.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—E. J. Sheehy The Correlation of Nutritive Value with the Dry Matter Content of Pastures.—Prof. J. Wilson: The Maintenance Requirements of Cattle on Different Kinds of Rations and at Different Rates of Production.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (4).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Institution of Mechanical Engineers), at 5.30.—F. Achard and L. Seguin: The Early British Railways as seen by Marc Seguin in 1825: The Four-cylinder Locomotive 'Chittaprat.'—F. Achard: The First British Locomotives of the St. Etienne-Lyon Railway.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Lord Rothschild: Exhibition of a Mounted Example of the "Dragon" (*Varanus komodensis*), from Komodo Island, Dutch East Indies.—Major C. M. Ingoldby: Exhibition of Specimens illustrating Climatic Phases of some African Squirrels (Genus Heliosciurus).—R. I. Pocock: Exhibition of the Skin of a new Species of Cheetah.—M. Smith: Contributions to the Herpetology of the Indo-Australian Region.—Dr. J. Waterston: A Remarkable Scelionid (Hymenoptera-Proctotrypoidea) from South Africa.—Prof. A. Meek: *Bipinnaria asterigera* (Echinodermata) from the Northumberland Plankton.—R. I. Pocock: The External Characters of the South African Striped Weasel (*Poecilogale albinucha*).—Prof. W. B. Benham: External Sexual Differences in the Terebellid Worms.—A Collection of Papers by the following Authors, dealing with the Results of the Cambridge Expedition to the Suez Canal, 1924:—P. Fauvel, W. A. Thorpe, O. Carlgren, Dr. W. T. Calman, R. Gurney, V. C. Robinson.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 6.30.—H. N. Green: Artificial Light as an Aid to Aerial Navigation.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Col. E. Mercier: Notes on the 60,000-Volt Underground Network of the Union d'Electricité.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—F. F. Renwick: Turbidimetry and Grain Size.—W. B. Ferguson: The Ferguson Density Comparator.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at College of Technology, Manchester), at 7.30.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—H. Brier: The Application of Pre-cooling by Primary Evaporation and Multiple Effect Compression to CO_2 Refrigerating Machines.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. J. G. de Montmorency: The Custodian of Tradition.

WEDNESDAY, FEBRUARY 23.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. J. H. Evans: Testicular Tumours of Congenital Origin.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. D. Lang and Dr. Stanley Smith: A Critical Revision of the Rugose Corals described by W. Lonsdale in Murchison's "Silurian System."—L. G. Anniss: The Geology of the Saltern Area (Torbay).

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at 9 Conduit Street, W.), at 6.30.—G. F. Barwick: Directory of Sources of Specialised Information.

INSTITUTE OF CHEMISTRY (Belfast Section), at 7.30.—Prof. Gregg Wilson: Primitive Australia.

ROYAL SOCIETY OF ARTS, at 8.—F. H. Carr: Insulin and its Manufacture.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—T. Johnson: Electro-deposition of Iron.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. Sylvia M. Payne: Observations on the Formation and Function of the Super-Ego in Normal and Abnormal Mental States.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea).

THURSDAY, FEBRUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Garstang: The Progress of Hittite Studies (1).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY, at 7.—Lantern Evening.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2).—A. A. Drummond: Further Notes on the Behaviour of Phenolic Resins.

FRIDAY, FEBRUARY 25.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science), at 2.30.—F. Tattersfield and C. T. Gimingham: Laboratory and Field Experiments on Contact Insecticides.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Sir Ernest Rutherford: Atomic Nuclei and their Transformations (Guthrie Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. J. E. H. Roberts: The Diagnosis and Treatment of Intrathoracic Tumours.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—R. I. Dodsworth: Loading and Unloading Facilities on Board Ship and Land.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Major W. Gregson and others: Discussion on Waste Heat Recovery.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 7.30.—C. J. Wharton: The Economic Production of Steam by Electricity.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. C. M. Walter: A Trip in the Norwegian Fjords (Lecture).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. N. H. Mummery: The Organisation of an Industrial Clinic.

INSTITUTE OF BREWING (at Institution of Electrical Engineers), at 8.15.—Prof. H. E. Armstrong: Horace Brown Memorial Lecture.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D'Arcy W. Thompson: The Solids of Plato and Archimedes.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section).

SATURDAY, FEBRUARY 26.

MERSEYSIDE AQUARIUM SOCIETY (at Liverpool University), at 3.—Prof. J. Johnstone: Address.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Leebetter: Winning Thin Seams of Great Britain.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. B. McEwen: Beethoven (1).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. T. Calman: The Shipworm, a Pest of the Seas.

SUNDAY, FEBRUARY 20.

GUILDHOUSE (Eccleston Square), at 3.30.—C. Bailey: The Religious Experiences of Ancient Rome.

MONDAY, FEBRUARY 21.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Prof. A. Wolf: The General Philosophy of Spinoza.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.15.—Dr. E. Barker: Population and its Bearing on National Life and Character.

ROYAL COLLEGE OF SCIENCE (South Kensington), at 5.30.—Dr. W. T. Gordon: The Origin and Structure of Rocks (Swiney Lectures). (Succeeding Lectures on February 25, 28, March 4, 7, 11, 14, 18, 21, 25, 28, and April 1.)

UNIVERSITY COLLEGE, at 5.30.—J. Haantjes: Afrikaans Language and Literature. (Succeeding Lecture on February 28.)

TUESDAY, FEBRUARY 22.

UNIVERSITY COLLEGE, at 5.30.—W. J. Perry: Cultural Anthropology. (Succeeding Lectures on March 1, 8, and 15.)

THURSDAY, FEBRUARY 24.

KING'S COLLEGE, at 5.30.—Prof. J. D. Wilson: The Mind: Education.

FRIDAY, FEBRUARY 25.

KING'S COLLEGE, at 5.30.—Prof. G. H. Wooldridge and others: Discussion on The Problem of the Humane Slaughtering of Animals.

SATURDAY, FEBRUARY 26.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Daryll Forde: Ancient Ships and their Modern Descendants.

SUNDAY, FEBRUARY 27.

GUILDHOUSE (Eccleston Square), at 3.30.—Prof. J. A. Thomson: The Naturalist's Approach to Religion.