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University and Civil Service Salaries.

UNIVERSITY teachers, and not least those outside Oxford, will be grateful to the provost of Worcester College for his outspoken letter in the *Times* of August 15, in which he contrasts the higher salaries in the Civil Service with those of university professors and tutors in Oxford. The correspondence which this letter has evoked is most interesting, and raises certain points which have not escaped notice in these columns.

It may be recalled that the Select Committee on Estimates appointed by the House of Commons, in taking evidence regarding salaries, asked the representative of the Treasury questions regarding (1) comparable positions outside the Civil Service, and (2) stipends of university professors and tutors. The provost of Worcester College states that in Oxford "the stipend of the best-paid professorships was, and still is, 900*l*." In this connection it should be pointed out that the average stipend for a university professor in the other universities and institutions of university rank in England and Wales is about 850*l*. per annum, while not a few receive no more than 500*l*. a year.

On the other hand, there are many Civil Servants receiving double the salary that "the greatest learning and distinction can obtain at Oxford, and many receiving much more than treble such stipends." But this is not the full tale, for the salaries of the permanent heads of Government Departments are at present 3500*l*. per annum—emoluments considerably beyond those received by the highest-paid officials in the universities. The tutorial fellow at Oxford, with his modest 800*l*. a year or so, may perhaps be pardoned if he fails to appreciate the point of view of the writer of the letter to the *Times* who may be taken to represent the views of the Civil Service, when he plaintively refers to the fact that after September 1 the salaries of these permanent heads of Government Departments will be "only" 3000*l*. a year. And all the more so if he believes with the provost of Worcester College that "with few exceptions Civil Servants of the highest class are men who in intellectual attainments, by virtue of which as tested in examination they were appointed, fell considerably short of the standard of a tutorial fellowship at Oxford."

From the point of view of the university teacher, whose emoluments at their highest do not approach to anything like this figure, and at their lowest are mere pittances, the situation is not without irony or even humour. Notwithstanding the very favourable comparison with the staffs of the universities, the Civil Service, we are told, is under the impression that it has not received the consideration to which it is entitled, and apparently is advocating a reference of the whole question of its stipends to the National Whitley Council for the Civil Service! Now it is not our purpose to argue the pros and cons of this question. What we are immediately concerned with is the obvious inadequacy of the remuneration of university teachers. "Academic remuneration is a disgrace to the nation," says one of the correspondents—a Civil Servant—in the *Times*; "University professors are scandalously underpaid," says another; while the provost of Worcester College brings a serious charge against the Government by accusing it of having done much to make it impossible for the universities to attract and retain the service of the very ablest men. Such statements without further support might be open to criticism, but it so happens that they are confirmed by statistics and evidence collected by the Association of University Teachers, to which reference has been made in these columns on previous occasions.

This is a very serious state of affairs and should give pause to thoughtful men. It is futile discussing the minor elements in the problem when the main facts are of so serious a nature. Whether a Civil Servant or a university teacher puts in more hours of work in a year is quite beside the point and from the very nature of the work impossible to decide. Equally beside the point is the fact that the nation's income from foreign investments has shrunk by a hundred millions per annum. The question is whether the university teacher is, under present conditions, adequately remunerated, and, if not, who is to blame. A permanent head of a Government Department receives 3000*l.* or more per annum, a headmistress of a council secondary school may rise to 700*l.* or 800*l.* a year, whereas an Oxford tutor or a professor in one of our modern universities receives on the average a salary of about 850*l.* a year. Is this just or equitable? Is it likely to maintain, let alone increase, the efficiency of the university by attracting to it the right kind of man?

The universities are doing work of the highest importance to the nation, whether it is examined from the cultural or from the utilitarian side. Without this work national life would be immensely the poorer, and yet the staffs are scandalously under-paid. Already this is reacting unfavourably upon the quality of the candidates for vacant appointments, and in course of time the reaction will become even more pronounced.

For this state of affairs the Government cannot escape criticism; we are in entire agreement with the pertinent remarks of the provost of Worcester College. The University Grants Committee is cognisant of the fact that university teachers are underpaid, and that the universities are more or less in debt. As their sources of income are limited, they naturally and properly look to the Government for further aid. An annual grant of a million and a half is quite inadequate, and, in proportion to the total Treasury grant towards education, wretchedly small. If the University Grants Committee cannot convince the Government of the necessity of augmenting the annual grant to the universities for the particular purpose of increasing the stipends of the staffs, it is about time a more representative body took over its functions.

Famous Chemists.

Famous Chemists: The Men and their Work. By Sir William A. Tilden. Pp. xvi+296. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1921.) 12*s.* 6*d.* net.

SIR WILLIAM TILDEN, like many other persons, has been frequently struck by the general lack of knowledge, even among well-educated people, of the personal history and achievements of the men who have created epochs in science. This, however, need occasion no very great surprise. If the mass of the community are practically ignorant of science owing to the circumstance that they have been taught nothing concerning it, it is scarcely a matter for wonder that they should have no knowledge even of the names of its most distinguished votaries and no interest therefore in their lives and doings. Yet, as the author says, the story of their lives is not infrequently full of interest, even to those who are not specially attracted to science, or have little concern for its progress.

There has been, however, a great awakening of late. The lesson of our recent experience has been driven home. It required the Great War to enforce it. For generations past a few enlightened men have been preaching, with what seemed to many an almost tiresome reiteration, the truth that science in these days is more than ever at the basis of national welfare and security. The peril of the greatest crisis through which this country in all its long history has ever been confronted has at length aroused it to a recognition of this fact. It is unnecessary to dwell upon the evidence of this belated appreciation. We see it in the general anxiety concerning the present character and sufficiency of our secondary education, in the extraordinary rush of students into our university laboratories and lecture-rooms, in the more general recognition by manufacturers of the relation of science to industry, and, lastly, in the action of the Government in creating, on broad and liberal lines, a great scheme of State-aided endowment of science. The establishment of the Department of Scientific and Industrial Research, with its network of affiliated research associations throughout Great Britain, marks an epoch in the history of science of which it is impossible to exaggerate the significance and potentiality. Of course we must be prepared for wasted effort and wasted money. To muddle through is characteristic of our method. Science is organised common-sense, and it is scarcely to be expected that a community which has hitherto had little training in the methods of science, and no opportunity of cultivating that habit of mind we designate as scientific, will work its opportunity with a maximum of economy. But the atmosphere thus created is bound to have its effect upon the general intelligence, and perhaps none of the many lessons of the war will prove to be more fruitful or more benign in its results.

One consequence, we may hope, will be a wider interest in, and a more generous appreciation of, the labours of those who have enriched science by discovery. Discovery begets invention, and invention begets wealth and prosperity, material comfort, and happiness in living. Science has innumerable gifts in her horn of plenty which she freely offers to her devotees who worship her assiduously and disinterestedly. But these gifts, precious as they are, seldom directly benefit those upon whom they are first bestowed. Those who receive them—the discoverers—give them away, with little or no expectation of material reward or worldly benefit to the inventors, who in their turn hand them on, on terms, to the rest of the community. It therefore behoves the inventors and the community in general, if only in common gratitude, to show some interest in the lives and fortunes of those who in the unselfish pursuit of truth for its own sake thus enrich their fellow-men.

The book under review appears at an opportune time. In it Sir William Tilden tells the life-story of a number of famous chemists, from the time of Boyle down to our own era. His work makes no pretension to be a history of chemistry. His purpose is to make the general reader acquainted with the personal history and work of certain prominent chemists, whose labours may be said to have been largely directed to a common purpose—the elaboration of the atomic theory. To apply Montaigne's phrase, he has gathered a posy of other men's flowers, binding them together with a silver thread of his own. This thread, which serves to connect the life-histories of a score of eminent chemists, is the conception of atoms as a theory of chemistry. From the wealth of material to his hand it was, of course, necessary to adopt some definite principle of selection. To the extent that the phenomena of chemistry are adequately explained by the atomic theory—that it is, in fact, the bedrock upon which the whole superstructure of the science rests—it may be urged that the work of every chemist conduces to its support, even when unconsciously directed to that end. Sir William Tilden has sought to draw a distinction between work that he regards as indispensable and that which is merely contributory but not essential to the establishment of the atomic doctrine, and on this ground he excludes all mention of many names that by common consent are certainly to be styled famous. This limitation has its difficulties, of which the author is no doubt well aware. It may be argued that the collective work of the chemists, British and Continental, of the Victorian era has done more to place the atomic theory on a firm experimental basis than all the labours of speculative thinkers from the time of Boyle to the death of Dalton. But the life-work of Laurent, Gerhardt, Stas, Kekulé, Hofmann, and Wurtz, as the author is constrained to point out, and with evident regret, finds no place in his book. On the other hand, it is difficult to see how the phlogistians he deals with, with the possible exception of Cavendish, contributed directly to the foundation of the atomic theory. Their work was for the most part wholly qualitative and empirical. Such work as that of Priestley or Scheele, for example, could afford no substantial basis for such a theory, except as supplying facts which enlarged the scope of the science. But this may be said of the work of every chemist who makes a discovery or pursues inquiry in the random method of Priestley.

In spite of the imperfection and limitations of the basis on which it is constructed, Sir William Tilden has put together a most interesting book which adequately fulfils the purpose for which it was written, which is to enlighten the general reader concerning the personal history and work of men who are distinguished for their services to chemical science and whose labours have permanently contributed, and to a noteworthy and memorable extent, to its development. The notices are pleasantly written, and care has been taken, whenever possible, to verify the biographical facts. The book is suitably illustrated with, for the most part, well-known portraits of the several chemists, and with occasional pictures of their laboratories and of apparatus which they employed. Perhaps the least satisfactory portrait is that of Proust. A better one is to be found in Jaeger's "Elementen en Atomen eens en Thans," which deals substantially with the same general theme as that of the book now reviewed, but carries it down, in its latest edition, to its newest developments, which are, indeed, partly dealt with by Sir William Tilden in the epilogue with which his book concludes.

History of Persia.

A History of Persia. By Brig.-Gen. Sir Percy Sykes. (In two volumes.) Second edition. Vol. i., xxviii + 563; vol. ii., pp. xx + 594. (London: Macmillan and Co., Ltd., 1921.) 70s. net.

THAT this book, first published in 1915, should already have appeared in a second and enlarged edition is a welcome sign of the times, if we may suppose that its popularity is due, not only to the attractive way in which Sir Percy Sykes has handled his subject, but also to the growing interest that is being taken in Oriental learning by many who before the war never realised the importance of such knowledge, and even now, perhaps, are but half aware how much depends on its cultivation and diffusion amongst us. Without understanding there can be no friendship, and without friendship no lasting peace.

Persia has a history of 2500 years, and what a history! Cyrus, Darius, Xerxes, Behistun, Persepolis, Marathon, Alexander and his successors, the Parthians, Ardashir, Shapur and Nushirwan, the wars with Rome, the overthrow of the Sasanian empire by the Arabs, Islam triumphant, Kerbela and the rise of the Shia, the Bagdad Caliphate, the revival of Persian nationalism, Seljuks and Assassins, the Mongol avalanche, Chengiz, Hulagu, and Tamerlane, the Il-Khans, the spacious times of Shah Abbas the Great, Nadir Shah, the Kajars, the Russian campaigns, the envelopment of Persia, the Revolution, the National Assembly and the first painful essays in constitutional government; all this, too, introduced by an account of yet more ancient civilisations which sprang up, flourished, and expired on Persian soil—Medes, Assyrians, Elam, Sumer, and Akkad—while in his closing chapters the author deals with political and military events of yesterday, including his own adventurous march on Shiraz, the Dunsterville mission, and the Anglo-Persian Agreement.

Obviously a work written on this scale must be either a compilation in the main or else the product of co-operative specialism, a method which will always appeal to students rather than to the general reader, and, in the present case, would probably have required ten volumes instead of two. It is no disparagement to Sir Percy Sykes to say that the chief merit of his history consists in the excellent use which he has made of his authorities, in the apt selection of materials, and in the skill with which they have been woven into a well-balanced and interesting narrative. To have accomplished so much, single-handed, is a remarkable achievement which easily outweighs some defects of detail and others of a more serious kind. Omissions, of course, were inevitable, but it seems extraordinary that only six lines could be spared for Rashidu'ddin Fadlu'llah, the Prime Minister of Ghazan and Uljaytu, equally eminent (to quote Prof. Browne) as a physician, a statesman, a historian, and a public benefactor, and beyond doubt one of the ablest men whom Persia has ever produced.

The author is at his best in describing actions and events; he can tell a story, he goes straight to the point, and his style is pleasing as well as vigorous. But with the inner or deeper side of his subject he is less at home, and here we find a tendency to emphasise comparatively superficial features instead of bringing out the essential. For example, in the notice of Omar Khayyám he gives a familiar reference to the poet's tomb, together with a photograph, for which we are grateful; but it might have been remarked that the quatrains attributed to Omar, and in part composed by him, derive importance from the fact that, being the work of many different hands, and having accumulated in the course of centuries, they exhibit the character, not of any individual Persian, but of Persia as a whole. This is a slight instance, and Sir Percy is so strong in most respects that he can afford to be a little disappointing in his treatment of literary topics, religious doctrines, dervish fraternities, and such matters as the influence of mysticism upon Persian political history. On the other hand, the strictly historical portion of the work is supplemented by chapters giving much useful information about geography, climate, fauna, flora, and minerals, inscriptions and monuments, architecture and art, etc.

The author knows the country well, and has a genuine, if not very profound, sympathy with its people. His two volumes are lavishly illustrated. For this reason alone, not to mention the pocket-maps which accompany them, they are valuable to students, while from what has been said concerning the range and variety of their contents it will be clear that they ought to find a place in the library of everyone who is interested in Persia.

The Kinetic Theory and the Quantum.

The Dynamical Theory of Gases. By Prof. J. H. Jeans. Third edition. Pp. vii + 442. (Cambridge: At the University Press, 1921.) 30s. net.

THE first edition of this book was published in 1904, the second in 1916, and now, only five years later (and three of those were war years), a new edition is required. By itself this indicates the value of the work, and it is also very satisfactory as showing the growth of interest in this important branch of mathematical physics. The main part of the book has scarcely been altered—indeed, too little so, for a good many of the misprints of the second edition have appeared again. In dealing with viscosity and heat conduction, Chapman's important work is given somewhat more fully than before; but it would, of course, be out of the question to reproduce in detail the stupendous formulæ which it involves. The only other point we will mention is to express a doubt whether the author's explanation of irreversibility really does explain that exceptionally difficult question. To put it in an extreme form, has anyone yet really discovered what distinguishes the past from the future?

The main changes are the additions at the end of the book, which deal with the quantum theory, and it must be confessed that we found these in some ways rather disappointing. A certain lack of harmony is produced by the policy of grafting a few chapters on the quantum on to the end of a book originally written before its existence was accepted. It must be recognised that it is a very difficult task to fit the subject in, for it is clearly right to give a complete account of the quantum; yet its field is a great deal wider than the mere kinetic theory of gases, so that its introduction necessitates the treatment of several other branches of physics, some of which are by no means elementary. What the author has given is certainly the most important part of the quantum theory—there is an excellent account of spectra, and also of the Debye theory of the specific heats of solids. The theories of Tetrode, Keesom, and others on the equations of state of gases, however, are barely mentioned; it is true they rest on much less firm foundations than the other questions, but still they are far more closely related to the subject-matter of the rest of the book, and their exposition would not have taken very long. Also the author gives only a very short discussion of the rotations of molecules, though there is direct experimental evidence as to their moments of inertia, and though Ehrenfest's formula for the specific heat of a gas is a type of function novel to the quantum theory. Again, it would have been interesting to have had more of an exposition of the method of solving problems by direct use of the relation of entropy to probability as typified by Planck's original calculation of the radiation formula. This method seems to us, on the whole, inferior to the author's, but it has been used a great deal, and must be understood by anyone who wishes to read the original papers of the subject.

In view of the greatly extended field that these chapters cover, only shortened proofs of many important theorems are given, and some of these are not fortunate. For example, in dealing with the displacement law of Wien the author states that the energy in each wave-length is unaltered during the change of wave-lengths, whereas in fact part of this energy is turned into work, and its disappearance is the essence of the process. Again, the author calculates the equilibrium between the energy of a vibrator and that of the surrounding electromagnetic field by finding separately the amounts of energy absorbed and emitted. This is essentially a problem of resonance; but in the calculation of the absorption the damping factor is omitted without justification. In this particular case the correct proof is no longer or more difficult than the author's.

In a subject like this, based as it is on very uncertain foundations, it must have been exceptionally hard to select what was sufficiently well established to merit inclusion. It will be seen that our chief quarrel with the author is that he did not give us enough. The book contains a great deal of invaluable information critically treated, which it would be hard to find elsewhere in English. If we have laid emphasis on the defects, it is because the excellences of the work are well known.

C. G. D.

Beast and Man in India.

Companions: Feathered, Furred, and Scaled. By C. H. Donald. Pp. ix+159. (London: John Lane; New York: John Lane Co., 1920.) 7*s.* net.

THESE are vivaciously written reminiscences of Indian animals with which Mr. Donald managed to establish friendly relations. The first is the tale of a bear-cub, Bhaloo, with a strong sense of humour which became very expensive to his owner. The second tells of the rearing of two weaver-birds (*Ploceus baya*), which justified their reputation for inquisitiveness and educability. A weaver, "carefully and kindly taught, will, within a week, let off a toy cannon, select a particular number out of many cards, and bring it to his master; he will catch a two-anna piece which has been thrown into a well before it reaches the water, and bring it back. Some of his tricks seem absolutely incredible, and yet they are simplicity itself, and one and all may be taught in a couple of days each. The first and most important step in his training is to teach him that an open hand means food, and that a closed fist does not. Everything hinges on his mastery of this secret, and the rest is simple." Of some interest are the instances given of apparent mistakes in building the wonderful nest, such as leaving no doorway.

The third companion was a flying squirrel (Pteromys), which moved along the ground in a succession of jumps, "rather a lumbering gallop," soon bringing fatigue. "The leap of the flying squirrel is said to be sixty to eighty yards, but I can safely say it is well over double that distance at times, as I have seen one go right across a valley nearer two hundred yards in extent." "On approaching the tree it means to settle on, the head is raised and the tail lowered so that the parachute then acts *against* the wind as a brake, bringing it slowly against the tree. The tail, to some extent, acts as a rudder, but the change of direction is really made by a slight drawing in of the extended limbs, on the opposite side to that to which the animal wishes to turn." Mr. Donald seems to have been happy with his varied companions, and they seem to have been happy with him. He tells us of his golden eagle (not, however, to be called Chrysætus, which spoils the name), of an Isabelline bear, a bull-terrier, a rock-python which could lift three chairs with its tail, and was happy on six crows every Sunday; of hawks and langurs; and more besides. He ends with a fascinating sketch of a fox, which suggests that the secret of domestication has not been lost. This is an enjoyable book, racy, objective, and shrewd, and it has excellent photographic illustrations. We like well enough some of Mr. Donald's pet names for his companions, such as Bhaloo for the bear, and Satan for the python; but Juggins for the golden eagle touches us on the raw.

Our Bookshelf.

Insect Life. By C. A. Ealand. Pp. xii+340+lxxiv plates. (London: A. and C. Black, Ltd., 1921.) 30*s.* net.

IN this sumptuous and profusely illustrated volume Mr. Ealand attempts "to provide a text-book of entomology, useful alike to the serious student and to the reader who takes up the subject as a hobby." To us he appears to have fallen between two stools. The opening chapter on classification raised our suspicions when we encountered more than five pages of tabular classification of no possible value to the "serious student," for no hint is given of the basis employed, while to the reader with entomology as a hobby it is positively soul-destroying to be faced with a prodigious list of mere names. The second chapter, on social habits, colouring of insects, and economic questions, is more readable, provided one already possesses a considerable knowledge of insect orders and suborders. From chap. iii. onwards, however, the accounts of the several orders, etc., are of no value to the specialist, and of but little interest to the amateur. Nowhere do we find either an account or an illustration of the essential structure of an insect, or even of the mouth appendages; true, the serious student should know the main facts about these; but where will he be if his serious study should by misfortune begin with "Insect Life"?

Many of the illustrations are beautifully coloured and do immense credit to the publishers; but the object of the author seems to have been to arrange a striking plate rather than to display the structural features of the insects. Thus in the coloured plates of the Coleoptera many brilliant and beautifully coloured species are shown, but the majority have their legs tucked away out of sight beneath the body, so that the tarsal joints are entirely invisible, and in some cases the antennæ are in the same plight. The figures (copied from Shipley's "Zoology of the Invertebrata") showing the emergence of the dragonfly imago from the nymph are peculiarly unfortunately arranged, for, as in the original, instead of being placed vertically, the drawings have been turned round into a horizontal position, with the result that the dragonfly is shown emerging in a position that is absolutely impossible and absurd. It is unfortunate that so showy a book contains so little of real value.

A History of Psychology. By Prof. G. S. Brett. (Library of Philosophy.) Vol. ii., *Mediaeval and Early Modern Period.* Pp. 394. Vol. iii., *Modern Psychology.* Pp. 322. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1921.) 16*s.* net each.

THE first volume of this work was published in 1912. Starting with an account of primitive animistic notions, it carried the history through the periods of Greek philosophy and Greek Christian philosophy to St. Augustine. The two volumes now added deal, one with the medieval and early modern period to the end of the seventeenth century, the other with the modern period, ending with a final chapter on "The Scope of Modern Psychology." It is difficult to appreciate the purpose or the usefulness of a work of this kind, however much we may admire the devotion and research which have produced it. As an encyclopædia it is of little value, for the simple reason that one human author cannot be encyclopædic. He cannot be a first authority in regard to all the writers with whom he deals. Also it is misleading to describe animistic speculations or even philosophy of mind as parts of the science of psychology. As a matter of fact, the modern science of psychology has little or nothing in common with the theories here recorded, and owes nothing to them.

A more serious criticism, however, is a negative one. Information we naturally expected to find and which might have made the history of real value is omitted. One illustration is typical. There is a chapter entitled "From Fechner to Wundt." If the reader should refer to it for an account of the psycho-physical law which has made Fechner's name famous, this is what he will find:—"The law known as the 'Weber–Fechner Law' has been so often described and discussed that we may be excused the task of repeating its definition." Practically all we are told about it is that "volumes have been written on it."

The Bases of Agricultural Practice and Economics in the United Provinces, India. By Dr. H. Martin Leake. With a foreword by J. MacKenna. Pp. viii+277. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 15*s*. net.

THE author of this illuminating book has applied himself to the elucidation of the bases and development of agricultural practice and economics, showing how improvements in methods of farming must necessarily be associated with the due recognition of economic factors if true advance is to be made. Although the text deals solely with India, the underlying principles are applicable to agriculture the world over, and the book throws fresh light upon the new problems that are constantly arising now that scientific principles and methods are being more widely applied to farm practice.

Agricultural practice is essentially based on the relations between the soil and atmospheric conditions and the crops grown, and these are set forth factor by factor, careful distinction being made between those which can and those which cannot be controlled. Possibilities of development and improvement are discussed with special reference to such points as hybridisation and selection, cultivation and manuring, as adapted to Indian conditions. Parallel with this, the economic aspect is considered, particular stress being laid on the possibilities that lie in co-operation of various kinds as a factor in the encouragement of agricultural development.

The book is strongly to be recommended, not only to those connected with Indian agriculture, but also to all who are interested in the progress of modern scientific farming, for the conditions discussed are so varied that they provide scope for the consideration of strongly contrasted aspects of the subject. W. E. B.

Groundwork of Surgery. (For First-year Students.) By Arthur Cooke. Pp. viii+183. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1919.) 7*s*. 6*d*. net.

WRITTEN by one who is himself a thinker, worker, and teacher, this book furnishes the beginner with an excellent introduction to the science, art, and craft of surgery. Most manuals are addressed by the expert to other experts, or at least to advanced students. In the present volume the author sets himself, very successfully, to lay the foundations on which a more detailed knowledge may be reared. The ground which surgery covers is indicated, and its broad outlines are defined; space is given to preventive treatment and surgical sanitation generally; and the main surgical affections of the different regions of the body are described. The book may be cordially recommended.

College Botany: Structure, Physiology, and Economics of Plants. By Dr. M. T. Cook. Pp. x+392. (Philadelphia and London: J. B. Lippincott Co., 1920.) 12*s*. 6*d*. net.

IT is said of this book by the author that it is "an effort to meet present conditions," but it is not very clear what these conditions are. The book is divided into sections on morphology, physiology, and classification, the last including general descriptions of the great plant groups. Some of the drawings, such as Fig. 30, representing a lenticel, and Fig. 152, depicting the pine cone and its parts, can only be described as crude; but the photographs of individual plants, of which there are many, are much more successful. A number of maps are given showing the various areas of crop production in the United States, and economic plants of all kinds are frequently introduced into the descriptions. The book would seem to be most suitable for American students beginning the study of agriculture.

Experimental Organic Chemistry. By Prof. A. P. West. (New-World Science Series.) Pp. xiii+469. (London: George G. Harrap and Co., Ltd., 1921.) 10*s*. 6*d*. net.

THEORY and laboratory experiments in organic chemistry are combined in this book. Only the more important compounds are discussed, and experiments of a difficult or dangerous character are purposely omitted. Review tables, giving at a glance the chemistry of groups of compounds, are supplied at frequent intervals. The theoretical part of the book is somewhat less satisfactory than the practical, for it is frequently very condensed. The book is well printed and illustrated. This is one of the very few elementary books on organic chemistry which give an accurate description of fractional distillation.

Reports of the Progress of Applied Chemistry: Issued by the Society of Chemical Industry. Vol. v. 1920. Pp. 626. (London: Society of Chemical Industry, n.d.) 15*s*.

THE annual reports on the progress of applied chemistry issued by the Society of Chemical Industry fulfil the same functions for applied chemistry as do the annual reports of the Chemical Society for pure chemistry. They constitute a most useful and authoritative review of the work done during the year. The present volume is the work of experts in the various branches of applied chemistry, and can be recommended to all who wish to keep in touch with the rapid progress of chemical technology.

Letters to the Editor.

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

The Natural History of Man.

IN an article on "New Experiments on the Inheritance of Somatogenic Modifications," in NATURE of February 3 (p. 742), Prof. Arthur Dendy writes: "It has long been suspected that the problem of the transmission from parent to offspring of somatogenic modifications ('acquired characters') might be solved more readily by physiological experiments directly involving the complex metabolism of the body than by crude surgical operations, such as the amputation of limbs." He proceeds to tell us of experiments which are thought to demonstrate that when certain toxic substances are injected into the blood of pregnant rabbits a deterioration of the eyes of the offspring sets in, which is transmitted and increased generation after generation.

Now examine the other side of the shield. Let us use a little of the evidence from associated sciences which zoologists and botanists have ignored. It has been said by naturalists that man is a domesticated animal, meaning, probably, that man is a social animal like ants and bees. Man is a typical wild animal, living under an enormous variety of conditions, which have become perfectly natural to him. At any rate, he is not under artificial selection. Again, it has been said by opponents of Darwin that no one has seen natural selection in operation, and that, therefore, its existence is a pure guess; and by yet others, supporters of Darwin, that man has escaped from selection. As a fact, every man, except the biologist as such, has seen natural selection in full blast, and, so far from having escaped from selection, man is everywhere stringently selected in a glaringly obvious way. Indeed, since we are able to follow the career of men with a completeness that is unique in the animal world, man is the only animal in which natural selection can be observed and its consequences traced to the last little detail. Apart from each man's personal experience and a voluminous literature, it is the principal function of all Departments of Public Health to collect precise statistical information bearing on this very subject.

Man is the prey of a multitude of living microbic species, which have become parasitic on him, and attack him in all sorts of ways and with every degree of stringency of selection. It is common knowledge that men vary in their powers of resisting various microbic diseases, and that these powers of resistance tend to "run in families" (*i.e.* are inheritable), as is conspicuously the case in tuberculosis—a fact which is still better observable when we compare men of different races; for example, West African negroes and Englishmen in respect to tuberculosis and malaria. Again, it is common knowledge that powers of resisting any disease do not necessarily imply powers of resisting another disease.

Here, then, is natural selection indubitably manifest in the only wild species in which observation of its operations is possible. What is the effect on races? Does any change result? If so, does it accord with Lamarckian or Darwinian doctrine? It may be laid down as a rule to which there is no exception that *every human race is resistant to every prevalent and lethal human disease in proportion to the length and severity of its past experience of that disease.* Here, then, is evolution indubitably manifest as a consequence of natural selection.

But this recital gives no conception of the fidelity with which evolution follows selection. Not only does selection by any disease cause evolution against itself alone, but there are also two main types of diseases which select in unlike ways and cause extraordinarily unlike racial effects. In one group (*e.g.* measles and smallpox) the microbes flood the victim with toxins, soaking even his germ-cells. He dies; or, reacting against these toxins, recovers within a definite period, the duration of which, speaking generally, varies with the abundance and virulence of the toxins. Recovery implies "acquired" immunity, which is often of life-long duration, and is simply a "use-acquirement"—a response to functional activity. The individual has become "used to," or trained by, the toxins through some physiological process, just as he becomes used to tobacco, or exertion, or the performance of difficult and complex thinking. Practically everyone is susceptible to this class of disease. As a rule, therefore, the survivors are not those who resist illness, but those who recover from it. In the other group (*e.g.* tuberculosis and leprosy) the microbes retain their poisons within themselves, and the illnesses caused by them are usually prolonged and of indefinite duration. The survivors are, as a rule, not those who recover from illness, but those who resist it, *i.e.* those who are "innately" immune. In this class of disease individuals vary greatly in resisting power. Thus, in tuberculosis, there are those who seem quite immune under the worst conditions, those who fall ill under bad conditions but recover when the conditions are improved, those who die after lingering illness, and those who perish swiftly and, as a rule, in early life. Here there is no "acquired" immunity; whoever is infected suffers nothing but injury.

Plainly in disease we have on a vast scale just those "physiological experiments directly involving the complex metabolism of the body" concerning which Prof. Dendy is so hopeful. If the Lamarckian doctrine be true, diseases of the measles type should, by the "transmission of acquired immunity," render the race less and less susceptible to infection until it acquires "innate" immunity; on the other hand, diseases of the tuberculosis type should enfeeble the race by the accumulation of injury until at last it perished. But nothing of this has happened. On the contrary, racial changes have followed precisely contrary lines, those of natural selection. Thus Englishmen who have long been exposed to measles are fully as susceptible to infection as Polynesians, but recover from illness more easily and frequently; whereas races which have long been exposed to tuberculosis (*e.g.* Jews) resist infection much more stoutly than those that have been less exposed (*e.g.* American Indians). The diseases of animals and plants (*e.g.* in the fly districts of Africa) tell the same story, but here natural selection cannot be as closely studied as in the case of man. We see only the consequent evolution. Now compare as to volume and duration the minutely studied and easily observed physiological experiments of Nature which Prof. Dendy ignores with those to which he pins his faith. Obviously, if anyone did establish that the injection of a toxin caused hereditary degeneration, he would discover, not a rule, but one of the rarest exceptions in Nature.

In order to demonstrate the importance of disease selection, it is worth while to pursue this subject a little further. Doubtless there have been many great human migrations, but two especially are recorded in history—that immense surge of Eastern people which established in their present sites many of the modern races of Europe, and that still vaster overflow which carried the inhabitants of modern Europe to the Western hemisphere. If history teaches any lesson with clearness, it teaches this—that unless conquered peoples are exterminated they invariably absorb or expel the conquerors. Hence the disappearance of the Greek, Roman, Saracenic, Norman, and Turkish governments.

All, or nearly all, human microbic diseases appear to have originated in the Eastern hemisphere, where men first multiplied sufficiently to provide a constant supply of nutriment to the parasites. Myth and history tell first of epidemics. Such diseases as measles suddenly appeared, attacked young and old, and then, having exhausted the food supply, passed to neighbouring populations, leaving behind a human remnant which had acquired immunity. Later, when populations became more dense, the multitudes of new births furnished a perennial supply of food, and enabled many of these diseases (*e.g.* measles and whooping-cough) to become endemic. Epidemic disease, especially if occurring at rare intervals, is always the more terrible; for the old as well as the young are affected, and in consequence the sick are left untended, business is neglected, and famine follows. Many perish who would otherwise have survived. Witness in modern times the fate of many Pacific Islanders. Endemic disease selects more stringently, but more cleanly; the old who have acquired immunity tend the young, and only the less resistant die. Some maladies, especially those which are insect-borne (*e.g.* malaria), are confined to localities, but most others are, in varying degrees, "crowd" diseases. Thus in England no one escapes frequent contact with measles and tuberculosis, which cause illness unless the individual be immune, and death unless he be resistant. All such diseases tend to become endemic as the crowd thickens. We speak of the deadly climate of West Africa; but that of England is even more deadly to visitors from thinly scattered tribes (*e.g.* nearly all savages). There is no evidence that any human race is mentally unfitted for civilisation, but there is the clearest evidence that, physically, only those races are capable of it which have evolved in response to that slowly increasing stringency of selection which occurs when populations gradually become more dense.

Of old the sword exterminated the conquered and dug deep the foundations of permanent empires. With advancing civilisation and the cessation of deliberate extermination, it lost its power. But when Columbus ended the long separation between East and West he bore weapons more deadly than the sword. Except malaria he met no considerable diseases, but the microbes of the East found virgin soil. Thereupon commenced the greatest event and tragedy in human history. The races of one half of the world began to replace those of the other half. As in the ancient Eastern world, measles, small-pox, and other diseases of definite duration swept the continent in vast epidemics. They left behind them an immune remnant. But tuberculosis, endemic from the first, owing to its long duration in the individual, exterminated wherever the conditions favoured its spread. Spain and Portugal, then powerful maritime States, and first in the field, elbowed the weaker British and French into the seemingly inhospitable North. But, while the tropics were defended by malaria, nothing protected the North, where British and French settlers poured into the vast void created by imported diseases. The former won the battle of Quebec. French immigration ceased, and all North America fell into the grasp of the Anglo-Saxon. Later the microbes created, and the Anglo-Saxons are now filling, another void in Australasia. Thus our race won a place in the sun, and to-day has more room for expansion than any other race. In actual truth, even if soldiers, sailors, and settlers founded the British Empire, it was the microbes that established it on enduring foundations. Germany began her war a century too late. If history repeats itself, the Anglo-Saxons are sure to lose their Eastern conquests, where every European settlement is surrounded by a flourishing native quarter; but seemingly they are rooted for ever in the West, where the natives can exist only in the wilds. Every travelling disease has reached almost its limits, and therefore diseases, like the sword, are losing their power of founding permanent empires. The period of the great human migrations is drawing to an end.

The story of the evolution against narcotics is similar. For example, individuals differ greatly in their degree of susceptibility to the charm of alcohol. Some men swiftly acquire an intense craving for deep indulgence in it; but most of us are temperate without effort or very little effort. In other words, we have no great susceptibility. Speaking generally, moderate drinkers are not those who resist temptation, but those who are not greatly tempted. Habitual heavy drinkers are always much tempted. Alcohol is a poison which especially affects the habitual heavy drinker, not only killing the worst cases, but also making many more susceptible to numerous ills—for instance, tuberculosis. Every race (*e.g.* Jew, Greek, Italian, South German, South French, Spanish, Portuguese, West African) which is now temperate in the presence of abundant supplies of alcohol was anciently drunken. That is, every race is insusceptible to the charm of alcohol in proportion to the length and severity of its past experience of it. Precisely the same is true of opium. Natives of India take it in moderation; the Chinese in greater excess, but in less excess than formerly; while Burmans and Australian blacks indulge immoderately and perish swiftly. Nature's unfailing plan of temperance reform is to remove the heavy drinker. The human plan is to remove drink and leave the potential drinker to multiply. But yeast and sugar cannot be eliminated, and human, unlike natural, laws are sometimes disobeyed, and are never immutable.

I have tried to sketch a little of the natural history of man, concerning which so little has been written, but which, even politically, is so much more important than his voluminously described political history. The evidence, none of which I think is disputable, is derived mainly from medical and historical sources, but the problems which arise are biological. They are too big for doctors and historians, who are mere specialists. Meanwhile what has biology done to establish the actuality of natural selection? She has measured some frozen sparrows, she has suffocated some crabs, and she is now conducting some "physiological experiments" to ascertain whether "acquired" characters are "transmissible." Some of her eminent professors have declared that natural selection is a myth, and the pulpits of the contemners of science are filled with acclamations.

But it is mind which presents biology with the greatest of her problems, tasks, and opportunities. Man is the educable animal. On the mental training of his young depends the intellectual status of the individual and the social status of the community. Men of science, especially biologists, frequently urge scientific education. What is it? It implies, I conceive, the supplying of information which is likely to be useful, intellectually or materially, in such a manner that the pupil is left a skilful, unbiassed thinker with an open, receptive, reflective habit of mind. So far as possible he is taught, not what to think, but *how* to think. In the opposite type of education an endeavour is made to close the mind—to bias, to stupefy, to induce an artificial incapacity to profit from fresh experience, to hold beliefs even in the face of conclusive evidence; in brief, to teach the pupil *what* to think, not how to think. Compare, as products of these opposite types of mental training, Darwin and Huxley with devout Mohammedan and Hindu ecclesiastics. The evidence in favour of scientific education is enormous, decisive, indisputable, but it lies outside the sphere of botany and zoology, in psychology and history. By whatever rational standards we judge human communities—material or intellectual progress, efficiency in peace and war, wealth, enterprise, energy, the production of great thinkers and men of action, civil war, brigandage, murder and other crimes, and so on—we find invariably that the societies the mental training of which has most nearly approached the scientific ideal are the superior. Compare the results of the mental training given by Socrates and his fellows to the ancient Greeks with that given by the Russian popes to their victims. Many nations (*e.g.* the Romans) have fallen because a change for the worse in mental training left descendants too inefficient to preserve that which better-trained ancestors had secured. Many nations (*e.g.* after the Reformation) have arisen because improved mental training enabled them to surpass competitors. Consider the late war and how completely the more biassed peoples have been smashed. But this is a subject too vast for present consideration; I have tried to deal with it elsewhere.[1]

I may be right or wrong as to the conclusions I have reached, but clearly the evidence and problems I have instanced exist. Clearly they are matters for biology, although they have been neglected by her.

Academic biology is of little account in the world. The hobby of some naturalists who use not a tittle of the evidence available, she possesses next to no established truth. Her few students are engaged in unending disputes, all of which are consequent on a misuse of words or a neglect of crucial testing. Her indefensible terminology separates her from a host of subsidiary sciences. But a biology clarified and simplified by a precise terminology, and in possession of a classification of characters similar to that employed in other studies, might easily become the queen of sciences. A few wide generalisations accepted by everyone would then replace the present chaos of opinions, and provide a basis for work of practical utility. The use of evidence from other studies would make their students her own. So strengthened, she would become a power in the land, and perhaps lay the foundations of that golden age of science and human wisdom and well-being of which we all dream.

Surely there are biologists who perceive that the failure to establish truth can have no cause other than lack of right scientific method, and who are prepared to substitute the method of discussion which has created other sciences for that of controversy which has wrecked biology.

G. ARCHDALL REID.

[1] *Vide* "Prevention of Venereal Disease," reviewed in NATURE, April 14.

Magnetic Double Refraction of Smokes.

THE interesting discovery recorded by Sig. Tieri in NATURE of August 18, p. 778, that the fumes from an iron arc can, when subjected to the action of a magnetic field, rotate the plane of polarised light, is in close accord with the view of the structure of such fumes advanced by Prof. Elihu Thomson in his recent letters to NATURE, and agrees also with the observation of Mr. Speakman and myself (see NATURE, June 23, p. 520; and July 14, p. 619).

Prof. Thomson explains the sudden enhanced luminosity of the light scattered by the iron oxide smoke when the magnetic field is applied by the particles arranging themselves along the lines of force. For this structure to be effective the particles cannot be spherical, but must consist of rods or chains, for only then would the intensity of the reflected or scattered light vary with "end on" or "length on" incidence. This was confirmed by a microscopic examination of the iron oxide fume, which showed the particles to consist of short strings or chains of roundish beads not touching one another.

The experience of Mr. Speakman and myself is that the fumes from metallic arcs in air undergo rapid changes with time. The minute particles produced at first by condensation of vapour aggregate together to form complexes, which often show a definite chain-like structure when examined after deposition on a slide, but in the air are continually altering their form under molecular bombardment.

Now it seems likely that if by magnetic or electric forces the small chains or strings can be made to space themselves with their axes all in one direction, not only will the effect described by Prof. Thomson be produced, but a beam of polarised light traversing the fume at right angles to the field of force would suffer rotation provided that the plane of polarisation is neither parallel nor at right angles to the longer axes of the small chains. This is just what Sig. Tieri finds, and it might be expected further, if the above explanation is the correct one, that the magnetic double refraction would vary with the age of the smoke and its method of production. The bluish-coloured smoke found by Prof. Thomson to accompany the yellow fumes from the iron arc, and which did not exhibit the magneto-optical effect, consisted probably of single particles, and would be unlikely to show magnetic double refraction. It corresponds with the initial stage of the oxide clouds we have studied before agglomeration has had time to occur.

This striking behaviour of iron oxide dispersed in air discovered by Sig. Tieri exhibits a close parallel to the behaviour of the same substance dispersed in water. Cotton and Mouton and others have investigated the magnetic double refraction of iron oxide hydrosol, and they ascribe the effect to the orientation of rod-shaped or lamellar ultramicrons. Further, the magnitude of the effect was found to increase as the colloid became coarser.

A continuation of the work commenced by Sig. Tieri may well lead to much interesting information on the form of the particles in smokes.

R. WHYTLAW-GRAY.

Eton College, Windsor, August 21.

The Contractile Vacuole.

IN connection with previous correspondence on the mode of production of the contractile vacuole in Protozoa (NATURE, vol. cvi., pp. 343, 376, 441), I find that it is, in point of fact, Prof. Marcus Hartog to whom the credit of the osmotic view is to be given. In a communication to the British Association in 1888 (Rep., p. 714) this observer pointed out that, owing to the semi-permeable surface membrane, substances in solution in the protoplasm of these organisms must attract water, which accumulates at a particular spot until it reaches the surface, breaks through the membrane, and escapes. The membrane spontaneously closes up as the distension is relieved. Prof. Hartog shows that if substances such as sugar or potassium nitrate are dissolved in the outer water to a sufficient osmotic concentration, the production of the vacuole ceases. The paper was reprinted in Ann. Mag. Nat. Hist., Sec. 6, vol. iii., p. 64 (1889). The theory was worked out in more detail by Degen (*Bot. Zeit.*, vol. lxiii., abt. 1, 1905), and is explained by Prof. Hartog in his article on Protozoa in the Cambridge Natural History (1906),

p. 15. My knowledge of Stempell's paper was derived from an abstract in which the osmotic aspect was chiefly emphasised. On reference to the original I find that this part of the process is obscured by a number of complicated subsidiary hypotheses. W. M. BAYLISS.

University College, London.

A Correction.

SOME months ago Sir Ray Lankester was good enough to write to me in regard to the statement in my "System of Animate Nature" (1920) that he had spoken of evolution as "a chapter of accidents." He asked me to verify the quotation, and I thought I had only to turn to my book-shelves for a minute to find the passage. But in spite of some months of very agreeable and profitable re-reading of Sir Ray Lankester's writings, I have *failed* to verify the quotation, and the only thing to do is to apologise. Perhaps I should have seen that the phrase I ascribed to Sir Ray Lankester was inconsistent with such sentences as these:—"Thus then it appears that the conclusion that Man is a part of Nature is by no means equivalent to asserting that he has originated by 'blind chance'; it is, in fact, a specific assertion that he is the predestined outcome of an orderly, and to a large extent 'perceptible,' mechanism" ("The Kingdom of Man," p. 9); and "They [the mental qualities which have evolved in Man] justify the view that Man forms a new departure in the gradual unfolding of Nature's predestined scheme" (*op. cit.*, p. 25).

I yield to no one in my appreciation of the services which Sir Ray Lankester has rendered to zoology and biology, and I can only express my regret that in a busy life I made a mistake which amounts to an unintentional misrepresentation.

J. ARTHUR THOMSON.

Natural History Department, Marischal College, University of Aberdeen, August 16.

Wrightson's Hypothesis of Audition.

THE hypothesis advanced by the late Sir Thomas Wrightson in his book "An Enquiry into the Analytical Mechanism of the Internal Ear" has, it would seem, received such wide acceptance that the following comments upon it may be of interest.

Wrightson suggested that the appreciation by the ear of the constituent notes in a musical chord is due to the recognition and measurement by the brain of certain time intervals, which occur between the changes in motion of the air when it is transmitting music. In proof of this suggestion Wrightson gives graphic examples. First he takes two simple sine curves representing two musical notes, and from them he obtains a third curve which shows the motion of the air when both notes are sounding together. On this compound curve he marks distances between crests, troughs, and crossing points which are equal to the wave-lengths of the two separate notes.

From the identity of these distances Wrightson concludes that when the observer appreciates the constituent notes in a chord he does so by recognising the existence of these time relationships.

I find, however, that this proof loses its value, since it can be shown by trial that purely arbitrary wave-lengths are also represented in the compound curve as frequently as are those of the notes actually present.

It is scarcely possible, therefore, to accept Wrightson's explanation of the power of analysis possessed by the ear, since, all wave-lengths being equally represented, there is no criterion by which the right notes can be recognised and the arbitrary ones excluded.

This criticism, considered in conjunction with that of Boring and Titchener (*American Journal of Psychology*, vol. xxxi., 1920, pp. 101–13), would seem to take from Wrightson's theory almost all the essential features which individualise it from the older telephone theory of Rutherford. H. HARTRIDGE.

The Generation of Heath-fires.

IT is the general practice to attribute the heath-fires which have been so common of late to the careless dropping of matches or to the camp-fires of picnic-parties. But this is not always the cause. An instance came under my notice during the late hot weather which seems to be worth recording. I was walking along one of the ridges at Finchampstead, Berks, and to the south was a fairly steep slope of peaty heath land, giving rise here and there to clumps of bracken, but exposed each day to the sun's rays for many hours at a time. Noticing some smoke emerging from the soil, I turned down the slope to stamp out a possible fire, and I found that as soon as it was put out in one place it emerged elsewhere, a foot or so away. My companion and I repeated the process in many places, but soon we saw that the smoke was emerging from a hundred places, and our efforts were useless. Smoke was rising out of the peaty soil over an area of at least a quarter of a square mile, and another hour of the sun's heat might have been sufficient to result in the place breaking into flame.

From a note in NATURE of January 27 last, p. 704, in regard to the spontaneous burning of coal-seams in the United States, I see that the fine dust of lignite may ignite at 150° C., and I suggest that in the case in point the finely divided carbonaceous soil may have been undergoing such changes under the heat of the sun, which may have brought up the temperature to something approaching this. Anyway, here was a considerable area smoking under the intense heat, and ignition could not have been far off. EDWD. A. MARTIN.

South Norwood, S.E., August 13.

Cornalith.

IN the *Bulletin of Agricultural Intelligence* issued by the International Institute of Agriculture, just to hand, there is a précis of an article in the *Annales de Gembloux* under the heading "Plastic Materials with a Casein Basis: Galalith and Cornalith." The latter word is not in the N.E.D. or in the recently published "Dictionary of Scientific Terms." Galalith, or "milk-stone," is well known, and cornalith will be "horn-stone." The first sentence in this précis reads: "Galalith and cornalith, two substances made from casein that has been treated with formalin, are produced now in various countries, especially in France, where there are already several factories."

It is stated that, in order to diminish the cost of opaque articles made from casein treated with formaldehyde, the raw material is sometimes mixed with the refuse of horns, horsehair, and other nitrogenous matter. When this is done is it called "cornalith," and, if so, does the name or term correctly describe the material?

It is also stated that attempts have been made to use vegetable casein extracted from soya beans, as being less expensive than casein obtained from milk. Has this been successfully accomplished, and, if so, can the resulting plastic material be called "galalith," or is some other term used? R. HEDGER WALLACE.

August 16.

Pulverised Coal as a Combustible.

By SIR R. A. S. REDMAYNE, K.C.B.

COAL, which has, ever since the growth of modern industrialism, proved the main source of artificial heat, power, and light in civilised countries, is likely to continue to occupy that position for very many years to come. In some industries it constitutes the chief item of cost in production; in others it is second only to that of labour. Its importance, therefore, as a factor in the cost of living is very great indeed. That the price of coal, at any rate for a long time, will be maintained beyond a pre-war level cannot, I think, be controverted. The higher wage demands of labour incident to the advance in the standard of comfort claimed are not likely to be so abated as to bring wages down to a pre-war position; for the same reason the cost of the materials so largely used in mining—*e.g.* timber, steel, lubricants, and machinery—will remain at a high rate. The chief hope of securing a reduction in the cost of production must lie along the lines of research. Similarly, also, the reduction in the cost of our fuel bill must be sought in economy in use—that is to say, in an endeavour to use efficiently every calorie available in the fuel.

In this connection the use of coal in the form of dust has for some few years been occupying the attention of engineers, particularly during the last five years, and more especially in North America. In the year 1919 the Fuel Research Board published a brochure on the subject, and the May number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* contains a most interesting article by M. Frion entitled "Le Chauffage au Charbon pulvérisé," being a report of the "Commission d'Utilisation des Combustibles," in which it is stated that "le développement devint assez rapide à partir de cette époque, et actuellement les industries du fer et de l'acier emploient environ 3 à 4 millions de tonnes de charbon pulvérisé par an, et les industries du cuivre un tonnage à peu près égal."

The use of coal in the form of dust for raising steam had, from isolated experiments, been known for the last thirty to forty years, but the fact that it is probably the most difficult method of burning coal delayed the development of the practice until means were discovered of surmounting the obstacles in the way of its use. When it is considered that if a cubic inch of coal which has an exposed surface of six square inches is crushed into cubes each of which has a side one-hundredth of an inch in length, and the exposed surface of the crushed coal becomes 600 square inches, the theoretical advantage of burning crushed coal becomes obvious. A more intimate mixing of the fuel and air is rendered possible, and this without using a large excess of air; for example, with an average boiler furnace fitted with mechanical stoking it is considered good working practice under normal conditions if 150 to 200 per cent. of excess air is being admitted to the furnace; on the other hand, under pulverised-fuel firing there is no difficulty in working regularly with not more than 20 to 30 per cent. of excess air.

One of the difficulties which originally lay in the way of the widespread use of pulverised fuel was the heat engendered in the grinding of the coal to the requisite fineness, sometimes resulting in combustion. Again, inasmuch as coal dust cannot be shovelled into and burnt in an ordinary furnace, special burners had to be provided. However, a number of well-tried and standard methods for both the preparation and the burning of the fuel are now in existence, the underlying principle of all of them being the same, though differing in the design of the various parts of the equipment. The coal is dried, pulverised, and the dust, passing to a furnace, is conveyed to a burner, and then, mixed with air, burnt in the form of a jet. Each system has its own peculiar methods of performing these operations, some systems being more suited to certain conditions than others. A point common to all the systems, however, is that of the fineness to which it is necessary to reduce the coal. It has to be ground so fine that the dust will pass through a 100-mesh screen (*i.e.* a screen containing 10,000 apertures to the square inch), and 85 per cent. through a 200-mesh screen (*i.e.* a screen having 40,000 apertures per square inch). In order to effect this the coal must be dried so as not to contain more than 1 per cent. of uncombined moisture, the dryness being necessary from the point of view of manipulation, as the fuel must be capable of being handled without clogging or sticking in the feeding and burning equipment. In the process of drying, care has to be taken against overheating, which may result in loss of volatile hydrocarbons. The cost of securing a higher degree of fineness than that specified above is not justified by the extent of the increased efficiency obtained. On the other hand, practice has shown that if the degree of fineness is much below the standard named above troubles arise due to deposits of ash and slag and from irregular burning.

The separation of the coal ground to suitable fineness from that which is not of sufficient fineness is effected by screening or by air separation. In the latter method a stream of air at constant velocity carries away from the crushed coal particles of a certain definite size and so secures a uniform product, but the use of an air separator requires upwards of 50 per cent. more power to work it than a screen to perform the same amount of useful work, in addition to which the cost of maintenance of the former is heavier, due to high velocity and excessive strains. With air separators the mixture of air and coal dust is carried to a cyclone dust collector, where the stream of air entering the larger volume of the collector is deprived of its velocity and the coal dust drops. With the screen separator the coal is elevated by a bucket elevator and conveyed to the furnace by a screw conveyor.

There are a number of different forms of burning the dust in use, the fuel being driven into the fire-box by means of either fans or compressed air. In one system the air pressure is exerted in the tank, which is in connection with the furnace by means of a pipe, and the dust forced in a stream, unmixed with air, through the pipe to the furnace. In another system the coal dust is drawn from the storage bin as required, mixed with air, and carried in suspension through pipes to the furnace at a velocity of 5000 ft. per minute. Mixing air with the coal dust would appear to increase the liability to explosion. In yet another system the dust from the feed worms is blown into the fire-box, the fuel and air passing as a cloud into the fire-box and being ignited by a piece of waste soaked in paraffin.

One economy incidental to the use of pulverised fuel under boilers has already been mentioned—viz. reduction in the amount of fuel as compared with lump coal to secure a given heat result. Other economies may be mentioned, as follows:—

(*a*) Ability to use low-grade coal.
(*b*) Saving in labour of stoking.
(*c*) Flexibility of the operation, coal-dust firing being almost equal in this respect to oil firing.
(*d*) Elimination of "banking" and easier disposal of ashes.
(*e*) Possibility of safely working the boilers at loads largely in excess of their normal rating.
(*f*) Ease of control of furnace conditions in the case of metallurgical furnaces.

Against these advantages, however, must be ranged the cost of preparing and conveying the pulverised fuel and the interest and depreciation on the capital outlay. These are very variable items, dependent, as they are, on local conditions in respect of labour, power, and fuel, but chiefly on the output per day of the plant. For instance, in the United Kingdom, under present conditions, it is not considered a paying proposition to use pulverised fuel in the case of stationary boilers having a lower fuel consumption than 40 tons of coal per diem. On the other hand, with a fuel consumption of 200 to 300 tons per diem a handsome saving can usually be secured by the replacement of lump coal by pulverised fuel under almost any conditions. As a rough guide it may be taken that with almost any of the well-known standard "systems" the cost of preparing, pulverising, and burning in the form of dust 1 ton of coal, will be about 5*s*. in the case of a plant dealing with 100 tons of coal per diem. Of course, the higher the price of the raw fuel the greater the saving by using it in pulverised form.

Pulverised coal has been successfully applied to almost every kind of heating work, with the possible exceptions of open-hearth steel furnaces, steamships, and such furnaces as glass tanks, where contamination of the charge from particles of ash is to be avoided. The first really successful application of dust-coal fuel was in respect of rotary cement kilns, where the conditions are such that the problem of the disposal of the ash does not exist, and a large combustion volume is available with a free, unobstructed passage for the flame. The next step in its application was in the direction of various types of metallurgical furnaces, more particularly reheating, puddling, and similar furnaces, and complete success has been obtained in most cases.

The case of stationary steam boilers of the water-tube type has been found more difficult of treatment. In the early stages of the adaptation of coal dust to firing, considerable trouble was experienced from the ash and the rapid wear of the furnace lining and from imperfect combustion. Experience has shown the way of avoiding these troubles, and it is now a fact that pulverised fuel can with complete and permanent success be applied in raising steam from any type of tube boiler. In the case, however, of the cylindrical internal flue type of boiler—as, for example, the Lancashire boiler—the process of dust firing has not, so far, proved successful under continuous operation; but, seeing that firing with "straight" oil and with "colloidal" fuel has succeeded in this type, there seems no reason why the problem should not in time be solved in respect of coal-dust firing.

Perhaps the most difficult conditions for the successful application of pulverised fuel were those in respect of locomotives, owing to the small combustion area available and the cramped conditions generally; yet recently it has been completely successful, and locomotives equipped with this system of firing are in use in the United States of America. A fact of peculiar importance, as pointing to a means of utilising low-grade fuel, is that on the Brazilian Central Railway some locomotives are being worked with pulverised coal derived from local deposits of inferior quality in place of using high-grade imported lump coal. In England a system for locomotive use has been successfully developed and has been in service for some time with very successful results. Enough has been said to show that the preparation and use of pulverised coal have been brought to a practical and economic stage, and where the conditions are suitable its use constitutes a proposition worthy of the serious attention of large consumers of fuel. To readers who wish to pursue this matter further the perusal is recommended of the report in the *Bulletin* already named, the Report of the Fuel Research Board, and Mr. C. F. Herington's work on "Powdered Coal as a Fuel."

As illustrative of recent developments, two cases may be quoted. One is from the *Bulletin*, in which M. Frion says:—

"Nous ne citerons que l'exemple particulièrement démonstratif de l'installation nouvelle de 50,000 chevaux en cours de montage à la Milwaukee Electric Railway and Lighting Co. destinée à alimenter une centrale de 200,000 kw." At home pulverised coal has recently been applied at the Hammersmith Central Electrical Station.

The advent of a new process in connection with coal dust has resulted in a considerable step forward being made towards the reduction in the extent of the equipment necessary in the preparation and conveyance of coal dust for combustion. This process is that by which the finely divided coal dust is intimately mixed with oil to form what is inaccurately termed a "colloidal" fuel, for *colloidal* it is not. In this process the coal is ground in oil, a mixture resulting which is sufficiently stable for all practical purposes, especially so when the proportion of solid fuel contained therein exceeds 50 per cent.; mixtures of equal quantities of oil and coal have been used after standing three months in barrels without any difficulty having been experienced in regard to sediment.

In the case of the so-called "colloidal" fuel, unless the amount of moisture is very excessive, the coal can be used without having to resort to drying preliminary to crushing, which means a curtailment in the equipment required as compared with the use of simple pulverised fuel. It has a further advantage in respect of transportation and of handling, in that it is a semi-liquid, and can be treated as an oil fuel, after due allowance for its greater viscosity. It is not liable to spontaneous combustion, and is burnt in the same manner as if it were "straight" oil.

The field for the use of "colloidal" fuel is great. The fuel can be employed wherever oil is applicable as a steam raiser. Its wide application will result in a vast saving in the consumption of oil, and its manufacture allows of the useful employment of low-grade coals and of coals deficient, for other purposes, in volatile constituents.

Remarks on Gravitational Relativity.[1]

By SIR OLIVER LODGE, F.R.S.

IV.

WHEN we come to the more general theory, which attends to the acceleration and not merely the velocity of the observer, I find myself in disaccord on some points with many eminent exponents, chiefly in connection with their abolition of the idea of "force," and the consequent replacement of gravitation by a modified geometry; as if the earth's natural motion was in a hypocycloidal sort of spiral, and was not under compulsion by any deflecting force.

A revolt against "force" as a real objective entity was led by that great mathematician and physicist, Prof. Tait of Edinburgh. In the first instance he rebelled against the practice, adopted by text-books of the period, of using the term "accelerative force" instead of "acceleration," and making a muddle of the laws of motion by formulating what they called Law 3 thus:—"When pressure communicates motion to a body the accelerative force varies as the ratio of the pressure to the mass." Then he objected to some of the pedagogic arrow-heads sprinkled on mechanical diagrams, especially the arrow-head representing centrifugal force; since it is obvious that no such force acts on the revolving body. Ultimately Tait or his disciples (W. K. Clifford too, if I remember right, also Mach and Kirchhoff) were prepared to abandon the term force altogether, and to substitute space-rate of change of energy, or time-rate of change of momentum, or mass multiplied by acceleration, as a more real equivalent. Tait even denounced the idea of balanced forces, saying that only their effects were balanced ("Ency. Brit.," 9th ed., art. "Mechanics," §§ 285–300); as if two opposing forces were each producing their proper amount of acceleration, or of momentum, but in opposite directions. Though how this kind of statement could include the production of scalar quantities, like work and energy, is not apparent. The whole idea of "cause" came into disrepute.

Now mass-acceleration truly is a measure of the force which produces it, but that does not mean identity. Reformers spoke sometimes as if they meant identity, and desired to get rid of the term force altogether because it had been so misused. After a lecture by Prof. Tait to the British Association on "Force" (at Glasgow, in the year 1876), Sir Frederick Bramwell amusingly said that in the North of Britain the term meant a waterfall, while in London it meant the police, and that really, after the lecture, he himself scarcely knew exactly what it did mean! In that lecture Tait had dealt pugnaciously with some misuses of the term by Prof. Tyndall and other scientific people; for it is not so long ago that the words *vis* and *Kraft* were used with but little modification or caution for the quite different conception of Energy. "The Persistence of Force" was a phrase frequently employed in philosophic writings. Indeed, an accurate nomenclature has scarcely yet penetrated into common usage; and the result is an unnecessary vagueness about the term, typified by Sir F. Bramwell's more than half serious confession. Centrifugal force, for example, can be treated correctly enough by equating it to the product of inertia and rate of change of velocity, but that does not do away with the force: the force is exerted by the revolving body against its constraints. The word is misleading if thought of, in what was no doubt its original intention, as a radial fly-away tendency; it should connote only

[1] Continued from p. 785.

an outward radial pressure, due to kinetic reaction against the normal component of acceleration. It is the necessary correlative of the centripetal force which must be acting on any revolving body. Centrifugal force is not acting on the revolving body, and, strictly speaking, should never be so thought of, or so depicted: it is the pressure or reaction exerted by the body on the groove or rail or æther, or whatever it may be that guides and deflects it.

Part of the mistake, if I may call it so, connected with the denial of physical reality to the directly apprehended thing called force, is the identifying of a thing with its measure. Because two things are equivalent it does not follow that they are identical. There is room for both; and force may be measured statically as well as kinetically. It is only unbalanced force that produces acceleration and calls out kinetic reaction. Acceleration is often prevented by an equal opposite force, but that does not abolish the force. Whether balanced or unbalanced, force is real enough. If Galileo had been put on the rack, the assurance of an Inquisitor that he was only suffering from balanced accelerations would have been no relief. It will be said that force is only one end of a stress, and that attention to the stress is the illuminating thing. That is perfectly true; but as a fact of experience we came across force before we understood about stress, and there are states of stress which we still are not able to understand, because they occur in the æther, and only display themselves by their "ends"—that is, by the pair of equal opposite forces in which they terminate—called in old phrase "action and reaction."

The weight of a book, or a stone, or an apple is a force acting on it; this force is due no doubt in the last resort to a stress in the ætheric medium, but we experience it as a force when we resist it muscularly; and though we may measure it by the mass-acceleration of the body when allowed to drop, it acts equally when the body is resting on a table or hanging from a twig; only then the reasoned and hypothetical æther stress is counteracted by an obvious stress in the material support. The stress can be measured by resting the body on a spring, or hanging it from a piece of elastic; and the strain so caused is surely an undoubted reality, about which it would be extremely artificial and confusing to postulate any kind of acceleration. Some day we may be able to dive into deeper constitutional secrets, and explain all stresses and strains kinetically in terms of the gyrostatic rigidity and elasticity of æther; but that time is not yet. Meanwhile the objects here used in illustration are in static equilibrium, are obeying the first law of motion and moving with uniform velocity, so long as the forces acting on them are equal and opposite and therefore balanced.

But an unbalanced force can always be equated to the kinetic reaction or mass-acceleration of the body acted on; and in dynamics unbalanced forces are those which demand attention. All the rest is the statics of strain. D'Alembert's principle rather tended to tempt us to contemplate spurious forces, for supposed convenience, so as to reduce kinetics to statics when writing down equations —for there must be equilibrium among the internal forces acting within the confines of any closed system—and a flagrant elementary example of the kind of thing thus led up to was the ordinary text-book treatment of centrifugal force.

Elementary Repetition.

If a governor ball or conical pendulum is depicted on paper, the only arrows that ought to be drawn on it are those representing the tension in the string and the weight of the body. But such a diagram looks unfinished; nothing could rest like that; the two forces are evidently not in equilibrium; they clearly have a resultant. The unpardonable, or at least the confusing, thing is for a teacher to draw an arrow indicating a force equal and opposite to that resultant in order to make the diagram look comfortable and static. The fact is that no third force acts on the body; the body itself reacts, its mass-acceleration is equal to the resultant force; and that is the proper fact to express in an equation; you cannot express it in a diagram. The diagram can be completed only by motion, and it ought not to look as if equilibrium were attained by any part of the system. The system as a whole is in equilibrium, or the internal stresses balance, directly the kinetic reaction is taken into account, not otherwise. Centrifugal force, as the term is often employed to signify a force acting on the revolving body, is a fiction.

Yet centrifugal force is a reality; it is essential to the equality of action and reaction. There ought to be no objection to the term or idea when properly applied. But it does not act on the revolving body at all. In every instance the real centrifugal force acts, not on the revolving body, but on whatever fixed centre is responsible for holding it in its orbit; or on the constraint, such as rails or groove or ætherial medium, which is directly effective in guiding and deflecting it. The centrifugal force of the moon acts, not on the moon, but on the earth. It is part of the cause of the tides. No doubt it is primarily exerted on the ætherial medium in contact with each lunar particle, and is thus transmitted to the earth at the other end of the gravitational stress.

To finish this trivial pedagogic discussion of centrifugal force in its true, as distinguished from its usual artificial, sense, and the confusion about which body the force really acts on, we may as well point out that the same sort of trifling difficulty—caused by there being always two bodies bounding a stress,[2] while we are liable to concentrate attention on one—is responsible for that simple old puzzle about the horse and the cart. If the cart pulls back as hard as the horse pulls forward, why does it move? Every good student, sooner or later, asks himself or his teacher this question. The correspondence columns of the *Engineer* at one time exhibited persistent misconception about this elementary matter among quite a large number of readers, and some text-book writers have been bothered by it. The confusion is caused entirely by the tacit assumption that both forces must act on the cart. Not so; one acts on the cart and one on the horse. Two forces and two bodies, one force acting on each. The difficulty disappears. The horse must get a grip of the ground to enable him to exert his force on the cart, true; and the cart exerts its reaction on the horse entirely be-

[2] The fact that an advancing wave-front may simulate a body, for this purpose, is of high interest.

cause of, and in proportion to, its mass-acceleration, until friction and other obvious extras have to be taken into account.

The Principle of Equivalence.

In returning from this, I hope pardonable, elementary digression to more general considerations, let me quote and amplify a sentence from a sort of summary which will appear in the *Fortnightly Review* for September:—

> To ignore or deny or supersede the gravitational stress, merely because we do not yet understand the particular configuration of the æther which is responsible for it and which renders it possible, is to blind our eyes dangerously to dynamical reality, and to rest satisfied with a mere geometrical specification of the motion as if it were a peculiarity of space.

The "principle of equivalence" formulated by Einstein claims that the inertia reaction of a revolving body, to the centripetal force responsible for the curvature of its path, is of the same character as what we call the force of gravity, due to the neighbourhood of a large mass; that this inertia reaction is indistinguishable from weight; and, generally, that no distinction can be drawn between an artificial field of force, such as that representing the effect of a carefully defined revolution round a centre, and what we are accustomed to think of as a real field of force, such as that surrounding the earth.

We are told that by referring motion to rotating axes it is possible to abolish revolution and to replace it by a centrifugal force acting outwards on the body, thereby enabling the body to be treated as if in static equilibrium. We do this when we draw a static diagram of a revolving body, say a conical pendulum or pair of governor balls, and when a spurious and non-existent force is supplied, to represent the inertia reaction, and to balance the centripetal-force component which in reality is curving the path. I called this "unpardonable" in an elementary text-book, and also wrong as a philosophic representation of fact, but as a mathematical device it seems to be permissible; at any rate, it is quite consistent with the principle of relativity. In fact, it is part of the foundation of Einstein's principle of equivalence.

Now it is true that the most careful experimentation (first Newton, and now Eötvös) has shown that weight and inertia are accurately proportional. So it is possible to balance weight precisely by inertia reaction, and, for calculation purposes, to treat centrifugal force as if it were an artificial kind of gravity, obedient to the same laws. But this can only be done with due caution and limitation, for it does not represent reality, and the laws are not in all respects the same.

We are also told that, by choosing accelerated axes as our frame of reference, weight can be abolished too. Passengers in an unsupported, and therefore freely falling, enclosure, such as a cage or lift, would experience no force of gravity; for nothing would require any support, and nothing would tend to move out of its place as defined by the walls of the room, which constitutes the passenger's natural frame of reference.

We are told still further that the behaviour of things inside an enclosure or cage in free space, dragged along by a hook with an acceleration of 32 ft. per sec. per sec., would be indistinguishable from the behaviour of things inside a stationary or equilibrated cage slung by the same hook above the earth. These examples are instructive, for in many respects the behaviour would be just the same. But such illustrations must not be pressed to philosophic extremes, as if there were really no discrimination. For one of the two cages, after the lapse of about a year, would attain the velocity of light; and surely something noticeable must happen then, even if only the invisibility of the floor. Moreover, force is not really evaded; for *something* must be dragging at the hook—something quite gratuitous—whereas the influence of the neighbourhood of the earth is a manifest *vera causa,* however little we may as yet understand about its ætherial mechanism. It must not be supposed that we have no criterion for what is *true* in all these cases; we need not allow that we have no means of discrimination, and that we are really subject to all the uncertainties and ignorances about absolute truth which tend to be grafted on to us by the doctrine of relativity in general and by the principle of equivalence in particular.

The fact is that the passengers-in-a-lift argument, like others that we encounter round about this subject, is of very limited application. It can be well used to illustrate certain non-obvious and interesting facts, but innumerable considerations contradict the idea that the force of gravity is really nothing else than a fanciful name for the mass-acceleration which can be written in equations as equivalent to it. After all, distinction is quite feasible between the reaction of a heavy body on the earth to its centripetal diurnal acceleration, and any corresponding fraction of the force of gravitation. The two do not even act in the same direction, save at the equator; and at the poles one vanishes. What is true is that the resultant between the pressure of the ground on a stone or man, and the real weight of the stone or man, is an unbalanced force which causes that stone or man to rotate round the earth once a day, and (if we allow for complete weight) round the sun once a year. Attachment to the earth has nothing to do with astronomical motions of our human body; for we are not attached. Each of us, and each loose pebble, is as much a planet as the earth, and nearly as much a satellite as the moon.

To say—if anyone does—that the force exerted by a gravitational field, such as might be due to a heavy mass at the centre of a wheel, is indistinguishable from any other constraint needed to curb the inertia reaction of a particle attached to the rim of the wheel when it is revolving, is false. For the way the force is applied is not the same, and the law of force is different. The one increases with distance from centre, the other diminishes with the inverse square.

To reduce the field of the earth locally to zero by means of a falling elevator or "lift" is feasible for observers inside the lift, so long as it is small. But if, in an extensive falling chamber, gravity is to be imitated or neutralised exactly, its parts must fall in different directions, or with different accelerations, or both.

The elimination or avoidance of the idea of absolute rotation, through imitating or replacing centrifugal reaction by the influence of the stars, or by an imaginary distribution of attracting matter in distant space, round the earth or other rotating body, is preposterous, and cannot be seriously contemplated.

I know that the mathematical physicists who allow themselves to assist their exposition by employing illustrations of this kind must be well aware of the limitations attending their use; but I do not think that philosophers always are, and they may not always attend to the cautionary language employed by careful expounders. In fact, the so-called "principle of equivalence," like other popular wordings of extreme relativity, is liable to lead an incautious exponent to go beyond what is legitimate or necessary, and to land him in paradox. Yet if not pushed to absurd extremes, and if the wording is carefully guarded, the principle of equivalence is useful enough; for it is true that any effect on bodies produced by their weight can be imitated by whirling them on a revolving table. Mechanically the principle is used in industrial separators of various kinds, and in any operation requiring an enhanced value of gravity; and the principle extends to optic and electric effects also.

Reference to Mercury's Orbit again.

The theory of relativity, though originally suggested by electrical theory, was developed without further reference to that theory, and reduces an orbit to a mere spatial relation determined by the central body. But it should be clear that, unless an æther is admitted, the gravitational potential or potentials essential to the theory must represent an action-at-a-distance of the central body on space. In the third article (NATURE, August 18, p. 784), when discussing the orbit of Mercury, I did not seek to explain how it was that an extra small perturbation was necessitated by the principle of relativity; because no question about it has arisen, and because it has been done, so far as reasonably possible, at least for the bending of light, by Prof. Eddington, in chap. vi. of his book "Space, Time, etc."; while the equations are in chap. v. of his "Report" to the Physical Society of London; or, in another form, in Cunningham's "Relativity," second edition. The theory for a planetary orbit is similar to the light-path theory; but it is difficult to put the gist of it into ordinary language. Suffice it to say (1) that Newton showed, in the "Principia" (Book I., sect. ix.), that the inverse square law is the only one to give an exact elliptic orbit, and that the slightest interference with that law would bring about a specified revolution of the orbit in its own plane, *i.e.* an apsidal progression; or, in vaguer words, would prevent the same orbit from being retraced or repeated by the planet. And (2) that the Relativity theory, virtually though not explicitly, does interfere with the exact law of inverse square, especially for a near planet. For in the ordinary equation for orbital revolution in general,

$$\frac{d^2}{d\theta^2}\left(\frac{1}{r}\right)+\frac{1}{r}=\frac{Pr^2}{h^2}$$

(with P as the acceleration at distance r from the central body M, and $\frac{1}{2}h$ as the constant rate of sweeping areas), the right-hand side is constant only for an inverse square law, $P=GM/r^2$. But relativity adds to the right-hand side, which ordinarily would be GM/h^2, another term, namely $3GM/c^2r^2$; and this small term is the one responsible for the departure from an exact conic-section orbit. The discrepancy thus introduced turns out to be right for Mercury, and insignificant for other planets; while it does not interfere with their eccentricities. Moreover, the same term is responsible for the bending of a ray of light. So the double success is very striking, and the jubilation entirely justified.

To sum up this portion.

Force is essentially a human conception derived from our muscular sense; and, from the psychological point of view, is as basic as motion, and more directly apprehended than matter. Unforced motion is straight and uniform,[3] not varying or curvilinear, and acceleration is not a fundamental property of matter, nor a diversion of empty space, but is always the result of pressure exerted upon a mass by other bodies, or in the last resort by the circumambient medium.

To geometrise physics, even if legitimate for convenience of calculation, is ultimately to complicate it. Directly the operation becomes complicated it becomes needless, or even obstructive. The new facts can be accepted, and the relativity equations can be used, but a physical explanation can still be looked for, and our knowledge of the universe will not be complete until it is found. We cannot be for ever satisfied with a blindfold mathematical method of arriving at results. We can utilise the clues so given, and admire the ingenuity which has provided them, but that is not the end; it is only the beginning. The explanation is still to seek, and when we really know the properties of the æther we shall perceive why it is that things happen as they do.

CONCLUSION.

The relativity method, by aid of its differential geometrical analysis, seeks to interpret all that is directly experienced through our senses as a manifestation of the peculiarities of space. Matter and all its functions are thus reduced to a kind of subjective space-time geometry, and everything absolute has disappeared from the physical world.

An alternative view of what may be the outcome

[3] Straightness means that no reason for deflection in any direction can be assigned; and the absence of any accelerating or retarding cause yields uniformity.

of the method—a view taken in these articles, though it is not likely to be immediately acceptable to fully assured relativists—is to regard the theory of relativity as an indirect attempt, not unlike the principle of Least Action, to treat all material phenomena as developments or manifestations of unknown essential features in one universal medium; thus restoring a kind of absoluteness to motion, and therefore presumably to space and time. From that point of view the comprehensive scope of the method, with its infinitesimal continuity of treatment, is hopeful and encouraging; and the highly abstract and symbolic modes of representation, which now seem inevitable in its more advanced developments, are the tribute to our ignorance of the kind of dynamics appropriate to a substance the properties of which must be more fundamental than any we are likely as yet to have encountered among its sensory derivatives, electricity and matter.

The Edinburgh Meeting of the British Association.

By PROF. J. H. ASHWORTH, F.R.S.

PROGRAMME OF THE SECTIONS.

THE Journal for the Edinburgh meeting of the British Association, now in the hands of the printers, shows the completed plans for the business of the various sections. In particular, attention may be directed to the careful arrangements for the joint discussions. "The Age of the Earth" is to be the subject of a discussion, by the conjoined sections of physics, geology, zoology, and botany, to take place in the Natural History Lecture Theatre, Old College—the largest theatre in the University, with accommodation for an audience of more than 400. The discussion will be opened by Lord Rayleigh, and other speakers will be Prof. Sollas, Prof. Eddington, Prof. J. W. Gregory, and Prof. Lindemann.

Sections A and B will take part in a discussion on the structure of molecules, to be opened by Dr. Langmuir, of New York. He will be followed by Prof. Smithells, Prof. W. L. Bragg, Prof. Partington, Prof. Rankine, and others.

Chemists and physiologists will find common ground in the discussion on "Oxidations and Oxidative Mechanisms in Living Organisms," to which Prof. Gowland Hopkins will contribute the opening paper.

The sections on geology and engineering are to discuss the various aspects of the proposed mid-Scotland canal. The geology of the suggested route will be explained by Mr. M. Macgregor and Mr. C. H. Dinham, of H.M. Geological Survey.

"The Origin of the Scottish People" is to be the subject of discussion opened by Sir Arthur Keith before the joint sections of geography and anthropology. Prof. T. H. Bryce, Lord Abercromby, Prof. R. Weymouth Reid, Prof. Jehu, Prof. W. J. Watson, and Dr. Tocher are to take part in this discussion.

The sections of geography and education will combine for discussion on the teaching of geography, which will be opened by Mr. G. G. Chisholm, and it is hoped that Sir Richard Gregory, Sir Halford Mackinder, Prof. J. W. Gregory, Prof. Patrick Geddes, Dr. Rudmose Brown, Mr. W. H. Barker, Mr. T. S. Muir, and others will put forward their views on this subject.

The sections of zoology and psychology are to discuss "Instinctive Behaviour." Dr. Drever will open for the psychologists, and he will be followed by Prof. Goodrich, Prof. J. Arthur Thomson, and others.

A joint meeting of the sections of economics, psychology, and education will be held to discuss "Vocational Training and Tests."

The discussion following the presidential address in Section K, in which Section C is to take part, on the early history of plants, with special reference to the Rhynie fossil plants, promises to be an outstanding feature. These plants, representative of the earliest known land flora, had an organisation different from that of any living land plants, and their investigation by Dr. Kidston and Prof. Lang has thrown much light on the evolution of land floras. In addition to the president of Section K (Dr. D. H. Scott), Dr. Kidston, Prof. Lang, Dr. Horne, Prof. Bower, and Dr. Lotsy will take part in the discussion. There is to be an extensive demonstration by Dr. Kidston in the Botanical Laboratory, Royal Botanic Garden, of sections of these Rhynie plants.

As indicated in a previous notice, the presidential addresses in other sections are to be followed by discussions, and in several cases should lead to interesting debates, for instance, on "The Principles by which Wages are Determined," on "The Place of Music in a Liberal Education," and (at the Conference of Delegates of Corresponding Societies) on "Science and Citizenship."

There are other discussions planned which, though nominally forming part of the programme of one section only, will attract interested members from other sections. Among these may be mentioned discussions on "An Imperial School of Anthropology for the Training of Civil Servants and Administrators in the Dependencies of the Empire," on "Heavy Muscular Work," on "Size and Form," on "Extramural Education," and on "University Reform."

There are to be, as usual, many communications giving the results of recent investigations, and there will be exhibitions of apparatus and specimens and demonstrations of methods.

Nearly all the sections have arranged excursions to places of special interest to their members. The local secretaries of the sections of chemistry, geology, engineering, and botany have been particularly active and fortunate in their arrangements. These excursions are necessarily limited in number, and only those really interested are expected to join them. The arrangements for these are in the hands of the respective sectional secretaries. There are in addition eighteen excursions open to all members. Information regarding these is given in the local programme, and further details can be obtained at the excursions counter in the reception room. The Excursions Committee has succeeded in making arrangements for members, up to the number of two hundred, to visit Loch Lomond, Loch Katrine, and the Trossachs by motor charabanc and boat, and for a further two hundred to visit the Scott country—Melrose, Dryburgh, Abbotsford, and the Valley of the Tweed—by motor coach. Early application for these excursions is desirable. It is hoped that full advantage will be taken of arrangements which have been made for small parties, not exceeding fifty in each group, to visit Old Edinburgh under the guidance of experts, each visit to extend over two afternoons. Members who will arrive in Edinburgh on Tuesday or early on Wednesday, and are interested in the Old Town, are advised to join one of the four parties which will set out on the Wednesday afternoon at 2.30. These will complete the inspection of the Old Town on the Thursday afternoon. Another party will start on Thursday afternoon and finish on Friday afternoon, and a third party will begin on Monday afternoon and finish on Tuesday afternoon.

There is to be a special graduation ceremonial in the McEwan Hall on Tuesday, September 13, at 3 p.m., at which honorary degrees in the faculty of law will be conferred. Members of the Association who propose to attend the ceremonial in academic dress are desired to hand in their names at the general inquiries counter in the reception room on or before the morning of Monday, September 12. The secretary of the University has kindly arranged to reserve seats for them and to include them in the academic procession.

Members who are golfers will be glad to hear that several of the well-known Edinburgh clubs have been good enough to intimate that a number of members of the Association will be made honorary members of the clubs for the period of the meeting. The local secretaries will be pleased to give particulars.

Obituary.

PROF. EDMOND PERRIER.

PROF. JEAN OCTAVE EDMOND PERRIER, the announcement of whose death appeared in NATURE for August 4, p. 721, had been, for longer than many of us can remember, one of the most distinguished of contemporary French zoologists. Born in 1844 at Tulle (Corrèze), he entered the Ecole Normale Supérieure in 1864, and for some years devoted himself to mathematical and physical studies; but he was a born naturalist, and the call of the natural sciences was too clear to be resisted. He entered the service of the Museum of Natural History in Paris in 1868 as "aide-naturaliste," and eight years later he became a professor in that institution. On the death of Prof. A. Milne-Edwards in 1900, Perrier was appointed director of the museum, a position which he held until January of last year, when he retired with the title of honorary director. He died in his official residence at the museum on July 31 last.

Prof. Perrier's published writings cover a wide range of subjects. His own researches—morphological, taxonomic, and faunistic—deal mainly with various groups of invertebrates, and are recorded in a long series of memoirs, many of which are of fundamental importance. His monograph on the structure of earthworms (1874) is frequently quoted by Darwin, who refers to it as "M. Perrier's admirable memoir." His researches on echinoderms are well known, and we need do no more than mention his memoirs on the collections of the *Travailleur* and *Talisman*, the *Blake*, and other expeditions, and his detailed study of the structure and development of Antedon. He was also the author of a considerable number of volumes of more general scope, one of the best known being "La Philosophie zoologique avant Darwin" (1884), in which he emphasised the important part taken by French thinkers in the development of biological theory. "Les Explorations sous-marines" (1886) was based largely on the results of the *Travailleur* and *Talisman* expeditions in the Atlantic, in which he had taken part. "La Tachygénèse, ou accélération embryologique" (in collaboration with Prof. Ch. Gravier, 1902), is an interesting and suggestive attempt at a synthesis of the facts of embryology. In his monumental "Traité de Zoologie," of which six fascicles have appeared since 1892 (a final part was in manuscript at the time of his death), he attempted a task which is now, perhaps, beyond the powers of any single man. His last published work, "La Terre avant l'Histoire" (1920), a general review of the origin and evolution of the living world, is distinguished no less by the author's encyclopædic knowledge than by the lucidity and charm of his style.

A list of Prof. Perrier's academic and other honours would be a lengthy one. He was elected a member of the Académie des Sciences in 1892; he was also a member of the Académie de Médecine, and of many foreign academies and learned societies, including the Linnean and Zoological Societies of London. The distinction of his literary style gained for him the coveted honour of admission to the "Société des Gens de Lettres," of which he was one of the few scientific members. He was one of the founders of the International Congress of Zoology, and succeeded Prof. A. Milne-Edwards as chairman of the permanent committee.

Of Prof. Perrier's personal qualities, a distinguished colleague and former pupil of his, to whom we are indebted for some of the facts recorded above, writes: "Je suis navré de la mort de mon vénéré Maître. . . . Il avait conquis les sympathies de tous par son caractère enjoué et si aimable, par son accueil charmant pour tous, les grands comme les petits, les puissants comme les faibles, par son exquise bienveillance. . . . Il restera de lui le souvenir d'un savant érudit d'une haute courtoisie."

A. T. SIMMONS.

MANY science teachers and students will learn with much regret that Mr. A. T. Simmons, inspector of secondary schools for the University of London, and author of a number of widely used text-books of science, died from pneumonia on August 19, at fifty-six years of age. Mr. Simmons received his chief scientific training at the Royal College of Science, London, in 1882–87, and during these years he and his fellow-student, Mr. H. G. Wells, were almost inseparable. After becoming an associate (physics) of the college, he was for three years lecturer in physics, chemistry, and other science subjects at the Southport Science and Art Institute, and while occupying this post he proceeded to work for the B.Sc. degree of the University of London, graduating with first-class honours in physical geography and geology in 1890. During the years 1891–97 he was science and second master at Tettenhall College, near Wolverhampton, where numerous students learned to esteem his high character and teaching aptitude. He came to London in order to undertake general editorial and advisory work for Messrs. Macmillan and Co., Ltd., in connection with school manuals on scientific subjects, and was a part-time member of the staff until his death. In association with Sir Richard Gregory, he founded in 1899 the *School World*, published by Messrs. Macmillan, and continued as joint-editor when that magazine was incorporated with the *Journal of Education* in 1918.

By his many years of devoted service on these periodicals, the sympathetic and helpful spirit in which he carried out his duties as inspector of science work in schools, and the assistance he afforded to many authors of text-books, Mr. Simmons won the highest regard from a large circle of the educational world. His influence upon the teaching of scientific subjects was strong and far-reaching, and his death will be mourned not only by his personal friends, but also by numerous teachers and students familiar with his books both at home and overseas. His personality and his works will long be cherished in most affectionate memory.

NEWS has reached us that one of the best Russian zoologists, PROF. N. A. CHOLODKOVSKY, academician and professor emeritus in the Academy of Medicine and at the Institute of Forestry, died last April in Petrograd at sixty-one years of age. Prof. Cholodkovsky was the author of numerous works on entomology and helminthology. One of his best works is a "Monograph on Chermes Injurious to Coniferous Trees," 1906. His excellent text-books on zoology are adopted in most Russian universities. To the general public Prof. Cholodkovsky was also known as a poet of high merit. To his pen belong the best translations into Russian of Shakespeare, Byron, Goethe, and others. For his masterly translation of Goethe's "Faust," with commentaries and a new criticism, he was awarded the Grand Premium in Literature by the Russian Imperial Academy of Sciences.

THE death is announced, in *Science* of August 12, of CHARLES BARNEY CORY, curator of zoology in the Field Museum of Natural History, which occurred on July 29, at the age of sixty-four years. Mr. Cory was one of the founders and a past president of the American Ornithologists' Union and a member of many learned societies, and was widely known for his ornithological writings.

Notes.

THE announcement appears in *Science* of August 12 that Prof. R. A. Millikan, of the University of Chicago, has been appointed director of the new Norman Bridge Laboratory of Physics at the California Institute of Technology, and chairman of the executive council of the institute. An income of 95,000 dollars for the new laboratory alone has been promised by the institute, and additional funds available comprise sums of 200,000 dollars and 50,000 dollars, which have been promised by Dr. Norman Bridge for the extension of the laboratory and its library respectively. With this generous provision it is hoped to create a large and effective laboratory for research in physics. In conjunction with the laboratory, the Southern California Edison Company is to erect an experimental station in the grounds of the institute for the investigation of the transmission of electric power at high potentials; Prof. Millikan will be partially responsible for the direction of this station. The main problem, however, which Prof. Millikan proposes to attack is the constitution of matter and its relation to the phenomena of radiation, a task for which the new laboratory will provide exceptional opportunities. It is also announced that Prof. H. A. Lorentz, of the University of Leyden, will be in residence at the institute during the winter term as lecturer and research associate in order to supplement the work of the mathematical physics department, and that Dr. C. G. Darwin, of Cambridge, has been appointed professor of this department for the academic year 1922–23.

THE council of the British Association for the Advancement of Radiology and Physiotherapy has recently issued a statement warning the public against undue optimism about the use of radiotherapy in the treatment of cancer. The new technique, which has been developed at Erlangen, Bavaria, has not yet been thoroughly tested, and, in any case, evidence of success cannot be assumed until after the lapse of some years. The council is of the opinion that of any single method surgery still offers the best prospects of cure in most cases of cancer. Combined treatment by operation and radiation therapy has been employed with good results, and so far the co-operation of the radiologist with the surgeon affords the greatest hope of success. The association has organised a scheme for the investigation of the claims made for the new intensive X-ray treatment, for which purpose a sum of 4000*l.* has been allocated by an anonymous donor (*Arch. Radiology and Electrotherapy*, No. 252, July, 1921, p. 38). It is suggested that a research scholar be appointed for two years at a salary of 350*l.*, with travelling allowance, and that he proceed to Erlangen, where the treatment has been in progress for several years. If it is found that the results obtained there approach the claims made, a complete outfit of apparatus such as that used at Erlangen would be ordered and installed at the Manchester Royal Infirmary and the work continued there.

THE President of the French Republic has conferred the Cross of Chevalier of the Legion of Honour on Col. Sir Arthur Mayo-Robson for services rendered by him to the French Red Cross during the war.

IT is announced that the Advisory Committee provided for by the Importation of Plumage (Prohibition) Act will be constituted as follows:—Lord Crewe (chairman), Mr. E. C. Stuart Baker and Dr. W. Eagle Clarke (representing ornithology), Mr. C. F. Downham, Mr. W. G. Dunstall, and Mr. L. Joseph (representing the feather trade), Lord Buxton, Capt. E. G. Fairholme, Mrs. Reginald McKenna, and Mr. H. J. Massingham.

AT a meeting of the Privy Council, held at Buckingham Palace on August 10, the petition of the Institution of Electrical Engineers for a Royal Charter of Incorporation was approved, and a Royal Charter has now been granted. His Majesty the King has also been graciously pleased to intimate his willingness to become patron of the institution.

IT is announced in *Science* of August 5 that the Municipal Observatory at Des Moines, Iowa, said to be the only municipal observatory in the world, was opened on August 1. The observatory building is to be equipped by Drake University with an 8-in. equatorial telescope. It is to be under the control of the university, and open to the public at least three times a week, and at any other time when occasion may warrant.

CAPT. ROALD AMUNDSEN has arrived at Vancouver from Nome, Alaska. The *Times* announces that he intends to sail for the Arctic next spring to resume his attempt to drift across the Arctic Ocean. Two aeroplanes furnished with sleds will be carried by the expedition. Meanwhile the *Maud* is on her way to Seattle for repairs and the installation of more powerful wireless equipment. It will be recalled that the *Maud's* first attempt to drift with the pack was unsuccessful, and that she was forced to winter in the ice off the coast of north-eastern Siberia, where she lost a propeller.

ANNOUNCEMENT was made of the coming Paris meeting of the Iron and Steel Institute, under the presidency of Dr. J. E. Stead, in NATURE of June 2, p. 434. A programme of the meeting, which will be held at the headquarters of the Comité des Forges de France on September 5 and 6, has now been issued. It is expected that ten papers will be submitted, most of them dealing with the constitution and properties of various types of steel, though two will be of economic interest. Advance copies of the papers can be obtained by members of the institute from the Secretary, 28 Victoria Street, S.W.1. At the conclusion of the meeting, alternative visits have been arranged to works in Lorraine, Burgundy, and Normandy.

IT is reported in the *Pioneer Mail* of July 15 that the Bose Research Institute, established some four years ago at Darjeeling, is actively at work and engaged in investigations of wide interest. The Government of India has obtained the consent of the Secretary of State for a permanent Imperial grant which will be double the income derived from public donations, of which Sir J. C. Bose's contributions alone will amount to 10 lakhs of rupees (66,666*l.*). Problems dealing with agriculture will be investigated on an experimental station at Sijberia, while at Darjeeling an attempt is to be made to conserve an entire hill-side with the view of investigating the flora of the district and of preserving wild plants from Sikkim and Tibet which are in danger of extermination.

AT a small business meeting held on August 16 at the Hotel Cecil, the Society for Constructive Birth Control and Racial Progress was formally constituted, with Dr. Marie Stopes as president. The objects of the society are: (*a*) To bring home to all the fundamental nature of the reforms involved in conscious and constructive control of conception, and the illumination of sex life as a basis of racial progress; (*b*) to consider the individual, national, international, racial, political, economic, scientific, spiritual, and other aspects of the theme, for which purpose meetings will be held, publications issued, and research committees, commissions of inquiry, and other activities organised from time to time as circumstances require and facilities offer; (*c*) to offer to all who still need it the full knowledge of the methods of control.

A CONGRESS of Applied Chemistry, to be held in Paris on October 9–12, is being organised by La Société de Chimie Industrielle de France. The congress, which will also be the first annual meeting of the society, will be split up into thirty-four sections, corresponding to various branches of industrial chemistry. All meetings will be held in the Conservatoire des Arts et Métiers, and the inaugural ceremony, which will take place on October 10, will be presided over by M. Dior, the French Minister of Commerce. The society is also organising, at the Conservatoire, a Chemical Exhibition, which will be open on October 9–16. Two sections only will be represented, those dealing with laboratory equipment and colouring matters, but it is hoped that the exhibition, at which most French manufacturers will be represented, will be the germ of a future chemical exhibition embracing all branches of industrial chemistry.

THE latest news from the Mount Everest expedition is contained in Col. Howard Bury's dispatch to the *Times* published on August 17. Leaving their base camp at Tingri, the expedition explored the approach to Mount Everest on the north-west. The chief obstacles were great glacier streams which proved quite unfordable in July, and could be crossed only where frail native bridges existed. The expedition crossed the Kyetrak glacier valley on such a bridge, and marching by Zambu reached the Rongbuk glacier, in the valley of which it camped at a height of 18,000 ft., some miles from the great Rongbuk Monastery, which stands at 16,500 ft. Progress in this direction did not look promising owing to the sheer precipices of 10,000 ft. which descend to the Rongbuk glacier, and even supposing the ridge summits at 26,000 ft. were gained, there still remains difficult rock climbing at greater heights. In the course of their reconnaissance Mr. Mallory and Mr. Bullock climbed a peak of more than 23,000 ft., but their coolies were unable to reach the summit. August was to be devoted to the eastern and north-eastern faces of Mount Everest, which have more snow and ice on them than the north-western side, and the base camp for this purpose was to be moved in the vicinity of Kharta, in the Arun Valley. Col. Howard Bury hopes to find a high pass leading from the Rongbuk glacier into the valley of the Kharta Tsangpo, but finds it impossible to get any accurate information from the Tibetans. The weather broke early in July, and poor visibility now hampers the work.

THE widespread faith in Australia in water-divining has led Dr. Griffith Taylor to examine its working in the Federal Capital Territory, and he has communicated his conclusions and some quotations from the literature of the subject to the Proceedings of the Royal Society of Victoria (vol. xxxiii., N.S., 1921, pp. 79–86). He dismisses water-divining as of no practical value and as of interest to the psychologist rather than to the geologist or farmer. His own evidence, however, like some other scientific tests of the question, is inconclusive. He reports two cases. A well was sunk at Ainslie at a point selected by a diviner, who "estimated that water would occur at about 56 ft." Dr. Taylor reports that "at 56 ft. some water came in; at 64 ft. water was 'bubbling in.'" In this case the well was sunk in an area where drifts lay on a slope of impermeable beds, and water could have been obtained at any site. This success was probably mere coincidence, but the prediction was justified by the result. In the second case another diviner recommended a site on a ridge of shale; naturally, the well was a complete failure. Dr. Taylor quotes records of more extensive inquiries, including the Guildford case of 1913, an early investigation by the Government of South Australia, and one in 1920 by the New South Wales Water Conservation Commission. This Commission's inquiry covered fifty-six bores selected by diviners, and of these 70 per cent. were successful; of ninety-six bores selected without the diviners' aid 87 per cent. were successful. The accumulation of evidence against the divining-rod is useful, and though it may show that the method is of no practical value, many of the tests are not conclusive against those who consider that certain individuals in suitable circumstances are influenced sub-consciously by underground water.

SIR FREDERIC KENYON'S presidential address to the Museums Association, in which he set forth his views as to the future development and arrangement of the British Museum (*see* NATURE, July 28, p. 689), is now published in the August issue of the *Museums Journal* (Dulau and Co.).

REFERRING to recent correspondence in NATURE, Mr. A. S. E. Ackermann writes to say that in August of last year at Ypres he saw bumble-bees abstracting nectar from the flowers of white-runner beans through a hole in the side of the corolla instead of in the normal manner.

THE camera is being used increasingly to elucidate the habits of birds, and striking success has been achieved by Dr. Overton in his observations on the great horned owl, described in *Natural History* (vol. xxi., No. 2). It has hitherto been supposed that the bird attacks its enemies and prey by means of its wings or bill. The remarkable series of photographs which are used to illustrate Dr. Overton's article clearly demonstrates, however, that the bird attacks solely with its feet. We have seldom seen so conclusive a collection of photographs of birds.

IN the June issue of the *Lancashire and Cheshire Naturalist* Mr. R. Standen records some interesting observations of his own and other naturalists on the feeding habits of squirrels, with particular reference to fungi. He has watched squirrels feeding on that most poisonous of fungi (to man), the Fly Agaric (*Amanita muscaria*). They were observed to knock off the cap and to eat only the stalk, but so far as is known they were none the worse, and appear to be immune to this particular form of poison. The late Rev. O. Pickard-Cambridge has recorded squirrels as eating *Boletus edulis*, and Mr. Britten has watched them feeding on the Blusher (*Amanita rubescens*), but both these species are non-poisonous. In America squirrels are known to store fungi with their other food, but British squirrels have not as yet been observed to follow this habit. Mr. Standen's notes raise many interesting points, such as the distribution of the poisonous substance in the tissues of the fungus, and the degree of immunity enjoyed by the squirrels. It is clear that there is much to be learnt about the natural history of our British mammals.

THE diminutive shrunken heads made by the Jivaro Indians have long been familiar objects in our museums. In *Natural History* (vol. xxi., No. 2) Mr. C. W. Mead gives an account of how and why they were made. The head, with a small part of the neck, is severed from the body. A cut is made from the base of the skull down through the neck, and through the opening thus made the bones of the skull are carefully removed. The skin and the remaining soft parts are next dipped in the juice of the *huito* fruit, which stains them black. The skin is then ready for the shrinking process. This is done by putting a number of hot stones into the cavity and constantly turning the head in order to bring all parts in contact with the stones. This process is repeated until the head is reduced to the required size. Among some of the tribes a single hot stone nearly as big as the head is used, and replaced by smaller ones until the work is completed. Hot sand is also used in some localities. The lips are then fastened by long pendent cords, and one is run through the top of the head to suspend it. Finally, the cut in the back of the neck is sewn up, and the trophy is completed. Originally a tribal custom of celebrating a victory over an enemy, the Jivaro Indian was not slow to turn it to commercial use when he found that the heads were in great demand among white men. We are told that advance orders were booked and in due course filled.

DR. MARIANNE PLEHN directs attention in an article in the *Allgemeine Fischerei-Zeitung* for August, a translation of which has been sent to us by the Editor of the *Fishing Gazette,* to what she regards as a hitherto unrecognised cause of disease in fish kept in tanks and ponds: this is an excessive quantity of oxygen in solution in the water. It is well known that an abundant growth of algæ in fish cultural ponds may be very injurious. So much oxygen is given off by the plants that the water may effervesce when it is stirred violently. In such circumstances more of the gas is taken up by the blood of fishes than can be used in the ordinary way by the tissues, and then a further rise in the water temperature may cause the liberation of gaseous oxygen in the blood. Vesicles, visible to the naked eye, are said to form in the skin, particularly on the fins. Similar gas vesicles may form in the orbits, giving rise to "exophthalmos." Gas embolisms may even form in the heart and vessels of the gills, causing immediate death. Not only oxygen, but also nitrogen, may, at times, be contained in solution in freshwaters to such an extent as to be the occasion of this "Gaskrankheit," and the author also suggests that gas-forming bacteria in the blood of fishes may be the cause of similar effects. The matter is one of much importance in salmon and trout hatcheries, and, quite evidently, it should be the subject of very careful investigation.

A TELEGRAM from Asmara (Eritrea) reports a rather severe earthquake in that region on or shortly before August 15. The shock was especially strong at Massowah and in the surrounding country, at least four people being killed and about twenty injured, while several houses collapsed. As a rule the earthquakes of Eritrea are infrequent and of slight intensity. Prof. Palazzo, in his catalogue of Ethiopian earthquakes from 1400 to 1912 (Boll. Soc. Sism. Ital., vol. xix., 1915, pp. 293–350), records 142 shocks, the strongest of which occurred in 1400, 1884, and 1901. Asmara itself seems to be one of the least stable regions. Early in 1913 (from January 24 to April 8), 208 disturbances were registered at the seismological station in that place, the strongest of which was of about the same intensity as the recent earthquake.

IT is satisfactory to learn that the valuable work of the Kilauea Volcano Observatory is to be maintained, if not extended. Under the supervision of Dr. T. A. Jagger, jun., and supported by the Hawaiian Volcano Research Association, all changes in the activity of the volcano have been chronicled for some years, and the earthquakes, local and otherwise, have been registered. In 1918 a grant of ten thousand dollars was made by Congress, and at the same time the question of placing the observatory under Government direction was considered by a committee of the National Academy of Sciences. On its advice the control of the Kilauea Observatory has been transferred to the Weather Bureau. The full report of the committee has now been published (Proc. Nat. Acad. of Sciences, vol. vi., 1920, pp. 706–16). A general scheme of investigation in either seismology or volcanology is, it considers, beyond the proper scope of the Weather Bureau. For the present, the committee suggests that seismographs might be added at certain selected meteorological stations, and that such work should, if possible, be placed under the direction of a trained seismologist belonging to the Bureau. While the maintenance of the Kilauea Observatory is regarded as of the first importance, the committee recommends that observations should be made on all the active phases of Hawaiian volcanism, and that, especially, the gigantic volcano of Mauna Loa, which represents a different stage in the development of a basaltic volcano, should be subjected to an investigation as systematic as may be possible, taking into account its much greater size and the difficulty of access.

THE hydrous calcium borate inyoite, described by W. T. Schaller from California in 1916, has now been found at a second locality, the Whitehead gypsum quarry, Hillsborough, Albert County, New Brunswick. E. Poitevin and H. U. Ellsworth describe a number of crystals, confirming the monoclinic character of the mineral (Canada Depart. of Mines, Geol. Surv., Bull. 32, 1921). It is "fairly soluble" in water, and separated out somewhat later than the massive gypsum, in the cracks of which it lies.

THE Geological Survey of Ireland has issued through the Ordnance Survey two new sheets of the geological map of the country on the scale of a quarter of an inch to a mile (1 : 253,440). Sheet 5 covers a region of unusual interest, and should be specially useful to dwellers in Belfast. Educationally, it serves as an epitome of the geology of Ireland. It includes the gneissic axis of Tyrone, the Caledonian area of Armagh and Down, with the Newry granite in its strike, the down-faulted Carboniferous series of Coal Island, and the Cainozoic granite of the Mournes. The Mesozoic beds, protected by the great plateaus of basaltic lavas, are well seen encircling Lough Neagh. Sheet 16 offers less variety, and shows the rapid succession of Armorican anticlines and synclines in the Devonian and Carboniferous systems round Cork city.

IN a short paper to the International Congress of Mathematicians, Strasburg, 1920, entitled "Une application des polynômes d'Hermite à un problème de statistique," Prof. Alfred Guldberg, of Christiania, reaches the series recommended for the representation of frequency curves and surfaces by Edgeworth in this country, and by Charlier, Thiele, Bruns, and others on the Continent. The large amount of mathematical work on such subjects that is being done in Scandinavia is noteworthy, but the application of the results of the mathematical work on a large scale to a great variety of statistics seems to be required if we are to estimate the usefulness of the work in practice.

THE report of the Royal Observatory, Hong-Kong, for the year 1920 by Mr. Claxton, the director, shows that the usual meteorological and magnetic results have been continued. Automatic records of the temperature of the air and evaporation were obtained with a Richard dry- and wet-bulb thermograph, and the direction and velocity of the wind with a Beckley and a Dines-Baxendell anemograph. The amount of rain is recorded automatically by a pluviograph, and the amount of sunshine is registered by a Campbell-Stokes recorder. Other observations are recorded by eye. The mean barometric pressure and mean temperature for the year were in fair agreement with the normals. The total rainfall for the year was 107·88 in., which is about 24 in. above the normal. The fall in an hour measured 1·44 in. on September 12, and 12·70 in. fell in forty-nine hours on July 18–21. Tracks of sixteen typhoons and four of the principal depressions which occurred in the Far East in 1920 are given in the Monthly Meteorological Bulletin for December. Observations from the Philippines are now received in time for insertion in the daily weather map. Wireless weather telegrams were received from 140 ships in the course of the year, and meteorological registers from 170 ships operating in the Far East. Upper-air research is being considered, as is also the installation of a seismograph.

THE *Meteorological Magazine* for July has an article on the design of rain-gauges, which affects largely the accuracy of rainfall measurements, now being considered with greater assiduity than in the past. The 5000 observers for "British Rainfall" show the necessity for uniformity and precision in the style of gauge. Universal adoption of the now recognised standard patterns of rain-gauge is advocated, and the rejection of certain obsolete patterns. The forms approved are the Snowdon gauge and patterns based on it, such as the Bradford gauge, the Meteorological Office pattern gauge, and the Seathwaite gauge. Some of the essential features given of an approved gauge are: The stout brass turned ring terminating upwards in a knife-edge, exactly 5 or 8 in. in diameter, which forms the rim of the gauge; the vertical cylinder, 4 to 6 in. deep, extending from the rim to the upper edge of the funnel, which is intended to retain snow and hail, to prevent the outsplashing of rain which has fallen upon the funnel, and to reduce to a minimum the risk of loss due to wind eddies; an inner collecting vessel, which can be removed for measuring the fall without disturbing the body of the gauge, the latter being slightly sunk in the ground; and a capacity of not less than 10 in. of rain for a daily gauge. Hints relative to self-recording gauges are also given. Makers of rain-gauges are asked to assist in the elimination of undesirable types of rain-gauge.

SINCE its introduction in 1829 the Trevelyan rocker has formed the subject of many scientific papers, but they have all led to the conclusion that Faraday's explanation of the motion of the rocker was substantially correct. According to Faraday the motion is due to the expansion of the material of the support under one of the two ridges on the under-surface of the rocker by heat communicated to the material from the rocker. This expansion throws the rocker on to its other ridge, allowing the first portion of heated material to cool until it is again the support for the rocker. This theory was put into dynamical form by Davis in 1873, and has been accepted as satisfactory. A recent study of the actual motions of a rocker carried out by Prof. Chuckerbutti, of Calcutta University, and given in vol. vi. of the Proceedings of the Indian Association for the Cultivation of Science, shows, however, that the theory is quite unsatisfactory. The tones produced are those of the elastic vibrations of the system composed of the rocker and its handle, and the pitch of each is determined by these vibrations under the constraints imposed on the rocker by the method of support.

THE third paper on the physical properties of clay, read by Mr. A. S. E. Ackermann before the Society of Engineers, contains a record of forty-nine more experiments, which carry our knowledge of this subject considerably further. By boiling the clay and allowing it to settle, some of the colloidal matter was got rid of, and as a result the pressure of fluidity was decreased by about 25 per cent. When a disc is pressed into a mass of clay, the mean radial speed of flow of the clay underneath the disc is about one-eighth the speed of penetration of the disc, and the mean speed of penetration of the disc when the load on it is just sufficient to produce the pressure of fluidity is about 1 cm. per minute. Some interesting experiments were made with the view of ascertaining the behaviour of the clay immediately below the disc; there appears to be a stagnant cap of clay which remains in contact with the lower side of the disc and travels with it. Even under considerable tangential stress there is no progressive strain in clay containing 25 per cent. of water, which thus behaves as a solid. The addition of an artificial head to the top surface of the same clay increases the pressure of fluidity by about 7 per cent. when the addition is 200 per cent. of the actual head. The experiments on discharging clay under pressure through sharp-edged circular orifices are also of interest. The rate of discharge increases more rapidly than the rate of increase of pressure, and ultimately there is a phenomenon analogous to the pressure of fluidity. Reducing the size of the orifice, keeping the pressure constant, reduces the discharge per unit area of orifice. The initial pressure necessary to cause the discharge to begin increases considerably as the diameter of the orifice is decreased. Practically the same result is obtained whether a disc or a sphere is used in determining the pressure of fluidity, and the result is independent of the diameter of the disc or sphere within a considerable range. Mr. Ackermann's work on this subject shows promise of great value to engineers in dealing with foundations and retaining walls, and we trust that his experimental work will be continued.

Our Astronomical Column.

THE RECENT METEORIC DISPLAY.—Mr. W. F. Denning writes that further proof of the unusually abundant display of August meteors is provided by Mr. S. B. Mattey, observing at St. Helier, Jersey, on August 11 during the quarter of an hour between 14h. and 14h. 15m. G.M.T., who saw sixty-two meteors. This indicates a rate of about 250 per hour, and proves that the shower was witnessed in extraordinary activity. About 25 per cent. of the meteors seen by Mr. Mattey were bright ones, exceeding stars of the first magnitude. Their light was frequently strong enough to illumine buildings near his place of observation; in fact, he describes the effect as being somewhat similar to that occasioned by so-called sheet lightning.

DETECTION OF ENCKE'S COMET.—A letter from Mr. J. F. Skjellerup, dated Capetown, July 29, announces that he and Mr. W. Reid detected Encke's comet on July 27 at 5h. 15m. G.M.T., when it preceded 19 Sextantis by 31 seconds, and was 2′ to the south of it, which makes its apparent position R.A. 10h. 8m. 11s., N. decl. 4° 58′. The estimates of its magnitude by the two observers were 9·5 and brighter than 8·0.

The following elements were predicted by Mr. Matkiewitch:—

$$T = 1921 \text{ July } 13{\cdot}28 \text{ G.M.T.}$$
$$\omega = 184^\circ\ 43{\cdot}5'$$
$$\Omega = 334^\circ\ 35{\cdot}5'$$
$$i = 12^\circ\ 31{\cdot}1'$$
$$\log a = 0{\cdot}34598$$
$$e = 0{\cdot}84671$$
$$\log q = 9{\cdot}53149$$

The above observation would indicate a value of T some 0·2 day earlier than the prediction.

The comet will be 1921 *d*.

The letter states that Pons-Winnecke's comet was observed at midnight on July 27, in R.A. 1h. 24m., S. decl. 38°, magnitude about 8·5.

STUDY OF THE MOON'S SURFACE.—Mr. Walter Goodacre has just brought out the eighth report of the Lunar Section of the British Astronomical Association. He dwells on the immense value in selenography of the splendid photographs taken by Mr. F. G. Pease with the 100-in. Mount Wilson reflector. He states that they show more detail than a 6-in. visual telescope would do, even with the best seeing. The report contains several charts showing on a larger scale much of the detail that has been detected on the photographs. One is of the "Straight Wall near Thebit," showing that it is really by no means straight. Enlargements of the craters Ptolemaus, Clavius, Copernicus, Arzachel, Gassendi, etc., show much new detail, mostly of the nature of tiny craters or narrow clefts. Mr. Goodacre considers that the new evidence is unfavourable to the theory of meteoric formation of the lunar features. Various fine details are noted, in particular an apparent landslip on the wall of Birt A.

Mr. J. W. Durrad contributes a fine drawing of Gassendi, showing numerous clefts on the floor, some of which are new.

THE DISTANCES OF THE GLOBULAR CLUSTERS.—The Bulletin of the National Research Council, Washington, D.C., for May last contains an interesting discussion between Dr. Harlow Shapley and Prof. H. D. Curtis on this subject. Taking the Hercules cluster as an example, they contend respectively for 36,000 and 3600 light-years as its distance. The strongest argument for the former distance is the presence of B stars in the cluster and the demonstration that the average absolute magnitude of such stars is zero or brighter, judging from the stars in proximity to the sun. Prof. Curtis prefers to work from the average absolute magnitude of all stars within measurable distance, but Dr. Shapley replies that the average is itself a function of distance, since the stars that are really very faint are altogether lost to view at moderate distances.

Another point discussed is the correlation between period and absolute magnitude in the Cepheid variables. Prof. Curtis gives a diagram showing that the case for this correlation becomes much less convincing than Dr. Shapley had supposed, when the number of galactic Cepheids employed is increased. Dr. Shapley replies that he used the Cepheid method solely as corroborative of several others, and that the strongest argument for the correlation is in reality deduced from the fact that the methods all fall into line so well.

The discussion also involves the status of the spiral nebulæ. Dr. Shapley's estimate of the size of our Galaxy is so great that if the spirals were similar objects they would be so remote that we could not expect to see novæ in them. From the fact that several novæ have been detected he concludes that they are not stellar, but actually formed of diffused matter. Prof. Curtis's smaller galactic diameter permits the view that the spirals are external galaxies. He estimates the distance of the Andromeda nebula (supposed to be the nearest spiral) as 500,000 light-years, and invokes the presence of a zone of occulting matter near the galactic plane to explain the observed distribution of the spirals.

The discussion is highly instructive, and the method of putting the two views of such difficult questions side by side is most helpful as a check on over-hasty deductions and a test of the weaker links in a chain of evidence.

New Facts of Colour Vision.

By DR. F. W. EDRIDGE-GREEN.

THE White Equation.—The fact that when two or three simple spectral colours are combined a white is produced which matches that from which the spectrum has been formed is the basis of many theories of colour vision. It is therefore of fundamental importance to any theory of colour vision.

In a recent paper (Proceedings of the Royal Society, B, vol. xcii., 1921, p. 232) it was pointed out that when an exact match of a red of λ 6670–6770 Å., a green of λ 5144–5156 Å., and a violet of λ 4250–4267 Å. with white was made, after fatigue with red light in the region of λ 670μμ, there was no longer a match between the simple and mixed whites, the mixed white appearing bright green, and in order that a match could be made the green had to be reduced to about one-half of the amount required by an unfatigued eye. It is obvious, therefore, that the underlying physiological processes are not the same with the mixed and simple whites. It should be noted, however, that no change in the equation is seen when the eye is fatigued with red light in the region of λ 780μμ.

Another fact of colour fatigue bears on this point; red of λ 670μμ can be matched with red of the end of the spectrum by varying the intensity, and so it has been stated that red λ 670μμ, as well as the terminal red, affects only the hypothetical red sensation. If, however, the eye be fatigued with red of the region of λ 760μμ, and red of the region λ 670μμ be afterwards viewed, this appears yellow, or even greenish-yellow, which could not be the case if the red sensation only had been affected.

The Change of Hue produced by the Addition of White Light to Spectral Colours.—White light is a purely relative term. The white light of the sun is not the same as that from an artificial source; the term is therefore employed as meaning the combined light of the source which is used. In making the experiments described, the light was that of a 1000-candle-power tantalum arc, which, compared with sunlight, is yellow. The apparatus used in these experiments was that described in the Proceedings of the Royal Society, B, vol. xcii., 1921, p. 232.

Various spectral colours were isolated on a screen coated with magnesium oxide, and definite proportions of white light taken from the source added. The scale of white light is arbitrary, the maximum amount of light it is possible to add being 100 divisions. A comparison white light taken from the source was used. Each colour became less saturated on adding white light. Red first became orange, then yellow. Orange became yellower. λ 585μμ, pure yellow, did not change in hue. Orange-yellow and yellow-green became yellow. Green became yellow-green. Blue, λ 480μμ, became white, the comparison white appearing yellow. The violet end of the spectrum from λ 480μμ, making a blue on the screen, changed to violet on adding 33 divisions of white light; light purple, on adding 100 divisions. Wave-length 585μμ, the point where the addition of white light produces no change of hue, is also the centre point of pure yellow and the apex of the luminosity curve.

The result of these experiments shows that the component part of white light which has the greatest luminosity effect is the hue to which all colours tend on the addition of white light.

The Anomalous White Equation without Colour-blindness.—Just as a man may make an anomalous Rayleigh equation without any evidence of colour-blindness (Proceedings of the Royal Society, B, vol. lxxxvi., 1913, p. 164), so may a man make an anomalous white equation without being colour-blind. As an example of this, a man was examined who presented no sign of colour weakness. He passed my card test, lantern test, and spectrometer with the ease and accuracy of an absolutely normal-sighted person. His luminosity curve was taken by the flicker method and corresponded with the normal. The wave-length of the apex of the luminosity curve was at 585μμ, which is the normal point. When, however, his white equation was taken, he put only eight scale-divisions of green instead of thirteen and a half or fourteen, which is normal, and the mixed light appeared red to the normal-sighted. An important fact was noted, namely, that after fatigue with red in the region of λ 670μμ the equation changed to him in the same way as the normal-sighted, and he required only four scale-divisions of green instead of eight. It is quite obvious that this was not a case of partial red-blindness.

The White Equation and Colour-blindness.—The colour-blind have been classified by some as red- or green-blind, in accordance with their white equations, those who put too much red in the equation being classed as red-blind and those who put too much green in the equation being classed as green-blind. There are, however, many who, whilst agreeing with the normal equation, are quite satisfied when a considerable additional amount of green or red is added to the equation. This explains why in certain cases some have been described as red-blind by one observer and green-blind by another.

A remarkable fact which does not seem to have been previously observed is that many colour-blind persons who strongly object to the normal match, but are satisfied with an anomalous equation, will completely agree with the normal equation when the comparison white light is increased in intensity so that it is much too bright to a normal-sighted person. This clearly shows that the normal mixed white produces the same effect so far as colour is concerned, but has a more powerful effect as to luminosity. This is in complete accordance with other observations, and is found in those cases in which there is abrupt and slight shortening of the red end of the spectrum. If there be shortening of the red end of the spectrum which does not affect λ 670μμ, and λ 670μμ has its normal light value, the mixed light will be more luminous than the simple white in the exact proportion of the shortening. This portion of red light not producing any effect has to be subtracted from the white light.

These facts are quite inconsistent with a hypothetical red sensation which is affected by light of all wave-lengths. Another illustration may make this point clear. A man with shortening of the red end of the spectrum and normal colour discrimination will put together as exactly alike a pink and a blue or violet much darker. If, however, the pink and blue be viewed by a normal-sighted person through a blue-green glass which cuts off the red end of the spectrum, both will appear identical in hue and colour. This proves conclusively that the defect is not due to a diminution of a hypothetical red sensation, because all the rays coming through the blue-green glass are supposed to affect the red sensation, and yet we have been able to correct the erroneous match by the subtraction of red light. On the other hand, there are colour-blind persons who, whilst disagreeing with the normal white equation, agree with it when the comparison white is diminished in intensity.

The facts in this article, whilst in complete accord with those previously given ("The Physiology of Vision," G. Bell and Sons, 1920), are inconsistent with any theory of three fundamental sensations of which the other colour sensations are compounded.

Defects of light perception are quite distinct from defective colour discrimination. All degrees of colour discrimination may be classified as dichromic, trichromic, tetrachromic, pentachromic, hexachromic, and heptachromic. This classification is fact and not theory. For instance, the dichromic have two colour sensations, red and violet, with a neutral division in the spectrum. There are innumerable varieties of dichromic vision, as there may be shortening of either end of the spectrum or defects in the luminosity curve. When the luminosity curve is the same as the normal there is no evidence to show that the perception of white is not the same as the normal.

I must express my indebtedness to Capt. Fulton and Mr. Isaacs, of the Board of Trade, for their help in making these observations.

Regional Geology.

OUR knowledge of the geology of England is enriched by Dr. J. E. Marr's conception (*The Naturalist*, February, 1921) of Yorkshire as an earth-block surrounded by down-folded strata, but with its own Carboniferous series little disturbed, owing to the rigidity of a pre-Cambrian mass beneath. The block, which became tilted somewhat to the east, has had an important effect on the drainage, and even on the progress of ice-sheets, in northern England.

A useful summary and map of the geology of Jersey, by G. H. Plymen, appear in the Proceedings of the Geologists' Association, vol. xxxii., p. 151 (1921), a journal that has maintained its characteristic features despite the difficult conditions following on the war. The Geological Survey should find a ready sale, even at the price of 10*s*., for its "Short Account of the Geology of the Isle of Wight," by H. J. Osborne White (1921), which contains a coloured geological map on the scale of one quarter of an inch to one mile. The second edition of the memoir that it succeeds is now exhausted, and we must look back on that handsome cloth-bound volume, issued at 8*s*. 6*d*., with the customary regret. But Mr. White's treatise is not a mere abridgment of the older one, since he brings to the work his wide knowledge of the south-east of England, and of the literature of the intervening thirty years. He adds original drawings, showing the development of the surface and the relations of the rocks to well known scenic features, and geologists who are fortunate enough to possess the memoir by Reid and Strahan must now add its successor to their libraries before they start once more for the island. Here, again, the question is raised as to whether memoirs by public surveys should be supposed to cover their own "cost of production," or whether their dissemination should, as in Canada and the United States, be regarded as a part of public education.

Dr. Arthur Winkler, as Ordnance-officer of the 7th Gebirgsbrigadecommando, was stationed at Santa Lucia, near Tolmino, in 1916, and found time to extend F. Kossmat's researches on the central Isonzo valley. He remarks, in the true spirit of science, that the war had inflicted wounds on the mountain-sides, and that many new exposures required registration. His observations, continued in 1918, are now recorded in a paper in the *Jahrbuch der geologischen Staatsanstalt*, vol. lxx., pp. 11–124 (1920), illustrated by numerous sections showing the Alpine folding of the strata, from the Triassic limestones to flysch of Eocene age. Glacial beds, dumped down into the valley, play an important part in the dusty groove, and walls of pebbly calcicrete are undermined by the green swirls of the Isonzo. Above them tower the crags of contorted limestone, marked by brown scars where slabs of rock have fallen away. Dr. Winkler's work brings back happier memories than those recently associated with the Bainsizza Plateau and Caporetto.

The Geological Survey of India issues a handsomely illustrated memoir, by C. S. Middlemiss, on Idar State, which lies on the tropic in the north-east of the Bombay Presidency. Evidences of solar weathering are given in the fine views of granite surfaces. The main interest of the district lies in the junction of the Delhi quartzite with the underlying series of Aravalli schists and gneisses. Quartzite blocks again and again appear to be stoped off into the Aravalli rocks; but the latter cannot in all cases be regarded as igneous invaders. The author suggests that the igneous masses which penetrate the Aravalli series softened the metamorphosed sediments until they behaved as a semi-solid or plastic mass. The floor of Finland seems to offer much support to his conclusions.

Dr. W. F. Hume, untiring in his surveys of barren lands, has issued, with his colleagues, a preliminary report on Abu Durba (Western Sinai). This bulletin, dated 1921, is No. 1 of a series on petroleum research. The oil that is traceable at Abu Durba seems to have been absorbed from shales into the Nubian sandstone, and may originate (p. 11) in organic matter washed down with the shale-particles into the Cretaceous sea.

A. L. Du Toit (Union of S. Africa, Geol. Surv., Explanation of Cape Sheet 28, 1920) traces in Pondoland the great monoclinal flexure that, as Penck showed, is responsible for the edge of the plateau-lands of south-eastern Africa. The down-folding has determined the coast-line, and ceased about the close of Cretaceous times. The inland region, however, continued to rise, since Upper Cretaceous beds, near East London, occur 1100 ft. above the sea. The shelves over which the rivers reach the sea represent successive stages of the uplift. One is inclined to ask once more: When was the great peneplain of the plateau-surface formed? How has it escaped dissection inward from its Eocene edge? Has it been perpetuated by wind-action in a region where rains are only seasonal and droughts are more prevalent than rains?

The first pamphlet of the Geological Department of Uganda (Entebbe, 1920) is written by E. J. Wayland, and is intended to direct the attention of residents to the interest of geological features. The prevalence of laterite is discussed; but we should hesitate to say that the iron was "from the first" in the state of hydrous oxide. Glauconite, mentioned in connection with clays, is a silicate and not a phosphate. Are not the cubic pseudomorphs in the argillites (p. 11) more likely to have been originally pyrite than rock-salt? The author introduces (p. 36) a useful geographical term, *arena*, for undulating areas more or less completely surrounded by hill-ranges. These areas are shown to result from the denudation of domes of strata, and rivers run through the surrounding walls. The Woolhope inlier may thus be called an arena, and numerous examples occur in the

Old Red Sandstone and Silurian country of Southern Ireland.

From Australasia we receive comprehensive descriptions of the "Palæozoic Geology of Victoria," by E. O. Teale (Proc. Roy. Soc. Victoria, vol. xxxii., p. 67), with a map of the Mount Wellington area; also of the "Geology of Western Australia," by A. Gibb Maitland, extracted from the Mining Handbook published in 1919 by the Geological Survey. The latter memoir has excellent sketch-maps and illustrations throughout the text, and includes a large coloured geological map of the State, dated 1920, corresponding with that described in NATURE, vol. cv., p. 498. This summary should be serviceable in very many libraries in the homeland, and should be made available in all Australian schools.

In Bulletin 21, at the moderate price of 5*s.*, the New Zealand Geological Survey continues its illustrated descriptions of the Dominion. The Osborne and Whatatutu subdivisions, which are here dealt with by J. Henderson and M. Ongley, lie on the east side of North Island, and include peaks rising to 4000 ft. on the main divide. Oil is found in the district, probably oozing from the Te Arai (Lower Miocene) and Cretaceous strata. As usual in these bulletins, the authors pay full attention to the origin of surface-features, and one of their pleasing landscapes shows us, incidentally, the gathering of thousands of sheep under the raised rock-platform of Waihau Beach.

New Zealand now extends its responsibilities to Pacific isles; and J. Allan Thomson describes (*N.Z. Journal of Science and Technology,* vol. iv., p. 49, 1921) the geology of Western Samoa. The lava-tunnels appear to have been used as dwellings, and terraces for sleeping-accommodation have been built up in them—a feature that will pleasantly remind playgoers of the opening scene of Kelly's "Bird of Paradise."

Among American publications, we may note, for comparison with the Triassic beds of Cheshire, the cemented sand-dunes of Eocene age in north-eastern Montana (A. J. Collier, U.S. Geol. Surv., Prof. Paper 120–B, plate iv.), and the cross-bedded De Chelly sandstones (Permian?) of Arizona (H. E. Gregory, *ibid.,* Prof. Paper 93, p. 31, etc.). The latter paper, which is on the "Geology of the Navajo Country," contains notable illustrations of erosion in an arid land. E. G. Fenton (Sci. Proc. Royal Dublin Soc., vol. xvi., No. 19, 1921, 4*s.* 6*d.*), in his "Studies in the Physiography and Glacial Geology of Southern Patagonia," brings us to an unusual field. He has specially examined, through years of residence, the results of glacial outwash and of river-erosion between the Andes and the Atlantic coast. He interestingly attributes the hollows known as *bajos* to the action of water falling over an ice-front during a pause in the general retreat of the pampas glaciers. Though he traces several epochs of retreat and of renewed glaciation, during some of which lavas flowed down into valleys cut by rivers streaming from the ice, Dr. Fenton finds no evidence of any genial interglacial epoch in Patagonia.

G. A. J. C.

Artificial Farmyard Manure.

AN article in the current issue (August) of the *Journal of the Ministry of Agriculture* under the above title somewhat modestly announces what must be regarded as one of the most notable advances in agricultural science made by our oldest agricultural research laboratory, the Rothamsted Experimental Station. For many years the composition and fertilising value of farmyard manure have occupied the attention of investigators. The chemical problems involved at first sight appear simple. When cattle are fed with food rich in nitrogen there is a corresponding enrichment of their excrement. "Cake-fed" dung has long been given a high value by the farmer, and on a purely chemical basis its merit was recognised by the man of science. Hence such publications as "Hall and Voelcker's Tables," which give the "residual" values of various foodstuffs—that is to say, the value of the fertilising constituents (mainly nitrogen) in various substances present in the dung of animals to which they have been fed. But the perplexing fact emerged that dung with this higher theoretic value did not give crop increases corresponding to its assumed chemical content. Nevertheless, so strong has been the effect of the publication of these theoretic values that they are given quasi-statutory effect. Entering tenants have generally to pay compensation "for improvements" based upon the quantity and quality of the foods consumed on the farm during the years preceding their entry.

In the paper alluded to Messrs. Hutchinson and Richards indicate the solution of the conundrum. Put shortly, they have established that the whole of nitrogen in the urine of animals will not be present in the manure as applied to the crops unless a certain ratio subsists between the nitrogen voided by the animals and the carbonaceous matter of the litter by which the urine is absorbed. It seems to follow that "compensation for improvements" should not be awarded on the basis of the food supplied to the stock until the valuer is assured that the feeding was accompanied by an adequate supply of litter, the adequacy being determined by the amount of nitrogen voided by the animals.

Messrs. Hutchinson and Richards show that the factors involved are, in the main, biological, not chemical. The "making" of farmyard manure is essentially the rotting or fermentation of straw. The former writer has published a paper (*Journal of Agricultural Science,* 1919, p. 143) which establishes that straw is fermented by a new aerobic organism, *Spirochaeta cytophaga,* and that this organism requires (in addition to air) a supply of nitrogen, preferably in the form of an ammonia compound (such as, in effect, urea is). It is shown that the amount of nitrogen required for the fermentation of 100 lb. of straw is 0·72 lb. Further, if the nitrogen is in excess of this amount, it tends to pass into the atmosphere as ammonia, with the result that, with a free supply of air, the end product is dung containing about 2 per cent. of nitrogen, *whatever* the original content of the excrement may have been. Under the conditions, however, which obtain in the ordinary farmyard, where some portions of the heap may receive more excrementitious matter than others, the ammonia set free where the nitrogen : cellulose proportion is greater than 0·72 : 100 may be picked up by those portions where the ratio is less, and used to build up their nitrogen content until the whole heap reaches the characteristic and uniform 2 per cent. content of nitrogen.

Using these results, it has been found possible to make an artificial product, closely resembling farmyard manure in appearance as well as in properties, by the addition of predetermined amounts of ammonia salts (such as ammonium sulphate) to straw. The commercial value of this development may be considerable. With the advent of the motor the supply of town dung has fallen off. Many market-gardeners are, consequently, in straits, for the so-called artificial manures are lacking in organic matter (humus), without which many garden and glasshouse crops cannot be grown satisfactorily. It may be that the ordinary farmer, too, will find a use for the artificial product. It is difficult under modern conditions to maintain sufficient animals to make all the straw produced into dung. Again, where animal excrements exist in abundance (as in milk production), lack of knowledge of the principles of the interaction between urine and straw leads to much waste of valuable fertilising material.

Another direction in which these discoveries may have a practical outcome is in removing the soluble compounds of nitrogen present in sewage. Under the existing sludge processes very little of this soluble matter is recovered. It has been shown that if liquid sewage is used to ferment straw, the effluent is practically free from nitrogen; it has all been retained by the straw.

Enough has, perhaps, been said to indicate the great practical importance of the discovery made by the Rothamsted workers. The scientific advance is not less notable, and marks another stage in the capture by the biologists of the agricultural field of research.

West Indian Zoology.[1]

By PROF. J. STANLEY GARDINER, F.R.S.

IN 1895 the State University of Iowa, acting through Prof. C. C. Nutting, who was already well known as a member of several marine expeditions, organised a zoological exploration of the Bahamas. Its object was twofold: to give their people experience of marine life in tropical seas, and to secure material for morphological and systematic research and for ordinary laboratory purposes. So satisfactory were the results that Prof. Nutting's staff themselves suggested a further expedition, this time to the Lesser Antilles. Preparations were commenced in 1916, so little was the entry of the United States into the war anticipated. Prof. Nutting himself went down to prospect in 1917, and finally the expedition sailed in April, 1918, the party consisting of nineteen persons, including six ladies.

Barbados was first visited, the party camping for six weeks in the quarantine station on Pelican Island, which was placed at its disposal by the Barbados Government. Groups were formed for shore collecting, row-boat work, launch dredging to 200 fathoms, land work, and laboratory observations.

Barbados Island itself is the most eastern of the Antilles, and, although now consisting largely of elevated coral and limestone rocks, contains the remains of land connecting it in early Tertiary times to South America. It was then sunk to great depths and overlaid by beds of ooze, "Barbados earth," noted for their richness in radiolaria and foraminifera. The uplift raised the sea bottom high enough for corals to thrive, and subsequent elevations are responsible for the terraced effects so apparent in the topography of the present land. The island is about 21 by 14 miles, and has now a population of nearly 200,000. All is cultivated, and land collecting was hence little likely to yield results of much value. The expedition, indeed, mainly concentrated on marine work, and the more striking animals of different groups are described; the whole forms a guide which will be of value to future workers. The general variety of life is interesting, but the uniformity of all tropical marine life in the coral-reef regions of the world is still more striking; indeed, Prof. Nutting's descriptions would apply almost equally well to faunas from similar grounds off Ceylon, Seychelles, or Fiji.

The second camping place was in the British dockyard in English Harbour, Antigua. Here, on account of the heavy swell, work had to be concentrated in the harbour and in the neighbouring Falmouth and Willoughby Bays. There were compensations in a neighbouring mangrove swamp with its peculiar fauna, in fairly smooth bottom, and in the land being little altered and still largely wild, covered with close tropical jungle. There are volcanic rocks of some age on this side, limestone rocks occurring principally in the north of the island, off which are the chief living coral reefs. The marine crustacean, holothurian, and worm faunas proved particularly interesting, and there are many observations on the modes of life of different forms. Clearly, while the whole surroundings were not so exciting to the party as those of the coral reefs of Barbados, the expedition must have obtained a large number of animals of great interest. Geographically, the mollusca in the clearly capable hands of Mr. Henderson, and the fossil geology in those of Prof. Thomas, may be expected to yield valuable information.

The immediate scientific results of this expedition are not likely to be great, but the whole idea underlying it, and its scope, are of great interest, for it might well be copied by British universities. Here was a party of nineteen charming people, half of whom were interested professionally, while the rest were students. They went off for a term, and came back to their university with a glimpse of what tropical life really is, an abiding picture which will make those who teach interesting to their students, for they will be describing what they have seen, living forms in their natural environments.

[1] University of Iowa Studies in Natural History. Vol. viii., No. 3. "Barbados-Antigua Expedition." By C. C. Nutting. Pp. 274. (Iowa City: University of Iowa, n.d.)

Thomas Wharton Jones, F.R.S.

SIR RICKMAN GODLEE'S memoir of Wharton Jones, reprinted from the *British Journal of Ophthalmology*, March and April, 1921 (London: Geo. Pulman and Sons, Ltd.), is a most admirable short study. It gives us in close compass not only the man's work, but also the man, from 1808 to 1891—a long life in the service of physiology and ophthalmology. Wharton Jones's work on the capillary circulation and on the processes of inflammation is memorable, and was recognised and honoured by all men of science: but the advance of the medical sciences carried the younger men far ahead of him. From Edinburgh, where Wharton Jones was one of Knox's assistants, and suffered a share of the public hatred which flared up over the Burke and Hare murders, he came to London in 1838 as lecturer on anatomy and physiology at Charing Cross Hospital; among his pupils were Huxley and Fayrer. In 1840 he was elected to the Royal Society. From 1851 to 1881 he was professor of ophthalmic medicine and surgery at University College. His thirty years of teaching and writing failed to shield him in later life from miserable poverty; he fell out of the running. He was found at last, in the bitter winter of 1880–81, "crouched over a fireless grate, his shoulders hunched up under a mass of shawls and shabby wraps, the picture of destitution . . . not only very ill, but penniless and starving." Friends saved him, and collected money for him; Huxley and Fayrer obtained from Mr. Gladstone a Civil List pension for him; Jenner obtained a Tancred pension for him. The work was ended in London, and for the last ten years he lived in a couple of tiny rooms in a cottage in Ventnor.

And here is the immense value of this memoir: that we are able to see why Wharton Jones made a better job of science than he made of life. His intense individualism, his combativeness, his opposition to the Darwinian new learning, his perverse liking for small personal grievances, his oddities of dress—these hindrances, none of them insuperable, yet were combined to keep him back from anything like the full happiness of success. "He seems to have missed," says Sir Rickman Godlee, "by so little, much that might have made him happy and successful. But this little made all the difference. . . . When all is said, it is impossible to believe that, on the whole, he had more than a very moderate share of happiness, or even of contentment."

Perhaps, as there are martyrs of science, so there are profiteers of science, men who inflate the value of scientific discoveries or seek to "corner" scientific facts. Wharton Jones was neither martyr nor profiteer. Only he could not get clear away from self-preoccupation; and it is a rather unhappy and perplexed face that looks out at us from the frontispiece of this masterly study of him.

University and Educational Intelligence.

CAMBRIDGE.—Baron R. von Hügel has resigned the curatorship of the Museum of Archæology and Ethnology, and Dr. A. C. Haddon, Christ's College, has been appointed deputy curator. Mr. R. W. Stanners, Gonville and Caius College, has been appointed University lecturer in historical and economic geography. Mr. T. G. Bedford, Sidney Sussex College, and Dr. J. A. Crowther, St. John's College, have been reappointed demonstrators in experimental physics.

Mr. F. J. W. Roughton, Trinity College, has been elected to the Michael Foster research studentship in physiology, and Mr. J. H. Richardson, Emmanuel College, Wrenbury scholar in political economy. Dr. R. L. M. Wallis, Downing College, has been awarded the Raymond Horton-Smith prize in medicine.

Mr. T. F. T. Plucknett, Emmanuel College, has been elected Choate memorial fellow at Harvard College.

Mr. H. H. Thomas, curator of the Herbarium, has been re-elected fellow of Downing College.

Two University lecturers in biochemistry are to be appointed shortly.

PROF. H. LEBESQUE, of the Faculty of Sciences, University of Paris, has been elected professor of mathematics at the Collège de France.

MR. H. P. PHILPOT, assistant professor at University College, has been appointed to the professorship of civil and mechanical engineering at the Finsbury Technical College; and Mr. A. J. Hale, chief assistant in the department of applied chemistry, to the professorship in that department. The entrance examination of the college will be held on Tuesday, September 20.

LOUGHBOROUGH COLLEGE, Leicestershire, has issued a calendar for the academic year 1921–22, in which full accounts of the intellectual and social activities of the college will be found. Work is distributed over a number of faculties, of which the most prominent appear to be those concerned with engineering and pure and applied science. Full details of the courses followed are given, together with a number of full-page reproductions of photographs of the workshops and laboratories. The engineering departments were opened in 1918, and they are designed to give specialised training to boys above sixteen years of age. The course covers five years, during which time the student passes through every department found in an engineering works. On the social side there are, among other societies, engineering, wireless, and chemical and metallurgical societies, while in June last the council of the Junior Institution of Engineers sanctioned the formation of a sub-section, with headquarters at the college. These societies are doing much to bring the student into contact with industrial methods, and should serve as the much-desired link between the technical school and the works.

THE "Handbook of Lectures and Classes for Teachers for the Session 1921–22," which has been issued by the London County Council, contains a number of features likely to interest readers of NATURE. The teaching of mathematics in elementary and continuation schools forms the subjects of courses in the section on mathematics; geography in secondary schools and as a pivotal subject in education are the themes of two courses in the section on geography. Natural science is well represented by a number of courses and lectures: Prof. A. Wolf is giving five lectures on "Pioneers of Science"; Sir William H. Bragg, six lectures on crystal structure; Prof. C. Spearman and the Rev. F. Aveling, ten lectures on the mentality of individual children; Dr. W. H. R. Rivers, five lectures on the psychology of dreams; Mr. C. Burt, ten lectures on intelligence tests; Mr. P. R. Coursey, five lectures on war developments in wireless telegraphy and telephony; and Dr. C. A. Keane, ten lectures on science in elementary schools. There will also be two courses of lectures on laboratory arts. The special science lectures are as follows: "Modern Astronomical Theories," by Prof. H. H. Turner, on October 15; "The Wonders and Problems of Food," by Prof. H. E. Armstrong, on November 12; "Fallacies," by Prof. Karl Pearson, on November 26; "Geology as a Basis for Geography," by Prof. W. W. Watts, on December 10; "Yeast, what it is and what it does," by Mr. A. Chaston-Chapman, on January 21; "Aluminium and its Alloys," by Dr. W. Rosenhain, on March 16; "The Relation between Pure and Applied Chemistry," by Dr. M. O. Forster, on February 4; "The Migration of Birds," by Prof. J. A. Thomson, on February 18; and "Vitamins," by Prof. A. Harden, on March 4. All lectures are open to teachers employed within the county of London; those outside the administrative county will be admitted where accommodation permits. The Council has also arranged for the issue to teachers of science in London schools of tickets of admission to the meetings of certain scientific societies. Communications should be addressed to the Education Officer, New County Hall, S.E.1.

Calendar of Scientific Pioneers.

August 25, 1814. Sir Benjamin Thompson, Count von Rumford, died.—The founder of the Royal Institution and of the Rumford medals of the Royal Society and the American Academy of Sciences, Rumford devoted much time to science and its application to practical purposes, and was one of the first to show that heat was "a mode of motion."

August 25, 1822. Sir William Herschel died.—Pre-eminent among the astronomers of his day, Herschel extended immensely the bounds of sidereal astronomy. In 1781 at Bath he discovered Uranus. His great telescope at Slough was one of the wonders of the scientific world. He made extensive observations of the moon and planets, first established the motion of the sun in space, discovered many nebulæ, and showed that the components of double stars were moving round their common centre of gravity.

August 25, 1867. Michael Faraday died.—Unrivalled as an experimental investigator and as a lecturer, Faraday was the assistant to Davy and the successor of Brande at the Royal Institution, and in 1833 became the first Fullerian professor. Though his investigations covered a wide range, the great work of his life was his series of "Experimental Researches in Electricity," to which all later students of electricity owe a vast debt.

August 25, 1908. Antoine Henri Becquerel died.—The son and grandson of distinguished physicists, Becquerel made himself famous by his memorable discovery in 1896 of radio-activity, for which in 1903, with the Curies, he was awarded the Nobel prize.

August 26, 1723. Anton van Leeuwenhoek died.—A pioneer worker with the microscope, Leeuwenhoek made important discoveries in support of the circulation of the blood, blood-corpuscles, spermatozoa, and other subjects, and contributed 112 papers to the Philosophical Transactions.

August 28, 1839. William Smith died.—The "father of English geology," Smith published his epoch-making geological map of England in 1815.

August 28, 1863. Eilhard Mitscherlich died.—The discoverer in 1819 of isomorphism and of dimorphism, Mitscherlich spent two years with Berzelius at Stockholm, and then in 1821 succeeded Klaproth as professor of chemistry in the University of Berlin.

August 29, 1816. Johann Hieronymus Schröter died.—For more than thirty years Schröter studied the topography of the planets. He has been called the Herschel of Germany. His observatory at Lilienthal, in which Bessel worked, was pillaged during the War of 1813.

August 29, 1868. Christian Friedrich Schönbein died.—Schönbein for many years held the chair of physics and chemistry in the University of Basle. In 1839 he discovered ozone, and in 1846 made known his invention of guncotton.

August 30, 1844. Francis Baily died.—After amassing a fortune on the Stock Exchange, Baily devoted himself to astronomy. He was a founder of the Royal Astronomical Society, reformed the Nautical Almanac, edited a star catalogue, and during the years 1838–42 repeated the Cavendish experiment for determining the density of the earth.

August 30, 1888. Johann Peter Griess died.—In 1858 Griess discovered the first diazo-compound, and three years later the first azo-colours, which have produced a revolution in the art of dyeing.

August 31, 1900. Sir John Bennet Lawes, Bart., died.—A great pioneer in the application of science to agriculture, Lawes was the founder of the Rothamsted Experimental Station, where for fifty-seven years Gilbert was his collaborator. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 8.—M. Léon Guignard in the chair.—A. **Demoulin**: Surfaces generated by circles.—P. **Fafou**: The domains of existence of certain uniform functions.—M. **Potron**: The representation of the group of 27 right lines in a group of quaternary collineations.—K. **Ogura**: The movement of a particle in the field of a charged nucleus.—L. **Dunoyer**: A new spectrum of cæsium. The metal was contained in a quartz tube, with plane parallel quartz ends, and surrounded with a wire spiral in which high-frequency currents were produced. The whole could be heated uniformly in an electric furnace. The vapour commenced to be luminous at 100° C., reaching a maximum luminosity at 250° C. The spectrum consists of fine lines with no trace of a continuous background. Measurements of more than 300 wave-lengths for the low-temperature spectrum are given.—S. **Procopiu**: Magnetic double refraction of mixed liquids and crystalline structure.—E. **Moles** and F. **Gonsalez**: A new revision of the density of oxygen gas. Special attention has been paid to varying the method of preparing the gas, and density measurements are given for oxygen prepared from potassium permanganate, potassium chlorate, mercuric oxide, and silver oxide, and by the electrolysis of water. The general mean is 1·42889, differing only by one part in 10,000 from the figure at present accepted, 1·42905. The densities, classified according to the method of preparation, showed no sign of any systematic error.—A. **Mailhe**: The preparation of a petrol from a fatty oil. Linseed oil was passed over a catalyst composed of copper, magnesia, and kaolin heated to 550°–650° C. The volatile product was further treated with hydrogen and reduced nickel at 180° C. After refining, petrol and kerosene fractions were obtained. The petrol contained benzene and naphthene derivatives.—G. **Vavon**: The velocity of the reaction in the hydrogenation by platinum black. The rapidity with which the hydrogenated body formed leaves the surface of the catalyst is a governing factor in the velocity of the reaction.—V. **Yéramian**: The synthesis and dehydration of ethylpropylphenylcarbinol. Ethylpropylphenylcarbinol was prepared by the Grignard reaction from propylphenylketone and ethylmagnesium bromide. This can be distilled without decomposition under low pressure (25 mm.), but is readily dehydrated, producing an unsaturated hydrocarbon, $C_{12}H_{16}$, probably 3-phenyl-3-hexene.—V. **Lubimenko**: The state of chlorophyll in the plasts. A study of the causes of the inactivity, from the point of view of photosynthetical reactions, of pure chlorophyll prepared by chemical methods. It was found that treatment of the living tissue by various solvents, besides coagulating the proteid substances in the plasts, produces sensible changes in the optical properties of the green pigment. The chlorophyll of the leaves of *Aspidistra elatior* can be completely removed by extraction with water. The absorption spectrum of the material thus extracted is absolutely identical with that of the living leaf. The chlorophyll is intimately related to the proteid substances of the plasts, and this is probably of a chemical nature.—M. **Romieu**: The crystalline inclusions of the eleocytes of Nereis and their relations with the eosinophil granulation.—C. **Levaditi**: Embryonic leaflets in relation to pathogenic micro-organisms. Mesodermic infections are caused by bacteria, fungi, spirillæ, and protozoa, whilst infections of the ectoderm are produced by virus, usually invisible and capable of passing filters.

SYDNEY.

Royal Society of New South Wales, July 6.—Mr. E. C. Andrews, president, in the chair.—W. R. **Browne**: Note on the relation of streams to geological structure, with special reference to "boathook bends." The influence of geological structures on the courses of streams, as illustrated by certain rivers of New South Wales, is discussed, and it is suggested that what Dr. Griffith Taylor has termed "boathook bends" in rivers are in many cases to be attributed to the presence of directive geological structures rather than to river-piracy and the breaching of divides.—Marie **Bentivoglio**: Notes on cassiterite crystals from New England district, New South Wales, and Stanthorpe, Queensland. The crystals were taken directly from hand-specimens of igneous rocks obtained from Stannum, Pheasant Creek, Mandoie Station, and Stanthorpe. Crystal habit varies with locality. Almost all the crystals are twinned, the twinning occurring on the *e*(101) face, according to the usual law. Doublets are the commonest grouping, but triplets and quartuplets were also observed.—Dr. E. E. **Turner** and F. H. H. **Wilson**: The decomposition of dimethyl oxalate by acetic acid. Pure methyl acetate may be prepared by the action of 80 per cent. acetic acid on dimethyl oxalate, the theoretical quantities of reactants being used. The yields obtained are virtually theoretical.—Dr. L. A. **Cotton**: The Kurrajong earthquake of August 15, 1919. The special feature of the Kurrajong earthquake is the peculiar **Y**-shaped character of the isoseismals. One arm of the **Y** and its stem lie subparallel to, and superimposed over, the line of structural weakness shown by the Kurrajong fault and the Glenbrook monocline. The other arm of the **Y** is not known definitely to coincide with a fault zone. The direction corresponds to a major direction of tectonic weakness—the Permo-Carboniferous geosyncline—and also to numerous large faults in the Maitland district. It is suggested that the earthquake was caused by block faulting in which the south-eastern corner of a crustal block has foundered. This would account for the peculiar form of the isoseismals. The shape of the boundary of the sound area confirms the **Y**-shaped form of the isoseismals.

Books Received.

Revelation and Science: A Reply to Higher Critics and Darwinists. By John Leslie. Pp. 156. (Aberdeen: W. Jolly and Sons, Ltd.) 3*s*. 6*d*.

Calculations in Organic Chemistry. By Prof. V. K. Bhagwat. Pp. xi+138. (Bombay: S. Govind and Co.)

British (*Terra Nova*) Antarctic Expedition, 1910–1913: Terrestrial Magnetism. By Dr. Charles Chree. Pp. xii+548+lx plates. (London: Harrison and Sons, Ltd.)

Memoirs of the Geological Survey, Scotland. Special Reports on the Mineral Resources of Great Britain. Vol. xvii.: The Lead, Zinc, Copper, and Nickel Ores of Scotland. By G. V. Wilson. With Contributions by Dr. John S. Flett. Pp. vi+159+2 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 7*s*. 6*d*. net.

Die Grundlagen der Geometrie: Als Unterbau für die Analytische Geometrie. By Prof. Lothar Heffter. Pp. iv+27. (Leipzig and Berlin: B. G. Teubner.) 18 marks=1·25 shillings.

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

Proceedings of the Aristotelian Society. New Series. Vol. xxi. Containing the Papers read before the Society during the Forty-second Session, 1920–21. Pp. iv+246. (London: Williams and Norgate.) 25*s*. net.

Liquid and Gaseous Fuels and the Part they Play in Modern Power Production. By Prof. Vivian B. Lewes. Second edition. Revised and edited by John B. C. Kershaw. (The "Westminster" Series.) Pp. xiv+353. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

The Angami Nagas, with some Notes on Neighbouring Tribes. By J. H. Hutton. Pp. xv+480. (London: Macmillan and Co., Ltd.) 40*s*. net.

The Fourth Dimension. By Prof. E. H. Neville. Pp. vii+56. (Cambridge: At the University Press.) 5*s*. net.

Zentralblatt für die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und Medizin. Edited by Prof. Richard von der Heide and Robert Lewin. Erster Band. 1920. Pp. 524. (Leipzig: Gebrüder Borntraeger.) 90 marks.

First Principles of the Electrical Transmission of Energy: A Survey of the Physical Basis of Electrical Transmission, its Methods and Phenomena from the Standpoint of the Electron, for Students and Practical Engineers. By Prof. W. M. Thornton. (Pitman's Technical Primer Series.) Pp. xii+116. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

CONTENTS.