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Labour and Science in Industry.

THE statement issued by the Trade Union Congress on February 19 entitled "The Attack on Labour Standards" calls for notice from those interested in the scientific organisation of industry. It is stated quite truly that "During the last 150 years industrial conditions have been revolutionised. Labour-saving devices have been introduced: steam and electric power have been developed, and the increased productive capacity of industry following innumerable inventions and scientific discoveries has enabled those who work by hand and brain to increase enormously their output." But if this increase in mechanical power is to be labour-saving, it must not, they go on to say, be at the expense of those who labour, and they have some fear that an attempt is being made "to utilise the present 'slump' for the purpose of degrading conditions of employment to the lowest possible point." In particular it is claimed that a reduction in the hours of labour is the only means of enabling the workers to share in the triumphs of civilisation and industrial peace, and that a firm front must be maintained on that point.

It would be impossible in a short article, and unsuitable in these columns, to enter on a discussion of the detailed questions involved in various industries at the present day; but the general question is one of the highest moment. Seeing that the application of science to industry has transformed society in the period referred to, and has indirectly affected politics, art, education—in fact every side of Western life—it behoves us to consider with the utmost care how far the mass of the workers has benefited by the change. By this it must ultimately be judged, for whatever may be the eternal value or eternal permanence of knowledge in itself, as soon as we apply it to the conditions of our life, it must be judged by the effects on the whole people and not on the few. As a human being, enjoying the products of industry, the happiness of the manual worker has an absolutely equal claim to moral or legal consideration with that of those who direct or organise his work.

This will scarcely be questioned nowadays on the employing side. Are not the "workers" on their side now ready to agree that, so far as we can judge in so difficult a matter, since the Trade Union action and legislation of the last three-quarters of a century, the conditions of the working-class are both happier, more intelligent, and more humane than they were before Watt invented the steam-engine?

But, it will be said, is not the betterment, if real, due not to science, but to legislation and other action necessitated by the evils which the industrial

revolution had produced? Above all, have the "workers" received a fair share in the increased products?

On the latter point a decision commanding universal assent is impossible. There is no absolute standard of justice in such affairs. If we can be satisfied on the general question, that the condition of the workers has been appreciably improved by the applications of science to industry and life, it would be unreasonable to seek a mathematical proportion. Can we? Immediately after the introduction of big machines and factory production, we certainly could not. The herding together of crowds of poor people in hideous, hastily constructed, and insanitary town-dwellings was a monstrous evil. Even now these conditions too largely persist to allow a very roseate picture to be drawn. But, on the other hand, so much has been done to ameliorate them that it would be equally untrue to paint quite so black a picture as may be heard described from Labour platforms. Life has been transferred from country to town for the mass of our people, and that has its inevitable drawbacks. But it is not on the whole an unhappy or degraded life. Houses have been, and are being, vastly improved. Hours of labour have been reduced, and there is not the slightest prospect of their return to the condition of the early factory years. Facilities for education and enjoyment have been vastly increased, or rather newly created. Health is remarkably improved.

One result of the change in industry due to science is seldom noted in these discussions, and yet it is one of the most important. Mass production and scientific machinery have between them thrown up a large new class of men intermediate between the manual workers and the capitalist director. This class—the foreman, the shop-steward, the manager, the man with exceptional organising or mechanical ability who invents and sets up on his own account—is the most characteristic human product of the industrial revolution and one of the weightiest factors in modern society. Those estimating the share taken by "Labour" in the fruits of scientific industry cannot omit this, which is the best paid section and nearest to the mainspring. Moreover, in general we may note that those industries which have absorbed most brains in their development, notably engineering, also pay the highest wages. Agriculture, which has up to the present remained most primitive, pays the lowest.

The application of science to industry does not appear, therefore, to carry with it the wholesale degradation of the working-class as is sometimes contended, though the great mass who do purely mechanical work are rightly the chief concern of the social reformers and the Trade Union Congress. F. S. M.

An Antarctic Saga.

The Worst Journey in the World: Antarctic, 1910–1913. By Apsley Cherry-Garrard. (In 2 vols.) Vol. 1. Pp. lxiv + 300 + 4 + 30 plates + 4 maps. Vol. 2. Pp. viii + 301-585 + 28 plates + 1 map. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 63*s*. net.

THIS is the sixth book to give the story, or part of the story, of Capt. Scott's last expedition, and it is in some ways the most remarkable of them all. Mr. Cherry-Garrard took part in three of the worst journeys ever made in the Antarctic or anywhere else, and the iron of his sufferings has entered into his soul and imparted a ferric quality to his recollections. He writes often with a forceful epigrammatic directness that makes one gasp; again he falls back into pages of rather heavy going, for his quotations from the other books on the expedition are very numerous, albeit they are well chosen. The very first paragraph of the preface sets the keynote of simulated cynicism and paradox.

"This post-war business is inartistic, for it is seldom that any one does anything well for the sake of doing it well; and it is un-Christian, if you value Christianity, for men are out to hurt and not to help—can you wonder when the Ten Commandments were hurled straight from the pulpit through good stained glass. It is all very interesting and uncomfortable, and it has been a great relief to wander back in one's thoughts and correspondence and personal dealings to an age in geological time, so many hundred years ago, when we were artistic Christians, doing our jobs as well as we were able just because we wished to do them well, helping one another with all our strength, and (I speak with personal humility) living a life of co-operation in the face of hardships and dangers which has seldom been surpassed."

This prepares us for the last sentence in the preface, which in turn illuminates the literary landscape of these volumes:

"My own writing is my own despair, but it is better than it was, and this is directly due to Mr. and Mrs. Bernard Shaw. At the age of thirty-five I am delighted to acknowledge that my education has at last begun."

An author possessed of so humble and hopeful a disposition should not take it amiss if a critic tries to help by suggestions of improvement as well as by hearty recognition of exceptional candour and artistic power.

To begin with, the historical introduction detracts from the value of the book, of which it occupies sixty-four pages. It ought to have been much shorter and focussed more directly on McMurdo Sound. Unfortunately, Mr. Cherry-Garrard went direct to Cook's "Second Voyage" and neglected to check his extracts in proof, otherwise he would not speak of "*sus*pissated

juice," nor would he have quoted a longitude as "2° East" without adding Cook's essential words "of the Cape of Good Hope." On the other hand, he omitted to consult the *Challenger* "Narrative," but took from some uncited source the surprising statement that the *Challenger* "spent three weeks within the Antarctic Circle," the actual time having been more nearly three hours. Later history as summarised by Mr. Cherry-Garrard also requires revision. Borchgrevink should have been mentioned as the first man to land on the Ice Barrier and travel over its surface, and Armitage might have been named as the leader of the first party to ascend to and travel over the great polar Plateau.

Incidentally, the paging of the book reveals the fact that it was designed as one volume, for vol. 2 begins with p. 301, and as the exigencies of printing made it difficult to end vol. 1 on p. 300 four unnumbered pages had to be introduced, and so a singularly clear description of the embryology of the Emperor penguin by Prof. Cossar Ewart, which occupies those pages, has necessarily escaped the index.

As a general account of Scott's last expedition Mr. Cherry-Garrard's book surpasses all the others. Mr. Priestley's book on the northern party, Dr. Griffith Taylor's and Mr. Ponting's on the main wintering party, and Capt. Evans's account of his personal experiences are fine books, each in its way dealing admirably with special aspects but leaving the expedition as a whole unchronicled. The two great volumes of Scott's Last Journey giving the official account omit the preliminary arrangements for the expedition, of which Mr. Cherry-Garrard gives a racy account, and enter too fully into the fears and anxieties of the leader on the great southern journey to leave a clear impression on the mind. Again, the exquisite reproductions of Dr. Wilson's beautiful water-colours and the panoramic sketches of scenery give to the volumes before us a charm that in large part compensates for the very high price which their inclusion necessitates.

If poetry be indeed definable as "emotion recollected in tranquillity," Mr. Cherry-Garrard has given us a true epic of exploration. His emotion was strong and his recollection is sardonically calm. The description of the "worst journey in the world" from Cape Evans to Cape Crozier in winter darkness to obtain eggs of the Emperor penguin is the most vivid and moving we have met with in polar annals. The mellow nobility of Wilson's character and the dauntless cheeriness and resourcefulness of Bowers made them ideal companions in a desperate adventure, and despite the deprecatory references to himself we can see that Mr. Cherry-Garrard was not unworthy of his associates. To be sure, Bowers would not have worried if all the penguin eggs had been broken, nor would Wilson have taken offence at the superior aloofness (real or imaginary) of a museum official, which hurt the author severely. All the same, we think the Gilbertian humour and grotesque exaggeration of Mr. Cherry-Garrard's efforts to extort from the "Chief Custodian" an expression of the value of the objects for which three men had put their lives to the touch may well be passed by as a piece of friendly banter, for to the general reader it serves as an artistic relief to the grim horror of the quest.

The description of the main southern journey and of the ascent and descent of the Beardmore Glacier is a most valuable piece of first-hand narrative. Still more must one appreciate the story of the return of the last supporting party under Capt. Evans, which is told in large part in the very words of Lashley, one of the two "naval ratings" who saved the life of their leader by heroism as fine as ever was. The diary, given in its original lower-deck language, is a masterpiece of rugged prose that defies all rules of grammar and is incapable of imitation.

Mr. Cherry-Garrard conveys a good impression of the scientific aims of the expedition in untechnical words; but in our opinion the real value of the book is as a contribution to polar psychology. Priestley has treated of this aspect of the expedition more formally; but here we have a quarry of the raw material with which psychologists will know how to deal. As a rule, official reports fail in a candid treatment of the human element in an expedition, while the unauthorised records of subordinates usually fail in trustworthiness. Yet we know more of the mental state of Cook's companions in 1773–75 from Forster's ill-natured volumes than from the great navigator's own calm narrative, and we get delightful sidelights on Sir James Ross from M'Cormick's "Polar Voyages" in spite of the conceit and short-sightedness of the writer. We cannot view Mr. Cherry-Garrard's analyses of the character of his leader or his comrades as ill-natured, while he is certainly totally free from any suggestion of claiming superiority for himself, and, save in the case of the "Chief Custodian" referred to above, he is obviously sincere.

To future students of polar travelling this book will prove invaluable whether all the opinions put forward in it are accepted or not. We are reluctant to raise controversies that would no longer serve a practical purpose; but no future explorer can afford to pass by the criticism of the rations used for sledge-travelling or the inquiry into the real cause of the collapse of Scott's party. While the immediate cause was, as Scott stated, the shortage of paraffin for heating and the totally unexpected low temperature of the air on the Barrier surface in March, Mr. Cherry-Garrard

indicates that an unfortunate dietary had led to the slow and gradual undermining of the health of all the members, lowering their vitality to a point which made the struggle hopeless. The discussion of this subject is painful; but it is scarcely likely that the views put forward will be accepted by the survivors of this or other polar expeditions without very careful scrutiny. It must be remembered that only experience can test the sufficiency of any diet, and that the best theoretical views are open to revision in the light of new knowledge. The War included so many large-scale experiments on mal-nutrition that any one criticising Scott or his advisers for their views in 1909 must be careful to do so with respect only to the state of knowledge at that time.

Capt. Scott was a great leader, and it may be that the wave of hero-worship which rose to so unprecedented a height when the news of his fate became known overshadowed the merely human side of his character. Even if all that Mr. Cherry-Garrard says of the strength and of the weakness of his late leader stands the test of time, the question cannot but arise whether the time for such a characterisation has yet come. In the future it will be a valuable piece of comparative study to contrast one great leader with another, but it will never be fair to compare the searching analysis of Capt. Scott with the more conventional presentment of other leaders whose qualities have been dealt with, let us say, with the reticence dictated by Victorian standards of consideration for the feelings of surviving relatives.

We think that it may be possible to combine fearlessness with good taste by placing on record in some safe keeping for future study the most intimate personal criticism of explorers by those who have been most closely in contact with them; and we should like to see all personal diaries of all the expeditions secured from the risk of destruction, especially from the risk of destruction by the writers themselves in after years, by deposit with a responsible institution in trust for posterity.

HUGH ROBERT MILL.

Indian Irrigation.

Triennial Review of Irrigation in India, 1918–1921. Public Works Department of the Government of India. Pp. v+222. (Calcutta: Government Printing Office.) 5 rupees.

INDIA is a land of many problems, and not the least difficult and perplexing is that of irrigation. The meteorological conditions vary there more than anywhere else in the world, within an equivalent area. The country contains alike the locality (Cherrapunji) with the greatest recorded average annual rainfall (460 inches) and arid tracts where rain is practically unknown. More troublesome than these extremes is the general irregularity of the incidence of precipitation, its unequal distribution, its capricious periodicity, its liability to entire failure. Drought and famine are ugly visitants to a country, but they are only too familiar to the unfortunate inhabitants of the land of the Moguls.

There is no need, therefore, to enter any plea or make any justification for irrigation works in India. Not merely the happiness and comfort but the very existence of many thousands of lives depends upon the provision of supplies of water by artificial means to the crops during the dry season.

The volume before us contains a record of the irrigation works carried out during the triennium 1918–21 by the Public Works Department of the Government of India. It also embodies an extremely interesting review of the inception and progress of various undertakings of the kind during a period of some forty years. The 10½ million acres irrigated by Government Works in 1878–79 have grown to 28 million acres in 1919–20. Perhaps a better method of forming an idea of the works themselves is to speak in terms of channels constructed. By the year 1900–1 there were 39,142 miles of Government channel in operation. In 1920–21 this length had increased to 55,202 miles. Every year there has been an average addition of 800 miles.

From an agricultural point of view, the triennium 1918–21 consisted of a central prosperous year between two lean years. In the first year the average deficiency in the rainfall throughout the plains was greater than in any preceding year since 1877. In 1919, on the other hand, the precipitation for the whole season was 5 per cent. above the normal. In the following year another set-back occurred, and the percentage below the normal ranged from 13 in the United Provinces to no less than 83 in Sind. Commenting on these facts and their relationship to the irrigation works already in existence, the report truly says: "But for the works, on millions of acres the crops would never have come to maturity; on millions more, no crops at all could have been sown. . . . It is safe to say that even 20 years ago, many tracts would have suffered from widespread famine which, owing to the facilities now afforded for irrigation, passed through the triennium unscathed."

The review of the triennium period includes a notice of the great Triple Canals project in the Punjab, commenced in 1905 and finally completed in 1917. It consists of 433 miles of main canals and branches and 3010 miles of distributaries, in connexion with which nearly 20,000 miles of watercourses have also been constructed. The total area commanded is 6250 square miles, and it is proposed that 1,675,000 acres shall be irrigated annually. Another notable undertaking referred to is the Divi Island project in the delta

of the Kistna river in Madras, which is an attempt to effect irrigation on a large scale by pumping. The installation comprises eight double-cylinder Diesel engines, each of 160 h.p. and driving a centrifugal pump capable of discharging 73 cu. ft. per second on a 12-foot lift. Another engine is to be added shortly.

Among the works now in hand is the Sarda Canal in the United Provinces. The decision to construct this canal finally settles what has probably been the most contentious question in the irrigation of India. The controversy over the matter has lasted for more than half a century. The canal when constructed will irrigate the North-Western districts of Oudh. It will comprise 478 miles of main canals and branches and 3370 miles of distributaries.

Space does not admit of reference to other interesting schemes which are described in the report. Its 222 pages are replete with useful information, which will repay study by those interested in the subject. There is a helpful series of maps and diagrams, many excellent photographs, and some tabular statements showing the financial results of the various irrigation operations throughout India. BRYSSON CUNNINGHAM.

Scientific Societies in the British Isles.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1921–22 by numerous Societies and Government Institutions. Compiled from Official Sources. Thirty-ninth Annual Issue. Pp. vii+374. (London: C. Griffin and Co., Ltd., 1922.) 15*s.* net.

THE appearance once more of Messrs. Charles Griffin's well-known Year-Book affords us an excellent opportunity for taking stock of the position of science in the British Isles. The volume is arranged in the customary style, the various bodies dealt with being divided among fourteen sections according to the nature of their activities. In each section again, there is a further grouping according to the location of the society, institution, or department in London, the Provinces, Scotland, or Ireland. As is only to be expected, most of the more important entries appear in the London groups. In each case, some particulars of the society or institution are given, together with a list of its publications during the year when available.

The total number of societies, research departments, etc., appearing in the 1922 Year-Book exceeds 550, of which it is fair to say that some 480 are concerned, directly or indirectly, with science. The remaining 70 are accounted for by literature, history, and law. In addition to these, there are long lists of local societies and clubs interested in photography, law, or medicine. The distribution of the societies among the various sections is also interesting. Section 1, including bodies dealing with all branches of science, has 75 entries; sections 5 and 7, covering biology and mechanical science respectively, have 90 each; section 13, on archæology, has 63, while section 14, on medicine, has 54 entries apart from the long list of local medical societies.

The various societies and bodies of a similar nature appearing in the Year-Book can be divided fairly sharply into two distinct groups; those which exist for the publication of research, and those which are better described as functioning for the popularisation and spread of knowledge. Of the five hundred or so entries appearing, about one hundred seem to fall into the former group; and of these 14, including the Geological Surveys, the National Physical Laboratory and the Royal Observatory at Greenwich, are supported by Government.

A mass of similarly interesting information exists in this valuable publication, and it may seem ungracious to ask for more. That is, however, the penalty of providing good fare. The sub-title of the volume states that it deals with the year 1921–22, but, for example, it is somewhat late in the day to find information on the British Association brought up only to the Edinburgh meeting of 1921. Further, we would suggest the inclusion of the numerous Research Associations now in existence, while it would add much to the interest of the volume if the number of members of each society could be indicated. A few errors in classifying the entries have been noticed; for example, the Nature-Study Society and the School Nature-Study Union appear in the section headed Psychology. These are, however, minor blemishes in a most valuable publication, which we believe is the only single volume providing an outline survey of the activities of most, if not all, the learned societies of the British Isles.

Aluminium and its Alloys.

(1) *Aluminium and its Alloys.* By Lieut.-Col. C. Grard. Translated by C. M. Phillips and H. W. L. Phillips. Pp. xxxiii+184+16 plates. (London: Constable and Co., 1921.) 17*s.* 6*d.* net.

(2) *The Institution of Mechanical Engineers: Eleventh Report to the Alloys Research Committee: on Some Alloys of Aluminium (Light Alloys).* By Dr. W. Rosenhain, S. L. Archbutt, and Dr. D. Hanson. Pp. ii+256+24 plates. (London: Institution of Mechanical Engineers, 1921.) 42*s.*

(1) LIEUT.-COL. GRARD'S book is essentially a treatise on the mechanical properties of aluminium and some of its commercial alloys. The extraction of the metal is described in two pages, and no more detail is given than in an elementary textbook,

although there are several plates showing the power houses of Continental works. The account of the economic position of the industry is also too meagre to be of much use. The valuable part of the book consists of a long series of diagrams of mechanical properties of metal that has been subjected to various thermal and mechanical treatments, and of a corresponding series for certain of the light alloys and for the aluminium bronzes. Tensile strengths are given in metric and British units—an excellent practice.

The lack of any theoretical discussion deprives these sections of much of their value. The ageing of duralumin and similar alloys is a puzzling phenomenon when presented in the form of a mere record of tensile and hardness tests, but becomes comprehensible when considered in the light of microscopical and electrical evidence, and interpreted by means of the theory of solid solutions. Most of the photomicrographs represent the copper-aluminium alloys, commonly called aluminium bronzes. The writer appears to be unaware of the work that has been done in this country, at the National Physical Laboratory and at the Royal School of Mines, which has thrown so much light on the properties of this metal and of the light alloys. The book will be found useful chiefly for reference, when information is sought as to the strength, hardness, cupping quality, etc., of the alloys with which it deals.

(2) The latest report of the Alloys Research Committee is of a very different standard. The recent work carried out at the National Physical Laboratory has led to the preparation of several new alloys of technical importance, the most remarkable being the alloy "Y," which retains its strength and resistance to alternating stresses at elevated temperatures, and is also resistant to corrosion. This alloy contains copper, nickel, and magnesium. The report includes studies of the constitutional diagrams of several of the binary and ternary systems, and an investigation of the causes of age-hardening in aluminium alloys. In this connexion the importance of magnesium silicide as a hardening agent is shown, and the changes of hardness with time and temperature are correlated with the changes in solubility of this compound in the solid solution. The principal casting alloys are found, from measurements extending over long periods, to be stable in dimensions, and there is no doubt that these researches have added to the range of structural materials of high quality available to the engineer, and that a great future lies before light alloys, suitably heat-treated. The photo-micrographs illustrating the volume are remarkably clear, and their beauty will be appreciated by all who have had occasion to prepare these alloys for examination. C. H. D.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. E. Abderhalden. Abt. V: Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus. Teil 3A, Heft 3, Lieferung 69: Entwicklungsmechanik. Pp. 441–538. 630 marks. Abt. IX: Methoden zur Erforschung der Leistung des tierischen Organismus. Teil 1, Heft 2, Lieferung 71: Allgemeine Methoden. Zoologische allgemeine Methoden. Pp. 97–438. 2160 marks. (Berlin und Wien: Urban und Schwarzenberg, 1922.)

THE number of subjects included in these two parts of Abderhalden's great "Handbuch" precludes, in a short notice such as the present, anything beyond a mention of the chief topics discussed.

Lieferung 69 is devoted to "Entwicklungsmechanik." Here Herbst discusses methods of artificial parthenogenesis; Günther Hertwig, the method of irradiation of the germ-cells by radium and Röntgen rays; Romeis, the technique of investigations on the action of organic extracts, such as muscle, thyroid, and suprarenal extracts, on invertebrates, anuran tadpoles and urodele larvæ; and Braus, the methods of tissue cultures *in vitro*.

Lieferung 71 is more extensive. Przibram is responsible for a chapter of about 90 pages on "Living Material for Biological Investigations." In this he considers the choice of species to be employed in biochemical researches, how and whence to obtain them, their transport and maintenance, the terrarium, the aquarium (including the setting up and aeration of seawater aquaria), and the insectarium. In addition, there is given some account of the application of chemical agencies, the means of obtaining and maintaining various degrees of moisture and of pressure, the application of mechanical agencies, and the alteration of the action of gravity. The subjection of the animals to the action of electricity and of magnetism, the application of heat and of light (measurement of the degrees of light, coloured light, ultra-red and ultra-violet rays), and the isolation and marking of the subjects of the experiments are also dealt with.

Two sections of 40 pages each are devoted to methods of preservation of zoological preparations and to zootomical technique. The methods of reconstruction by means of wax or paper plates are fully explained, while shorter but useful sections deal with the preparation of simple text-figures by the author, and with the production of transparent museum preparations.

Oxidations and Reductions in the Animal Body. By Dr. H. D. Dakin. Second edition. (Monographs on Biochemistry.) Pp. ix+176. (London: Longmans, Green and Co., 1922.) 6*s*. net.

THE complex chemical compounds taken as food by animals are not brought by a single reaction of oxidation to their final states of water, carbon dioxide, and urea. They pass through many intermediate stages, which are of great interest and importance, not only from the purely chemical aspect, but also on account of the fact that many of them play a part in the production

of substances which have a profound influence on physiological processes. It is the object of Dr. Dakin's monograph to describe these intermediate stages, and the reader may be satisfied that he will obtain the latest information on the subject. The book is to be highly recommended. It has a good index and a complete bibliography. The section on carbohydrates has been almost entirely rewritten since the previous edition. The description of oxidations which can proceed with the aid of water without free oxygen is of interest in itself, but such processes are of subsidiary importance in the higher animals, since these cannot exist without free oxygen.

With reference to certain views held as to the significance of catalase, the author concludes that there is no evidence that this enzyme has any connexion with oxidation; it may, however, be of use in decomposing excess of hydrogen peroxide, produced in the course of autoxidation, into inactive oxygen. The author points out that he is not concerned with the thermodynamics of the various reactions, nor with the catalytic mechanisms by which they are brought about, although he devotes a few pages to autoxidation and the peroxide systems, and to the important glutathione system of Hopkins. This omission is not to be regarded as a serious defect, because the object of the monograph is of a different kind. It reminds us, however, that there is an urgent need for a monograph dealing with the thermodynamics and general physical chemistry of the oxidation mechanisms of the living organism. W. M. B.

A Treatise on the Integral Calculus: with Applications, Examples, and Problems. By J. Edwards. Vol. 2. Pp. xv+980. (London: Macmillan and Co. Ltd., 1922.) 50*s.* net.

IN the second volume of his large treatise on the integral calculus, Mr. Edwards deals with multiple integrals, gamma functions, Dirichlet integrals, definite integrals in general, contour integration, elliptic functions, the calculus of variations, Fourier series and integrals, mean values and probability, and the harmonic analysis. The volume contains an immense collection of formulæ and questions extracted from examination papers and from the older literature of the subject, which may prove useful for reference to the sophisticated reader, but are more likely to repel than to inspire the students for whom the book appears to be intended.

Mr. Edwards is confessedly out of sympathy with modern tendencies in mathematical education, and thinks that students do not learn enough skill in manipulation. He prefers that they should devote their energies to acquiring proficiency in methods which are in many cases obsolete, rather than that they should obtain the same results by a systematic application of a few powerful general theorems. This tendency is particularly obvious in the chapters on definite integrals and on elliptic functions. In consequence, that residuum of problems for which the older methods are still the most suitable receives rather less than justice. His use of the methods of differentiation and integration under the integral sign, change of the order of integration, etc., is uncritical, and is not likely to conduce to clear thinking on these important subjects. His definition of a function of a complex variable is unsatisfactory, and entirely misses the point in failing to emphasise the crucial importance of the existence of a unique derivative. In the bibliography of the chapters on the calculus of variations he refers the reader to a number of obsolete treatises, but ignores the important modern works of Hadamard and Kneser.

The teacher of to-day may use this work for reference himself, but he will scarcely wish his pupils to make their first acquaintance with the processes of analysis from its pages. E. G. C. POOLE.

Farm Buildings. By W. A. Foster and Deane G. Carter. (Agricultural Engineering Series.) Pp. xv+377. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 15*s.* net.

THE little work under notice is intended to guide the American farmer and agricultural student in designing and constructing farm buildings. It is stated that farm buildings have had their most rapid development in America in the years since 1910. Prior to that one could, and indeed still can, find the early buildings put up by the first settlers, made of logs, if trees were abundant, or of sods or boards if they were not, as happened on the prairies. Now, however, these rough constructions have largely disappeared, or remain only as stores of subsidiary importance, and their place is taken by large new and characteristic-looking structures of steel and concrete. The change is not only one of convenience: it represents a great saving on the farm. It is estimated that at least 100,000,000 dollars is lost annually to American farmers through depreciation of farm machinery due to lack of proper housing; that 200,000,000 dollars are lost annually owing to the consumption of badly stored food by rats; and further, that considerable increases in milk and meat production could be obtained if the animals were better housed.

The authors discuss the best types of barns, stables, cowsheds, pigstyes, etc., and give many illustrations showing how to adapt the design to the available situation or space, and what materials should be used in construction.

The English agricultural student will find the volume of particular interest for its sections on silos, pigstyes, and cattle-sheds, and for a fund of information showing how the American farmer, suffering from even greater shortage of labour than his British confrère, has nevertheless succeeded in putting up buildings of undoubted utility.

British North Borneo: An Account of its History, Resources and Native Tribes. By Owen Rutter. Pp. xvi+404+plates. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 21*s.* net.

ALTHOUGH Sir West Ridgeway, the chairman of the British North Borneo Company, contributes a preface to this volume, it is in no sense an official publication. This will be appreciated by those who are conversant with recent criticisms of the company's methods of administration. The author is both fair and unbiassed.

The story of North Borneo is not without stirring incident. In the last century its coast was infested with pirates, whose extermination was first undertaken seriously in 1845 at the instigation of Rajah Brooke of Sarawak. Their subjugation was completed only in 1879, the year the British North Borneo Company was

formed. Of the numerous native risings with which the company has had to deal, the most formidable was that headed by the redoubtable Mat Saleh, who was defeated and killed in 1899.

Mr. Rutter gives a very complete account of the geography and economic resources of the country, of which, however, the greater part is still undeveloped. The native population offers many points of interest to the ethnologist. The Dusuns and Muruts, the up-country agricultural population, are of Indonesian stock. The coastal peoples, Bajau, Illanun, and others, represent an incursion of Malayan stock. The latter are Mahommedans, while the former are pagan. A remarkable feature in the religious beliefs of some of the Dusuns is the cult of the sacred jar, in each of which a small company of relatives has a joint ownership.

Incandescent Lighting. By S. I. Levy. (Pitman's Common Commodities and Industries.) Pp. x+129. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

THE author has produced an interesting and well-written book which gives a good historical account of the development of artificial lighting; particular attention being given to incandescent lighting. A chapter is devoted to the growth of the rare earth industry. The dramatic discovery of rich deposits of monazite in the British Empire, and notably at Travancore in India during the War, was a great help to this country; the sands at Travancore contain more than 45 per cent. of monazite. The processes of extracting pure thorium compounds from monazite demand great ingenuity, and they are well described. Descriptions are also given of the recent great improvements in the manufacture of incandescent mantles. The author gives a very fair comparison of the costs of oil, gas, and electric methods of lighting. The average candle-power (formerly called the mean spherical candle-power) should, however, have been taken as the basis of the comparison and not the mean horizontal candle-power.

Lubrication and Lubricants: a Concise Treatment on the Theory and Practice of Lubrication; the Physical, Chemical, and Mechanical Properties and Testing of Liquid and Solid Lubricants; with Notes on Recent Developments and Examples from Practice; for Engineers, Chemists, and Students. By J. H. Hyde. (Pitman's Technical Primers.) Pp. x+114. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

ALTHOUGH very uneven, the little book under notice is interesting. The definitions are usually rather carelessly given, if at all. Thus, in the chemical section (which is not very satisfactory) neither the iodine nor the acetyl value is explained, although both are quoted. Langmuir's name is incorrectly spelt throughout the book. The chapter on recent developments is of interest, and deals among other matters with the variation of efficiency with temperature and the effect of adding vegetable to mineral oils. We have previously commented on the very ambitious titles of the small books in this series; the remark applies in the present volume, and any one who expects what he might from the title will be disappointed.

Molybdenum Ores. By Dr. R. H. Rastall. (Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire.) Pp. ix+86. (London: J. Murray, 1922.) 5*s.* net.

THE molybdenum minerals, their origin and mining, are dealt with, and an account of the metallurgy of molybdenum is also included in this work. The account of the electrical treatment on p. 5 does not seem complete, as no mention is made of the furnace charge. The sections on the sources of supply appear to be exhaustive, nearly every reported occurrence of molybdenum being mentioned, together with the production, if any. The table on p. 12 indicates that the demands for the metal are limited; the production in 1918 was equivalent to about 800 metric tons of metal; that in 1921 was only 7 tons. The principal use is in the preparation of special steels; a lower amount of molybdenum will replace tungsten in a high-speed tool steel, and a small amount of molybdenum is said to improve a mild structural steel.

History of Chemistry. By Dr. F. P. Venable. Pp. vii+169. (London and Sydney: D. C. Heath and Co., 1922.) 5*s.* net.

DR. VENABLE'S "History of Chemistry" is a second edition of a book that appeared in 1894. A history of chemistry which contains no illustrations or diagrams, and in which formulæ are used only in the few passages where their historical development is under consideration, must be subject to serious limitations and in the nature of things cannot be much more than a sketch. It is not quite clear to the reviewer what type of reader will be attracted by such a sketch; but it is likely that the well-read student of chemistry will find some interest in this brief outline, and may be led by it to follow up the history of his science in some volume in which more details are given.

The Elements of Scientific Psychology. By Prof. Knight Dunlap. Pp. 368. (London: Henry Kimpton, 1922.) 18*s.* net.

THE author has here produced one of the best and most useful of the many text-books now available on psychology. He is a good experimentalist, and is thoroughly alive to the importance of a knowledge of physiology to the psychological student. He shows himself able at the same time to maintain a distinctively psychological point of view. The main faults of the book are that it attempts to cover too much ground, and that occasionally it presents, as text-book material, conclusions which require to be subjected to much further research.

Grundzüge einer Physioklimatologie der Festländer. Von Dr. Wilh. R. Eckardt. Pp. v+123. (Berlin: Gebrüder Borntraeger, 1922.) 4*s.* 6*d.*

DR. ECKARDT has produced a useful little book, which aims at giving an outline, according to the most recent investigations, of the distribution of temperature, pressure, and precipitation in the main land-masses. Particular attention is paid to Europe. There are a number of sketch maps and diagrams, and a short bibliography. The book gives in a convenient and authoritative way information that is not generally accessible in a collected form. It should prove very acceptable to students of geography.

Letters to the Editor.

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

The Wegener Hypothesis of Continental Drift.

THE chief value of the discussion on the Wegener hypothesis is that it has given rise to a reconsideration of the problems presented by the configuration and relations of the major features of the earth's surface.

The elaborate structure of theory built up by Dr. Wegener, and so effectively criticised by Mr. Lake (see NATURE, February 17, p. 226), will have few, if any, thorough-going defenders in this country, but some of its leading features cannot be lightly dismissed. Mr. Crook (NATURE, February 24, p. 255) has recalled to our notice the suggestions put forward by Osmond Fisher, and later by W. R. Pickering, that the separation of the moon from the earth, which Sir George Darwin believed to have resulted from tidal action, took place in the region now occupied by the Pacific; that our satellite took with it three quarters of the earth's crust, and that the remaining quarter, from which our continents trace their descent, has since split up into fragments which have drifted apart over the heavier fluid magma below, leaving channels between them, the most important of which is now the Atlantic Ocean. Here we have an interesting approximation to certain of the assumptions of the Wegener hypothesis; but both Osmond Fisher and Pickering, it will be noticed, considered the separation of the continents to be the result of a general drift towards the Pacific. In this they differ from Wegener, who attributes it to a varying lag of the earth's crust relatively to its interior, so that one portion became separated from another.

If the former view is well founded there should be a certain amount of symmetry about an equatorial diameter drawn to the centre of the Pacific from its antipodes in Africa. It is therefore interesting to note that Prof. Sollas in a communication to the Geological Society in 1903 (Q.J.G.S., vol. 59, pp. 184-8) declares that "an axis of terrestrial symmetry" "passes through the middle of Africa on the one side, and the Pacific Ocean on the other," a depression in the Pacific corresponding to a dome in Africa. He is inclined to accept Osmond Fisher's hypothesis, that the Pacific owes its origin to the birth of the moon, and suggests that the African dome represented an unsuccessful attempt on the opposite side of the world to give birth to a second satellite. This symmetry is, it is true, obscured by the east and west folding, which is such a frequent feature in the earth's crust, and is attributed by Wegener to a drift away from the poles towards the equator, but is not improbably the result of a movement from the equatorial region to the poles due to the slowing down of the earth's rotation and consequent decrease of the ellipticity of its figure and of the equatorial protuberance.

Like Mr. Crook, Prof. Sollas follows Suess in believing that the Atlantic owes its origin not to continental movement but to the foundering of the tract which it now occupies. My principal object in writing is to point out that the hypothesis of the drifting apart of North and South America from Europe and Africa is quite consistent with that of a subsidence and submergence of a great part of the ocean area that now separates them; and that the latter is in fact the consequence of the former.

The evidence, based on similarity of lithological characters and fossil contents of the rocks, that South America east of the Andes and the Falkland Islands were once in much closer proximity to Africa, is to my mind conclusive, and scarcely less is that of a former association of a great part of India and of Australia with Africa. There seems, too, every reason to believe that, although masked in places by other tendencies, there has been a general movement of the lighter continental crust or Sial from Africa towards the Pacific. This appears to be a drift from a region of a comparatively low gravity to one of higher gravity.

As we have seen, Wegener and others believe that the earth's crust lags behind the solid core as a result of tidal retardation, and that this lag varies from point to point. If this is the case, the folded mountains that have their roots deep in the earth's interior will, no doubt, have a smaller lag than other portions of the earth's crust, and therefore, as Prof. Joly suggests, a relative movement from west to east. How far such movements are of importance it is at present impossible to say.

Whatever may be the ultimate causes of the relative movement of continents, they can only be effective when they operate in a direction in which the earth's crust does not possess sufficient rigidity to oppose them. We can no longer suppose that there is a fluid substratum to the earth's crust. It is probable that the solid crystallised zone below the oceans is usually fifteen to twenty miles in thickness, and at those depths the enormous pressure of 90 to 120 tons to the inch will give a comparatively high rigidity at the temperature of about 800° C. that may there prevail, even to an uncrystallised magma. Where, however, a great thickness of sediment has accumulated in the neighbourhood of a continent on a sea-bottom, it will—as Dana was the first to point out—by acting as a blanket, cause the temperature of the rocks beneath to rise and become less rigid, especially if they are basic in composition. In this rise of temperature, Prof. Joly believes radioactivity plays an important part. At the same time the area concerned will sink slowly to satisfy the requirements of isostasy, forming a trough parallel to the coast line. If a period of compression in a direction at right angles to the coast supervenes, the rocks will yield to it and the trough will be laterally compressed and deepened while the sedimentary accumulations are thrown into folds. In this way the land masses surrounding the Pacific have been enabled gradually to advance inwards from its circumference, their progress being marked by folded mountain ranges. Yet the Pacific, as a whole, apart from the marginal portions, being comparatively free from sedimentation, has preserved its rigidity and successfully resisted compression.

On the other hand, there seems reason to believe that Africa is in the main the centre of a region of tension, due to the outward drift of continental masses in the circumstances already described. It is obvious that the separation caused by such a movement must involve a deficiency of material in the separating tract, and a loss of stability on the margin of the separated masses. Sometimes the blocks into which they are divided by jointing will fall forward one upon another like a succession of bricks and so give rise to a number of faults dipping away from the rift. Examples of this are seen in Skye and Caithness. More usually the slow subcrustal movement towards the line of fracture will carry the solid crust with it. The result will be a series of faults hading towards the region of tension and with a downthrow in that direction. In North Devon and Cornwall I have shown that there is evidence that there has been a general debacle of the rocks towards the west in Tertiary times. North-west and south-east faults occu- every few yards with a considerable hade to the south-

west; but the slickensides show that the movement was oblique, partly down the fault planes and partly parallel to the strike of the faults to the north-west, the latter component being the more important, so that the total movement to the west must have been considerable. At the same time there has been a general tilt of the country in that direction. I am given to understand that somewhat similar faulting occurs in the South of Ireland, and, no doubt, it exists elsewhere on the eastern shores of the Atlantic. The total westward movement visible on the land does not amount to more than a few miles, but the downward displacement that accompanied it must have resulted in the submergence of a large area to the west, and the same structures, no doubt, extend still farther in that direction under the sea. In the actual neighbourhood of the rift (to use the convenient term employed by Prof. J. W. Gregory) there may well be a complete absence of the Sial, so that the Sima would be found close below the abysmal deposits of the deep sea, as Wegener supposed to be the case. There is, however, no reason to suppose that the opposite shores of the continents represent the actual margins of the rift, and we cannot expect to find the close correspondence between them which he endeavours unsuccessfully to demonstrate. Submarine plateaus rising in the midst of greater depths may represent portions of Sial submerged between two rifts.

The solution of these problems should be regarded as an urgent task for the immediate future. There is little doubt that further information with regard to the density of rocks below the sea-bottom would result from the systematic measurement of the variation of gravity at sea with concurrent determination of its depth. The new methods that are now available are at once more rapid and more trustworthy than those previously employed, and might well be carried out either by the Navy or the great ocean liners. Valuable information, too, will be yielded by the Eötvös balance with respect to the rocks below the sea in the immediate neighbourhood of the shore.

JOHN W. EVANS.

The Function of Mendelian Genes.

IN NATURE of March 3 there appears a letter from Mr. Julian Huxley on "The Function of Mendelian Genes," in which he criticises a paragraph in a review of mine published in NATURE of January 20. As I think that the difference between Mr. Huxley and myself is due to a certain extent to a misunderstanding of my meaning, perhaps you will allow me space to make a brief reply.

Mr. Huxley's main point is that in treating Mendelian genes as measures of pathological damage to the hereditary substance, I forgot that each discovery of a presumably pathological mutant gene implied the existence of an allelomorphic normal gene in the type, and that in this way we were enabled to analyse the hereditary machinery of the type.

The paragraph to which Mr. Huxley alludes was a small item in a review devoted to vitalism. Mr. Huxley and I had a prolonged battle in *Science Progress* last year, and perhaps before long we may have another friendly encounter in the same journal. As he alludes to this contest in a footnote, I may here say that he is incorrect in stating that he forced me to admit that not all mutations were pathological. All I said was that I could not make such a universal statement without examining each case, but I may add that I have yet to meet with the Mendelian mutation which is not pathological. My answer to Mr. Huxley is that of course I recognise the existence of hypothetical allelomorphic normal genes, which taken together make up the hereditary machinery of the type, but I doubt the value of the analysis of this machinery into genes at all. The only analysis of the hereditary complex which seems to me to be at all interesting or fruitful, is its dissociation into the factors out of which it was actually historically built up. I regard this complex as the solidification, so to speak, of the reactions of the race to the varying experiences through which they have gone during past ages. New habits have been superposed on old ones, with accompanying modifications of structure; and when we have unravelled this history completely, we have given as exhaustive an account of the origin of the hereditary machinery as is possible.

The normal "gene" is an imaginary section of this machinery invented to account for the damage which a mutant gene introduces. Mr. Huxley alludes to the existence of multiple allelomorphs as *proving* that the recessive mutant gene is not the mere absence of something which we call the dominant gene. I think that a series of multiple allelomorphs inevitably suggests a graded series of varying degrees of damage, or, as we may phrase it, a series of increasing intensities of defect. Such a series is given by the mutants of the red eye of the wild Drosophila. These are listed as vermilion, scarlet, cherry, pink, eosin, cream, and white! What other plausible explanation can be given of these than the gradual disappearance of the dark red pigment of the normal eye?

One of the mutant genes of Drosophila produces a variation termed "balloon wing." In insects showing this variation the two layers of ectoderm forming the wing are widely divaricated from each other, the space between them being occupied by a bubble of air. Now there is a general consensus of opinion based on palæontology, embryology, and comparative anatomy as to the evolutionary history of insects' wings. They began as slight lateral extensions of the dorsal terga of the thorax, at first in all three segments; but later they were confined to the posterior two segments. In the beginning they served merely as parachute planes to break the fall of the insect when it leaped into the air; later, as they grew longer and flexible, they became capable of independent movement, and so developed into the varied types of wing found at the present day. On what phase, one may ask, of this history of progressive functional evolution does the existence of the balloon wing mutant throw the smallest light?

We are gradually learning to recognise that the body of an animal is built up by the co-operation of the semi-independent growths of a number of tissues and organs which, however, mutually limit and determine the extent of each other's growth. The compromise which is arrived at, is expressed in the normal specific or racial structure of the animal, and may be expressed by the term "regulatory balance." When the race is exposed to new surroundings, the regulatory balance is altered and a new race is evolved. This accounts for the fact noticed by Sturtevant that allied species differ from one another in numbers of minute points affecting all the organs of the body, whereas mutations are characterised by marked differences affecting only one or two organs. Mutations may be defined as pathological disturbances of this regulatory balance; if they are so severe as to produce a noticeable effect on the offspring when introduced by only one parent, they are dominant; if their effects are only apparent when both parents are affected, they are recessive.

Mr. Huxley's comparison of the mutant black mouse to the melanic local races of wild species is unfortunate. The black mouse (which I have often reared) is covered with a fur of so uniform colour as to make it exceptional among mammals. It may be

compared to the various melanic sports which occur in other species of mammal, such as the black leopard. I have seen a black individual among a litter of the common Canadian squirrel.

On the other hand, a melanic local race implies a new regulatory balance. As an example of the relation of racial character to the environment, I may mention the common red grouse of Scotland, supposed to be the only species of bird peculiar to Britain. In Europe there is the allied species of willow grouse, differing in having the tips of the primaries white and in turning white in winter. When a Scotch landowner imported the willow grouse he found that in two or three generations they became indistinguishable from the red grouse; and when red grouse were introduced into Norway, they reverted in a few generations to a form indistinguishable from the willow grouse.

E. W. MACBRIDE.
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March 5.

Definitions and Laws of Motion in the "Principia."

IN his recent interesting article (NATURE, February 17) on the Definitions and Laws of Motion in the "Principia," Sir George Greenhill reopens a very old discussion (NATURE, vol. 39, 1888-9). It might have been expected that the lapse of one-third of a century would have been sufficient for reconciliation of the engineer and the physicist. Every scientifically trained engineer knows, as Sir George Greenhill knows, that no confusion is introduced by the employment of a given multiplier or divisor in every term of an equation.

The only new feature now given in the mathematical discussion lies in his equation (1),

$$Wv/g = Ft,$$

in which it is insisted that the g as a divisor *must* be attached to the v and not to the W. But, in the weight problem, this merely makes the equation an identity with W = F; and, if we introduce F as a non-gravitational force, say by the use of a spring-balance, or a column of compressed air, etc., still giving t its old value, we find a different average F, and therefore a different W, at different localities. It is this local variation of W which reveals to the physicist an absence of that aspect of invariance, the existence of which he, as a scientific man, feels compelled to search for. And his search is not in vain; for he finds that, with v, t, and average or actual F (non-gravitational) all constant, W *is* proportional to g, and therefore the attachment of g to W is justified, in his belief, by Nature. In fact, he has come into contact with the *materiae vis insita*.

I have never known any student of engineering who, having first had a normal training in physics, felt compelled, in his engineering studies, to alter his ideas. He knows that his "factor of safety" in constructional details is large enough to cover such variations of g as he meets with in practice. The real quarrel (if it still exists) is only one regarding the use of the word "pound," and the context in the engineer's or the physicist's statement usually prevents confusion, even if it were not the case, as I have always found it to be, that the student of engineering is quite willing to speak, when clearness requires it, of the mass of a pound and the weight of a pound.

I do not agree with Sir George Greenhill that Mach was right in saying that Newton's Def. I. is only a definition of density. I regard it as presuming that the meaning of density is known, so that the definition is really one of the *quantitas materiae*, to which the *materiae vis insita* or *inertia massae* is proportional. It then implies the physical law that inertia is independent of the form of aggregation, and depends, for a specific material, only on the extent of the aggregation. Nor do I agree with him that Newton's use of many different words for the name of the same thing was undesirable. We must remember that Newton was the pioneer, introducing new ideas, and requiring therefore to use every form of phraseology or nomenclature that might help to make them understandable.

Sir George Greenhill disagrees with Tait, and credits him with the honour of introducing innovations. Now Tait was a modest man, and a loyalist towards Newton. He gives the honour to Newton, whose interpreter only he was. The further statements on this point made in Sir George Greenhill's second article do not alter the position.

Tait's wise words (*l.c.*) of a third of a century ago are well worth attending to to-day, apart from electrons. He said ". . . mass is the personal property of a body, one of the invariable things in nature:—and not an accidental property dependent, for its amount and even its very existence, on the momentary surroundings. The letter M has hitherto been used by Newtonians in this sense. If anyone has since attached to it another and different sense, *he* is responsible for the consequent confusion. Would it not be well if Prof. Greenhill, and the School to which he has attached himself, would kindly leave to Newtonians their M, as defined for them by their Master; and (with severely logical consistency) turn it upside down (thus, W) when they wish to embody their own revolutionary definition? No Newtonian will refuse to recognise $Wv^2/2g$ as a correct expression for so much energy:—though he will probably think it both clumsy and complex, and will prefer to write as usual his $Mv^2/2$."

W. PEDDIE.
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IN his article under the above title in NATURE of February 17, Sir George Greenhill expresses the opinion that it would be worth while to examine the previous state of the theory of dynamics to see what laws were current before the statement as given by Newton. The evidence of Newton on this point is often overlooked, though it is noted by Tait. In the scholium to Corollary VI. on the Third Law of Motion, Newton freely acknowledges the work of his predecessors.

"Hactenus principia tradidi a mathematicis recepta et experientia multiplici confirmata. Per leges duas primas et corollaria duo prima Galilaeus invenit descensum gravium esse in duplicata ratione temporis et motum projectilium fieri in parabola; conspirante experientia, nisi quatenus motus illi per aeris resistentiam aliquantulum retardantur."

In these days of the Fletcher trolley and Atwood's machine it would be interesting to know what were the experiments Newton had in mind as confirming dynamical principles. Mach has pointed out the great achievement of Galileo in arriving at the First Law of Motion, but he does not assign him credit for a knowledge of the Second Law. It is quite apparent from the above quotation that in the time of Newton there existed a tradition that Galileo's teaching of dynamics embodied the Second Law as enunciated in the "Principia." This is borne out by Lagrange in his introduction to the second part of his "Mécanique Analytique," in which he states that the Second Law is contained in the note added by Viviani at the suggestion of Galileo to the "Dialogues of Two New Sciences" (Eng. Trans. Crew and De Salvio, p. 184), deducing that the speeds falling down planes of different inclinations but of the same height are equal. In this note it is assumed as self-evident that the

accelerations of a given body are as the forces producing them. This result combined with the fact that all bodies have the same gravitational acceleration corresponds to the form ($F/w=a/g$) recommended for elementary teaching and favoured by Sir George Greenhill.

The acknowledgment which Newton makes to Wren, Wallis, and Huygens for the discovery of the laws of impact is generally known in connexion with his description of his own experiments on impact. His attitude towards these experiments is different from that of the critical exposition of dynamics of to-day, in which the Third Law is placed in the position of honour from which the Second Law is derived by observation or experiment. With Newton, however, the Third Law requires justification, as shown by the conclusion of his description of his experiments on impact, "atque ideo actionem et reactionem esse aequales."

One other extract is worthy of attention. Under Definition III. of *materiae vis insita* Newton remarks, "Per inertiam materiae fit ut corpus omne de statu suo vel quiescendi vel movendi difficulter deturbetur." This objective view of inertia is better adapted for the general qualitative introduction to inertial mass than the innate view consequent on an initial statement of the First Law. This objective view frequently finds expression in elementary text-books, but might receive greater emphasis in view of the electromagnetic theory of inertia, and the initial discrimination between inertial mass and gravitational mass forced on us by the modern theory of relativity. The quantitative definition of mass as a measure of inertia merely interprets "difficulter deturbetur" in terms of acceleration. We may say then, as a preliminary to a more exact definition, mass is a measure of the difficulty of accelerating a body.

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The Resonance Theory of Hearing.

I HAVE been reading with great interest various accounts of ingenious models made to illustrate the resonance theory of hearing, but I have been unfortunate enough to miss any clear reference to any structure in the cochlea which could respond on a physical basis to all vibrations which are capable of being appreciated by the human ear, or rather nervous system.

I have before me a pianoforte with a register of seven octaves, containing wires which vary from about 150 cm. in length and more than 0·4 cm. in diameter to wires 10 cm. long and tightly stretched. If the range were continued to the eleven possible octaves the extreme dimensions would be proportionately modified, being lengthened in the one case and shortened in the other. This, I take it, is the best pianoforte manufacturers can do, and that if they could have used shorter or finer wires they would have done so.

Let us turn then to the human cochlea and form some idea of its dimensions relative to such an instrument. It consists of a tube coiled two-and-a-half times, about 35 mm. in length, and varying from 4 mm. to 1 mm. in diameter. The total cubic contents of the cochlea, according to Sir Arthur Keith, are 70 cubic mm. The third canal of the cochlea has a diameter varying from 0·5 mm. to 0·8 mm. The basilar membrane has, according to Keith, a diameter varying from 0·17 mm. to 0·4 mm., with an average area of 13·2 sq. mm.

If the cochlea as a whole be considered, it can be likened in size to a stout silk thread 35 mm. in length. If the third canal of the cochlea alone be considered it can be likened to a silk thread 35 mm. in length, with an average width of 0·5 mm.

How is it possible to imagine structures of this order of magnitude capable of differential resonance to the vibrations of sound? From the ability of the investigators who have been dealing with the problem, I am certain that such an elementary difficulty cannot have escaped them for a moment, but I shall be grateful to any physicist who will throw light on a problem which is as difficult as it is fascinating. If the presence of anatomical resonators capable of responding to vibrations of the varying length indicated can be demonstrated, the resonance theory can well be considered. Otherwise it must be abandoned.

JAMES W. BARRETT.

105 Collins Street, Melbourne,
January 5.

SIR JAMES BARRETT'S letter expresses a difficulty in the way of acceptance of the resonance theory which I believe to be more generally felt than perhaps any other, namely, the difficulty of conceiving that a structure so minute as the cochlea, which may be compared in size to a small split-pea, can contain a series of resonators capable of responding to some 4000 separate tones extending over about 11 octaves. When we compare the suite of strings of a piano, which will respond only to 85 separate tones in 7 octaves, although they occupy with their case a space of 10 to 15 cubic feet, and weigh several hundredweight, the whole conception seems indeed bizarre and absurd.

This difficulty may be considered under two headings:

(1) How to account for the minuteness of the scale.

(2) How it is possible to have such a wide range of tones within so small a cubic space.

(1) *Scale.*—If it be granted that we are to look for our resonating elements in the transverse fibres of the basilar membrane, the scale of the cochlea will be determined by the length of these fibres. This again will be determined by the formula

$$\text{Number of vibrations per sec.} = \frac{1}{2 \times \text{length of string}} \sqrt{\frac{\text{tension in dynes}}{\text{mass of unit length of string}}}$$

or

$$n = \frac{1}{2l}\sqrt{\frac{t}{m}}.$$

It is obvious that in this formula, for any particular value of n, l can be given any value we choose by assigning suitable values to t and m. Theoretically, there is no reason why the resonators should not be 10 or even 1000 times smaller than they are in the cochlea. Practically, the limits of what is possible are set by the strength, fineness, and flexibility of the materials available. The particular factor which renders this extraordinary reduction of scale possible is, that in the cochlea the factor m is large out of all proportions with what obtains in any of our stringed instruments. This result is attained by the beautiful mechanical device of loading the strings each with a definite mass of cochlear fluid.

(2) *Differentiation.*—The fibres of the basilar membrane are differentiated for length, tension, and mass just as are the piano strings. Accepting Keith's measurements, the differentiation for length is sufficient to account for $1\frac{1}{2}$ octaves; that for mass (as determined by the "fluid load") for about $2\frac{1}{4}$ octaves. The remaining six to seven octaves of the audible scale must be due to variations of tension, as applied by the spiral ligament. This means a proportion of something like 1 to 5000 or 10,000 between

the lowest and highest tension. In a good section of the cochlea the spiral ligament will be seen to exhibit a progressive differentiation in bulk and closeness of texture not inconsistent with such extremes of tension. Further, the upper and lower limit of tension can be roughly calculated, and the resulting values are possible ones. The highest is only about a quarter of the breaking strain of tendinous structures of the same fineness.

Helmholtz recognised quite clearly the bearing of the " load " on the basilar fibres in rendering possible the small scale of the cochlea, though he failed to realise the *progressive differentiation* of the fibres for mass thereby effected. He says, " That such short strings should be capable of corresponding with such deep tones must be explained by their being loaded in the basilar membrane with all kind of solid formations ; the fluid of both galleries in the cochlea must also be considered as weighting the membrane, because it cannot move without a kind of wave motion in that fluid " (second English edition translated by A. J. Ellis, p. 146).

No doubt if Helmholtz had known the anatomical structure of the spiral ligament, which was described by Albert Gray in 1900, the whole mechanism of the cochlea would have been clear to him.

GEORGE WILKINSON.

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Stirling's Theorem.

IN starting from $dn = 1$ and then making dn infinitesimal, Dr. Satterly's demonstration in NATURE of February 17, p. 220, is scarcely convincing, and the error introduced by this step is represented in his answer by the absence of the factor $1/\sqrt{n}$ or the term $\frac{1}{2}\log n$, neither of which is entirely negligible when n is large. I suggest the following adaptation of his proof, which avoids, I think, the inconsistency referred to above.

$$\text{Log } \underline{|n+1} - \log \underline{|n} = \log (n+1).$$

$\therefore$ by Taylor's theorem

$$(\mathrm{D} + \mathrm{D}^2/\underline{|2} + \ldots) \log \underline{|n} = \log n + 1/n + \ldots$$

all terms on the right being negligible after the first when n is large.

$$\therefore \log \underline{|n} = \frac{1}{\mathrm{D} + \mathrm{D}^2/\underline{|2} + \ldots} \log n$$

$$= \frac{1}{\mathrm{D}} (1 - \mathrm{D}/2 + k\mathrm{D}^2 +) \log n$$

$$= \int \log n \, dn - \tfrac{1}{2} \log n + k/n + \ldots$$

$$= n \log n - n - \tfrac{1}{2} \log n + \mathrm{C}.$$

The constant can readily be evaluated by the use of Wallis's expression for π.

JAMES STRACHAN.

20 Woodside Terrace, Darlington,
February 23.

Echinoderm Larvæ and their Bearing on Classification.

THOUGH loth to prolong this discussion, I wish, in fairness to Dr. Mortensen and myself, to say that I did not accuse Dr. Mortensen of regarding the echinoderm metamorphosis as a case of metagenesis. What I did write in NATURE for December 8, 1921, seems to agree entirely with Dr. Mortensen's statement on March 10, 1923—a statement accepted by Prof. MacBride.

Against Dr. Mortensen's view, that the sucking disc of Brachiolaria is a relatively recent acquisition, Prof. MacBride would cite me as in substantial agreement with himself (NATURE, January 13). That agreement extends to our common belief that all groups of echinoderms have passed through a fixed stage at some time in their ancestral history. On the precise relation of that fixed stage to the adult structure in the case of the starfish, we do not agree. Dr. Mortensen, it appears, is one of those who support my particular view. The sucking disc of the Brachiolaria has certainly been regarded by me, as by Prof. MacBride, as confirmatory evidence of the general theory. But if, as Dr. Mortensen now suggests, it be a secondary development, the theory does not necessarily fall, and Dr. Mortensen distinctly says that it does not. On the other hand, assuming Dr. Mortensen to be correct in his assertion that the forms with such a larva are only the more specialised, the sucker may none the less perpetuate an ancestral structure.

Until the geological history of the starfishes has been more fully worked out along the lines followed by Dr. W. K. Spencer, it is safer to express no opinion on the classification of the forms now living.

F. A. BATHER.

March 11.

Constitution of Black Maketu Sand.

WE have made a careful chemical and X-ray analysis of the black sand from Maketu, N.Z., from which Dr. Alexander Scott believed he had isolated the oxide of a new element. We are able to confirm Prof. Bohr's conclusion that no new element is present.

Starting with 1000 grams of material free from silica, and insoluble in sulphuric acid. Fusion with sodium bisulphate did not bring this into solution, thus confirming Dr. Scott's experience, but it is interesting to note that on fusion with *potassium* bisulphate the residue went into solution completely, and was found by both chemical and X-ray analysis to consist of about equal parts of iron and aluminium. Prof. Bohr found an appreciable quantity of titanium in the residue, while we found no more than a trace ; but as our residue was only 0·2 per cent of the ore our extraction was probably more complete.

C. J. SMITHELLS.
F. S. GOUCHER.

Research Laboratories,
General Electric Co., Ltd.,
Wembley, March 8.

Scientific Periodicals for Czech Students.

I HAVE recently received a most earnest and pathetic request from a group of Czech students at the University of Prague asking me whether this Society could send them an English scientific periodical. Unfortunately we have no funds for this, but it has struck me that it might be possible for some of your subscribers, who perhaps do not have their copies of NATURE bound, to let me have them to send to these students. It would be a really kind and charitable act, and would be helpful in promoting the good feeling between ourselves and the Czecho-Slovaks, which is so useful at the present time.

If the papers were to be sent from London, I could arrange to call for them at stated times, so that no trouble of packing or postage would be involved.

B. O. TUFNELL.

The Czech Society of Great Britain,
Kensington Palace Mansions, W.8, March 2.

The Egyptian World in the Time of Tutankhamen.

By Dr. H. R. HALL.

THE name of Tutankhamen, king of Egypt, whose reign may with comparative certainty be placed in the decade 1360–1350 B.C., is now a household word, and is probably known to many who have never heard of Thothmes or Rameses. The discovery of his tomb at Thebes by Lord Carnarvon and Mr. Howard Carter, with its wealth of funerary furniture and the magnificent state which probably enshrines the actual body of the king, has made Tutankhamen familiar to all; so that, at any rate for the time, we regard him as the typical Egyptian pharaoh of his age. But, as a matter of fact, he was an ephemeral and undistinguished monarch personally, and his short reign is only remarkable for one fact, the return of Egypt to the polytheistic faith of her forefathers after the short episode of the Disk-worshipping heresy of his father-in-law, Akhenaten, the artist, poet, and pacificist, one of the most extraordinary figures of the ancient world.

Akhenaten is the outstanding figure of his century, but he, again, is not the typical great king of his time: it is his father, Amanhatpe or Amenhotep III., the Memnon of the Greeks, who can rightly claim that position. Akhenaten was too strange and unconventional a figure. Tutankhamen began by following the heresy of his father-in-law, but in his day the reaction came, and the great god Amen of Thebes, king of the gods and head of the imperial pantheon, returned to his own. It is probably on this account that Tutankhamen was buried in the magnificent splendour that we see: Amen-Ra and his triumphant priests saw to it that the returned prodigal received fitting burial, with all the provision that the old religion could give him to ensure his dignity and well-being in the next world.

It is at the moment of his return to the national religion's fold that we survey the state of the world as known to the Egyptians, for to go further afield would bear us into endless paths of speculation. Egypt and Mesopotamia give us the only known chronological bases for real history at this time; to go outside their world, into the Bronze Age of Western Europe, for example, would be to cast loose from the control of known dates and events and to speculate merely as to the probable growth of civilisation, not to write history.

What was the world like outside Egypt, as known to the Egyptians, in Tutankhamen's day?

About 1580 B.C. the Syrian and Canaanite invaders who had dominated Egypt for at least two centuries, the Hyksos or Shepherd-Kings, had been expelled by force, and the Egyptians, filled with the spirit of *revanche*, had in their turn imposed their rule on the lands of their oppressors. The raids of the earlier kings of the XVIIIth Dynasty, which now occupied the throne of Thebes, had crystallised under Thutmases, or Thothmes, III. into a settled policy of conquest and empire, and Amenhotep III. was the undisputed ruler of Syria, Palestine, and Phœnicia.

These countries were regarded by the kings of Babylon and Assyria as the rightful domains of the king of Egypt, their peoples as his subjects. He was their lord in peace and war. Egyptian residents and generals controlled the native princes. The Egyptian frontier ran from the Amanus and north of the Aleppan district to the Euphrates near Carchemish, and thence down the river for some distance, till it turned off and ceased in the undefined wastes of the desert, reappearing at the head of the gulf of Akabah, in the land of Edom. The great historical cities of Syria, Aleppo, Carchemish, Damascus, and Jerusalem; the Phœnician cities of the coast from Arvad in the north, past Byblos, of old an Egyptian centre, Tyre, and Sidon to Akko in the south; the towns of the Philistine coast, from Dor to Gaza; had already existed for centuries. But though the Phœnicians were there, the Philistines were not yet in the land which afterwards bore their name, Palestine. They did not arrive in Canaan till nearly two centuries later.

Outside the Egyptian border to the west, in the days of Amenhotep III., the ancient kingdom of Babylonia existed in august but somewhat faded and inert majesty, as old as Egypt and as proud, but weak and querulous, trusting to the power of old renown as her protection against attack rather than to warlike prowess. Officially she now bore the name of Karduniyash, an appellation given her by the kings of her foreign Kassite dynasty, a race of conquerors, probably of Indo-European origin, who had come from beyond the Zagros some four centuries before.

North of her, on the Tigris, was Assyria, also an ancient power, but younger; Babylonian in culture, but more purely Semitic in race; and rejecting the claim to suzerainty which Babylon sought to impose on her. To the west of Assyria was the ill-defined kingdom of Mitanni, the land of Northern Mesopotamia between the Khabûr, the Euphrates, and the mountains of Diarbekir, inhabited by an intrusive race of uncertain origin ruled by kings probably, like the Kassites, of Aryan origin.

Farther west, beyond Taurus, was the confederation of tribes of the Anatolian Hittites, who owed allegiance to an overlord, the "Sun" of Khatti, reigning in central Anatolia, at a city represented by the modern Boghàz Köi, east of the Halys. The ancient Semitic population of Cappodocia no longer existed, having been destroyed or expelled by the Hittites.

Hittite tribes had already crossed the Taurus, inhabited the districts of Aleppo and Carchemish, and had even pushed outposts down as far south as Palestine, where they lived under Egyptian rule, side by side with the Canaanites and with Aryans from Mitanni.

South of the Anatolian Hittites was Cilicia, inhabited by a kindred race, of whose culture we know little, but that it owed much, probably, both to the Hittite and to the Syrian.

The island of Cyprus, the people of which also were racially related to the Anatolians, probably, had recently been conquered by Ægean tribes from Rhodes and Greece itself, who brought with them the Mycenæan culture, now beginning in Greece to take the place of the Minoan civilisation of Crete from which it was derived. The Minoan civilisation was now eclipsed on account of the collapse of the dominion of Knossos, which had sent ambassadors to Egypt in the days of Thothmes III.

This was, leaving out of account the Sudan in the south and the wild Libyan tribes to the west, the world as known to the Egyptians. Of Italy, they probably had as yet no knowledge.

Towards the end of the reign of Amenhotep III. a revolution broke out in Syria and Palestine. Shubbiluliuma or Suppilulius, king of the Hittites, a monarch full of guile, aspired to oust Egypt from the control of Syria and to destroy Mitanni. He found tools ready to his hand in certain discontented and rebellious Amorite princes of the Lebanon and in the Phœnicians of Arvad, and stirred up strife. Amenhotep quelled the revolt for a time, but it broke out again, and when his extraordinary son, Akhenaten, ascended the throne, the whole country seethed with turmoil.

The new king was interested only in his project of reforming the Egyptian religion; he was a man of art and of peace, and for the first time in history, perhaps, a great king refused to go forth to war, and allowed his dominions to fall away from him.

Palestine and Syria were in chaos. Wandering tribes, among them those Khabiri who have been credibly identified with the Hebrews, overran the land, the Hittite princes of the south revolted, and with them certain chiefs of Aryan (? Mitannian) origin who also had settled there under the Egyptian dominion. The Canaanite chiefs and Phœnician princes who remained faithful were gradually borne down in the absence of help from Egypt, and at the end of Akhenaten's reign the whole country had fallen away from the king.

In Tutankhamen's day the great prince Huy may represent himself on the walls of his tomb, as he does, bringing Semitic chiefs to offer tribute to his majesty, but we see that this can have been but a farce: the king's writ ran no farther than the coast of the Shephelah, probably. In the north the Amorites had but exchanged one master for another, for they now became the vassals of the Hittites, albeit under a looser control than that of Egypt. The Hittite control of Syria continued unchallenged till the days of Seti I. and Rameses II., fifty years later, when Egypt essayed to reimpose her yoke on the Semites. Long wars ensued, waged directly by Egypt against the Hittites, until about 1279 B.C. a peace of exhaustion was concluded between the protagonists, a peace of which we have the full protocol, signed and sealed by the Great King of Egypt and the Great King of Khatti, couched in diplomatic and legal phraseology that might have issued from a modern chancellery. It was a compromise: of her old Asiatic dominion Egypt retained only Palestine; Syria fell to the Hittites and remained theirs till, eighty years later, the invasion of the Philistines and their seafaring allies from the North overthrew the Hittite kingdom and tore Palestine itself from Egypt.

Tutankhamen, then, was confronted across his attenuated frontier by a far more formidable foe than the Babylonian could ever be. Mitanni was gone—destroyed by Shubbiluliuma after all help from Egypt had proved vain. Assyria, trusting in the prowess of her soldiers, kept her independence of both Babylon and Khatti; Shubbiluliuma seems prudently to have let her be. Her king, Ashur-uballit, was a long-lived and probably a politic as well as a doughty ruler. Somewhat later, in the time of Rameses II., Shalmaneser, king of Assyria, was a much more powerful monarch than the Babylonian Kadashman-turgu, and it was partly in apprehension of his power, probably, that Rameses and Khattusilis, the Hittite ruler, finally compromised their differences.

The collision of different national civilisations at this time produced none of the mutual approximations that might have been expected. Only Egypt began to show signs, more accentuated later, of Semitic influence in her culture. Babylon, however, shows no signs of Egyptian influence, the Hittites perhaps a little, the Mycenæans more. But there is no landslide in any direction anywhere. Each people remained faithful to its traditions. There were colonies of Mycenæan artists, as of Semitic and even Hittite craftsmen in Egypt. But though the Egyptians prized and used Greek products, we find no direct imitation of Minoan art even in the free and untrammelled Egyptian art of Akhenaten's time, though the works of the Minoan artists must have appealed to the realistic and truth-loving king. There is no trace of Minoan or of Mesopotamian influence yet in any of the objects of Egyptian art discovered in Tutankhamen's tomb of which photographs have been published: the weird heads, for example, of one of the gilded couches that have been thought to be Mesopotamian in aspect are merely heads of the Egyptian goddess Thoueris in her fierce and typhonic character. We should, in fact, expect Mesopotamian influence less than Minoan or even Hittite. The Thoueris-head was adapted by the Minoans for the heads of their water-demons.

Such, in brief survey, are the main characteristics of the outer world known to Tutankhamen and his people, and of Egypt's relations with it.

Recent Advances in Photographic Theory.[1]

By Dr. C. E. K. MEES.

THE study of the physico-chemical relations on which depend the form in which a precipitate is produced has been developed by a number of workers in recent years, and its application to the precipitation of silver halide has been studied by Sheppard and Trivelli. In his earlier work Trivelli made a large number of photomicrographs of emulsions taken from standard photographic plates and films, one of which is reproduced in Fig. 1. It will be seen that the silver bromide grains, of which the emulsion is composed, are of very varied sizes, there being present a large number of small grains, down to the limit of those visible with a microscope, and a smaller number of large grains, including some of very much greater area than the smallest grains present. The largest grains are all polygons, with angles of 60° and 120°. There is a tendency to round off the corners and edges of the small grains, so that the smallest grains appear to be more or less spherical.

[1] Communication No. 165 from the Research Laboratory of the Eastman Kodak Company. From a lecture delivered before the Franklin Institute of Philadelphia on December 7, 1922.

A study of these small spherical grains by R. B. Wilsey, however, using the methods of X-ray crystal analysis, shows that even the smallest grains are still definitely crystalline and have the same structure as the large grains, the crystalline form being a cubic lattice.

So long ago as 1915 it was realised that the distribution of the different sizes of grains in an emulsion might play a very important part in determining the characteristics of that emulsion. The problem was to measure the distribution of the grains; that is, the number of grains of a given size which occurred in an emulsion and the variation of the number with the size of the grain. This problem has often arisen in scientific work. It has been studied in connexion with suspensions of all kinds. Various indirect methods of attacking the problem have been suggested. It is possible to get determinations by settling the emulsion, taking advantage of the fact that the larger particles will settle most rapidly according to Stokes's law, but the direct method is, clearly, to spread out

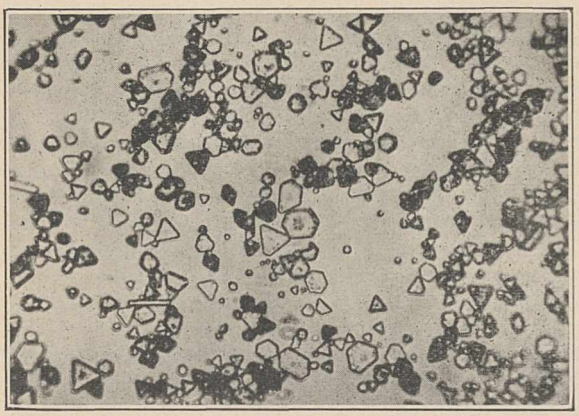

FIG. 1.

a thin layer of the emulsion and to count the different sizes of grains occurring in it. Trivelli photomicrographed a thinly coated emulsion at an enlargement of 2500 diameters, enlarged the negatives to 10,000 diameters, outlined all the grains of these enlargements, and then planimetered the grains and obtained tables showing the areas of the different grains present, at least a thousand grains being counted for each emulsion. Sheppard and Wightman obtained the same results by the use of the camera lucida instead of photomicrography. From these tables curves were obtained showing the relation between the size of grains and the number present for several standard emulsions. Fig. 2 shows the results for the portrait film and slow-lantern emulsions. It will be seen that the curve shows a distribution of sizes of grain which corresponds approximately to a probability curve, the maximum number of particles being of a diameter of approximately 0·5 μ, the particles both smaller and larger than this being fewer, until we have very few particles indeed of larger size than 2·7 μ and also few of smaller size than 0·2 μ. On this small side no particles can be measured less than 0·2 μ, because this is the limit of the resolving power of the microscope.

It is probable, however, that curves showing diameters will not be of real value, because the controlling factor will not be the diameter of the particles, but their projective area, as shown in Fig. 3.

Svedberg investigated systematically the relation between the size and sensitiveness of grains in photographic emulsions. He prepared emulsions so thinly

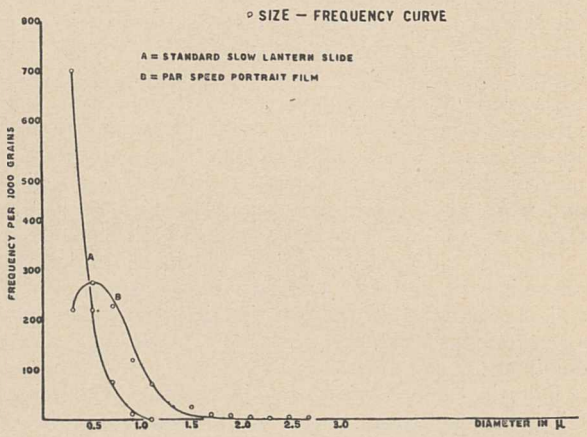

FIG. 2.

coated that the grains were all in single layers, and counted the grains of different sizes by classifying them into four classes. The emulsions were then exposed and developed, and the developed silver removed, the remaining grains, representing those which had not been made developable by the action of light, being counted. In this way curves could be obtained showing the sensitiveness of the grains of each class, and it was found, as might be expected, that the larger grains were much more sensitive than the smaller grains.

Svedberg next assumed that the product of the light action in the halide grain—that is, the substance of the latent image—consists of small centres distributed

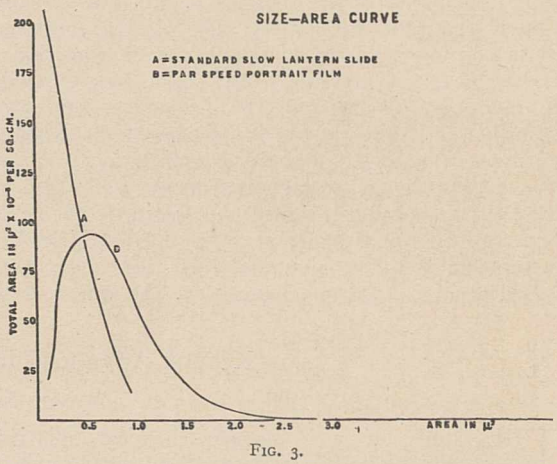

FIG. 3.

through the grain or through the light-affected part of the grain, and that these centres are distributed according to the laws of chance. If a plate be developed for a very short time the grains show these centres as small black spots upon them. This was shown by Hodgson as early as 1917 (Fig. 4).

Not only did Svedberg demonstrate the existence of these centres, but he also made plain their relation to the silver bromide grains by photographing the grains

before development by deep red light, then developing for a short time and removing the undeveloped halide. On the plate there are then left small dots, and comparisons with the first plate showed these to correspond with the silver halide grains originally present.

Svedberg has shown that the number of centres produced in this way by initial development increases with the exposure in accordance with the usual photographic laws, and it might be assumed that the discovery of these centres produced during development is a proof of discreteness in the action of light upon the grain, and that they must result from a structure in the silver bromide grains existing either before exposure or produced during exposure, and corresponding, for example, to spots of sensitiveness. While the evidence for this seems very great, it must be remembered that we know nothing about these centres until development takes place, and that even if the whole grain were equally affected by the action of light and changed to the same extent, we should still expect development to take place first at some local

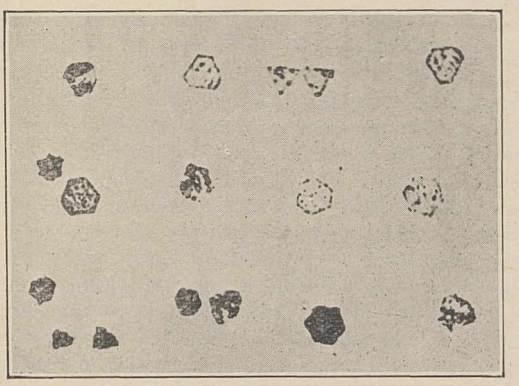

FIG. 4.

spot corresponding to slight surface differences in the grain. A sheet of metal immersed in acid, for example, will not be attacked uniformly all over the surface. Because of the impurities, action will start at individual points.

In a very important paper, Toy has given measurements showing that the number of nuclei produced on initial development are proportional to the number of grains which become developable on complete development, and that the larger grains not only have more nuclei on account of their size, but that these nuclei are also more sensitive to light than those in the smaller grains, the sensitivity of a grain being the sensitivity of its most sensitive nucleus. Svedberg considers that the number of developable centres per unit area of grain surface is a measure of the light sensitivity of the silver halide of the emulsion. From Toy's work it would seem to be doubtful whether we can speak of the light sensitivity of the halide itself in terms of the nucleus theory, since this will vary with the size of the grain.

Recently, a number of phenomena have been observed which are very difficult to explain by the use of the classical wave theory of light, and it seems not unlikely that it may be necessary to turn to a theory having some analogy to the corpuscular theory. As a first step towards this, Max Planck suggested his now well-known quantum hypothesis, according to which an atom radiating energy liberates it in discrete quanta, the amount of energy corresponding to each quantum being a constant multiplied by the frequency of the light. Bohr adopted Rutherford's theory of the structure of the atom, considering the atom to consist of a nucleus containing an electron carrying a positive charge of electricity, and to be surrounded by one or more electrons carrying a negative charge, the electrons revolving about the positive nucleus itself. He imagined that the electrons revolve without radiating, but that when an electron suffers some violent shock it gives up energy, and this energy is radiated and has the value of Planck's quantum. Thus, if an electron, by the sudden impact of another electron, for example, is thrown out of an atom and is attracted back to its place by the nucleus, then, as it falls back, it will send out a pulse of energy, and it will be seen at once that, if light is produced by such a behaviour of electrons, it is inherently probable that it will be radiated in pulses rather than continuously. Since, according to Bohr, the frequency of the vibration emitted is exactly proportional to the energy which the electron releases, Planck's quantum condition is fulfilled, and we have the famous equation,

$$Ve = h\nu,$$

where V is the voltage acting on the electron charge e, ν is the frequency, and h is Planck's constant.

In an X-ray tube the discharge of electricity is in the form of a stream of corpuscles travelling with a very high velocity, which depends upon the voltage of the electric current applied to the tube. When these corpuscles strike the target their energy is radiated in the form of X-rays, and we know that these X-rays partake very closely of the nature of light, except that the length of the waves is about one-thousandth of those of light, or, what is the same thing, their frequency is a thousand times as great. It is to this that they owe their great penetrating power.

On the classical wave theory of light, then, we should imagine that an X-ray tube having its target bombarded by the stream of corpuscles produced by the current would emit waves of X-rays spreading into space, just as waves of light are imagined to spread from a source; but now comes a great difficulty. When these X-ray waves travelling out pass through a gas and are absorbed, they cause the molecules of the gas to emit electrons, and these electrons are emitted with almost exactly the same velocity as the electrons in the tube which produced the X-rays themselves. The extraordinary nature of this phenomenon is well illustrated by Sir William Bragg in a recent article. He takes as an analogy the dropping of a log of wood into the sea from a height of one hundred feet. A wave radiates away from where it falls; the wave spreads; its energy is more and more widely distributed; the ripples die away; at a short distance, a few hundred yards, perhaps, the effect will apparently disappear. If the water were perfectly free from viscosity, and there were no other causes to fritter away the energy of the waves, they would travel indefinitely, always diminishing in their height. Now, at some point, say a thousand miles away, these now

microscopic ripples encounter a wooden ship. We should expect that they would produce no effect, especially as they may have passed many other ships without having affected them, but, for some reason, as these tiny ripples reach the ship, a plank of the same weight as the log is hurled out of the ship to a height of exactly one hundred feet, and the whole energy which was originally supplied by the log falling into the water is concentrated upon the ejection of the plank. It will be seen at once how inadequate the wave theory is to account for this phenomenon. Similar difficulties occur in connexion with photo-electricity or the liberation of electrons under the influence of light.

The method by which a photographic emulsion adds up light during a long exposure has always been a great problem when it is considered from the point of view of the classical wave theory. If we accept the idea that the grains of silver halide in an emulsion are exposed to a continuous flood of light from a distant star, for example, then each grain must be imagined to be integrating light until it has received enough to make it developable. Since the exposure required in astronomical photography is frequently very long, we must consider that the grains continue to integrate the light for many hours, and it is difficult to imagine any mechanism which would enable them to do this. The difficulty is enhanced by the fact that even a very brief exposure continues to produce an effect after an interruption of a long period, so that if all the grains have been affected by the first exposure, they must be capable of storing energy quite insufficient to make them developable and to hold this energy for a long period, and then resume its accumulation at the level where the interruption occurs. In the same way, when we study the exposure of the individual grains, even if we could imagine some mechanism by which the grains could store up the energy falling upon them until they became developable, we should expect that all the grains of the same size would become developable at the same time, unless, indeed, we assume the process of exposure to be autocatalytic in nature. When grains are examined under the microscope, however, some of them are found to have been affected before others. If we imagine that they all have become exposed to a uniform flood of light, we must consider that these grains differ in sensitiveness among themselves, and that the possibility of change on exposure, so that they become developable, is due to the presence of a sensitiser. This may be either concentrated unequally in the different grains or may form centres of sensitiveness similar to those supposed to exist by Svedberg and other workers in the field, who think that the centres found at the beginning of development are the origin of sensitiveness, and are present from the time of making the emulsion.

If we had no prior knowledge of the wave theory of light, however, it is clear that the simplest explanation of the sensitiveness of different grains would be that, instead of a continuous flow of light in the form of waves on to sensitive films, the light was falling upon it as a rain of projectiles, and that these projectiles made developable any grains that they hit, the grains that were missed not being developable, but being hit later if they continued to be exposed to the radiation. Naturally, the bigger the grains the more likely are they to be hit, so that a calculation can be made of the relation between the size and the percentage number of grains which will become developable after a given exposure.

Silberstein suggests that the projectiles, rather than being called "corpuscles," which gives the idea that they are round, should be called "light darts," and should be imagined to consist of a long train of waves of very small diameter travelling with the velocity of light.

It is obvious that this theory of light darts would meet the difficulties which are offered by the phenomena of X-rays and photo-electricity to the idea of a continuous wave front, while not excluding the possibility of the formation of interference and diffraction effects. At first sight it would seem to offer a solution of the problem of the integration of exposure by the silver halide grains of the emulsion, since we might assume that, instead of a grain integrating energy falling upon it until it had received enough to make it developable, it was not affected at all until struck by a quantum of light, and then became developable completely. If this was so, however, we should expect that the amount of energy necessary to make a grain developable would be, on the average, one quantum, and at most a few quanta, more than one being necessary because of the chance that a fresh grain would not be struck by every "light dart" falling upon the emulsion, some falling between the grains and others striking grains which were already developable.

In some work which has just been started in our laboratory we are getting results from which I think we may conclude as a preliminary statement that, for high-speed emulsions, several hundred quanta of violet light are necessary per grain in order to make the grain developable. If this is confirmed, the light dart hypothesis would seem to be scarcely sufficient by itself to explain the integration of energy by the emulsion, and we are thrown back on to the idea of differential sensitiveness among the grains, or of spots of limited area on the grains, so that of the hundreds of quanta striking a grain only one may be considered to be operative, the rest falling upon the insensitive portions of the grain. Suppose that the fraction of a grain which is sensitive is ϵ, and this consists of an average of $\bar{K}$ spots of ω area, then

$$\bar{K}\omega = \epsilon a.$$

Now, if a grain has no spots, it will be quite insensitive and will not be developable, no matter how long it is exposed, so that the value of $\bar{K}$ and ω can be determined experimentally by counting the grains left over after a very prolonged exposure.

In any case, a question of great importance in connexion with the latent image is the amount of energy required to make the silver halide developable. If the new determinations show that several hundred quanta of violet light per grain are necessary, then a revision of ideas relating to the latent image itself will follow, as compared with those ideas derived from the belief that the energy available is only one quantum per grain, in which case it is clear that the latent image must depend upon a change occurring in a single atom of silver or

halogen, since the only work we can imagine one quantum capable of doing is to release a single electron from an atom. If several hundred quanta per grain are available, then it is clear that not one atom of silver per grain may be affected, but that several hundred atoms may be changed, and that an appreciable, though very small, amount of chemical decomposition may be effected by the energy available.

More important still, quantitative differences in the amount of latent image present in a grain become possible. If only one quantum per grain is available, a grain is either exposed or not exposed, but if energy corresponding to an amount of several hundred quanta is used, we might imagine that a grain could become partly exposed, so that, for example, it might be developable by a developer of high reduction potential but not by one of lower potential. Moreover, grains might clearly be of different degrees of sensitiveness—that is, they might require different amounts of energy to make them developable—and the whole idea of quantitative differences in sensitiveness and exposure, which is so difficult if we imagine one quantum of energy per grain to be sufficient to produce a complete change in the grain which will make it developable, becomes perfectly intelligible. On the other hand, the division of the sensitive area into a number of small sensitive spots, which accords with the ideas both of Silberstein and those of other workers such as Svedberg who have located sensitiveness in "centres," would still enable us to retain the idea that a single quantum of energy is sufficient for exposure if it reaches one sensitive spot.

Obituary.

DR. JAMES GOW.

THE lamented death on February 16 of Dr. James Gow, formerly headmaster of Westminster School, and author of "A Short History of Greek Mathematics," calls for notice in NATURE. Educated at King's College School, Gow went to Trinity College, Cambridge, in 1871, and was 3rd Classic and Chancellor's classical medallist in 1875. He was elected fellow of Trinity in 1876, the year in which it was observed as a curiosity that the four fellows of Trinity then elected all had monosyllabic names and mustered no more than fifteen letters between them: Cox, Hicks, Lord, Gow. Three of them, including Gow, rowed for the historic Second Trinity Boat Club, now extinct.

Gow's mind was alert, quick, and versatile; he could have succeeded at almost anything he undertook. The son of an artist, he had himself decided talent in the same direction; he was, as an undergraduate, devoted to music. But his main work was in classics, and even there his interests were very varied. His fellowship dissertation was on the origin of grammatical gender; he edited the Odes and Epodes and the Satires of Horace; and he produced one of the most useful books ever written for schoolboys, a "Companion to School Classics"—a pioneer work which gave a lead to more ambitious and bulky handbooks since issued from the University Presses and elsewhere.

The "Short History of Greek Mathematics" is another proof of Gow's versatility. His original intention was to write a history of the city of Alexandria. He contemplated a chapter in that work which should deal with the mathematical school from Euclid to Diophantus. But this project led him insensibly to more general mathematical topics, such as the development of numeral systems, Egyptian arithmetic, Greek calculation and Greek theory of numbers, with the result that the material accumulated became too extensive for a chapter in a more general history, and he decided to make Greek mathematics the subject of a separate work. Such a book was very much wanted; here, too, he was breaking new ground. There were three recent and important German works by Bretschneider, Hankel, and Moritz Cantor, but no book in English at all comprehensive. The undertaking was the more arduous in that Gow had made no special study of mathematics since his schooldays, and it is no small proficiency in mathematics that is required for the compilation of such a history. The work proved a little uneven owing to the fact that the arithmetical portion was written on a scale too large to allow of the history of geometry being treated with equal fulness if the whole work was to be in a reasonable compass; and Gow realised that with "a history like this . . . the utility will no doubt vary as the brevity" (p. 145).

The best possible test of a book is, perhaps, the impression that it makes upon a reader who takes it up thirty or forty years after its publication. This book stands the test well. It is true that the mass of the material that must be included appeared to Gow at times to be overwhelming; for he speaks in his preface of the labour having often been dreary. But this certainly would not be gathered from the finished work, which is from first to last anything but dreary. Many things in it have necessarily been superseded as the result of subsequent researches, but the book can still be read with the same pleasure as it aroused on its first appearance. T. L. H.

REV. WILLIAM WILKS.

HORTICULTURE is the poorer by the sudden death on March 2 of the Rev. William Wilks, vicar of Shirley, Croydon, 1879–1912. The son of Dr. G. F. Wilks, born at Ashford, Kent, on October 19, 1843, William Wilks was educated at Clapham and Pembroke College, Cambridge, where he took his degree in 1864. He was intended to follow his father's profession, but forsaking that course, after studying at Wells, he took orders, and was appointed curate of Croydon in 1866. The rest of his life, except for his annual holiday on the Continent, or latterly in Scotland, was spent in that neighbourhood, and when in 1912 he resigned his vicarage he went to live and garden next door at the "Wilderness" which he had built, and where he died.

There is no need to speak here of Mr. Wilks's parish work—the concourse of local people at his funeral at Shirley showed how it was appreciated—but rather

of his work in and for horticulture. For nearly sixty years he was intimately connected with the Royal Horticultural Society. His grandfather and father had both taken a keen interest in gardening at Charing and Ashford, and the curate of Charing, the Rev. J. Dix, for some time chairman of the Royal Horticultural Society's Floral Committee, was an intimate friend of his youth. His love of Nature and gardening was still further fostered by his education under Prof. Pritchard, and by his vicar at Croydon, Canon Hodgson, so that when he went to Shirley he was well equipped to follow his bent in the large garden of the vicarage. He became a member of the Royal Horticultural Society's Floral Committee about 1880, and at the great reconstruction of the Society in 1888 he was appointed honorary secretary. He filled the post of secretary until 1920, when he retired and was elected to the council.

In 1888 the Society was in very low water; its liabilities were great, its finances low; it had less a horticultural than a social policy; it seemed doomed to early wreck, after weathering the storms of eighty-four years. With its new secretary, Sir Trevor Lawrence, Sir Daniel Morris, Sir William Thiselton-Dyer, Sir Harry Veitch, Mr. George Paul, Sir Michael Foster, Dr. Masters, and others, a determined return to a horticultural course was made, and in steering that course William Wilks took a leading part. He was a great secretary. A man of wide vision, a fine judge of men, courteous, tactful, able to bend men and things to the policy the new council had determined upon, cautious but ready to seize opportunity, loyal to his council and inspiring loyalty, ready with encouragement, kindly in restraining excess of zeal, an able organiser, under him the Society progressed from potential bankruptcy to financial prosperity, from a membership of about 1000 to more than 16,000, to the possession of its fine hall and offices, its Journal (which he edited from 1888 to 1906), its great garden at Wisley, with its school of horticulture and the development of research into gardening problems which all along he had seen to be essential to sound progress, and which, as soon as finance permitted, he fostered with all his power. His aim all through was to further British horticulture in its widest sense, and for his work for the Society, until it had been placed upon a sound financial footing, he took not even the most modest remuneration. The Society to-day is a monument to his work.

The gardens of the world, large and small, even into the Arctic regions, are the richer for Mr. Wilks's own gardening efforts, for from an aberrant field-poppy he raised the wonderful strain of Shirley poppies, and freely distributed seed every year to all comers. As with his poppies and foxgloves, he deemed no pains too great to spend upon the selection and increase of beautiful hardy things, and no pleasure to exceed that derived from sharing his beautiful things with others. His writings in the Journal were of these things. In his quiet garden he grew the choicest of hardy fruits, for he was a pomologist of no mean order, and he cared for and studied there the plants and animals it contained and attracted, with all the love of a true naturalist.

Sir Ernest Clarke.

Sir Ernest Clarke, a man of singular ability, and gifted in many different directions, was perhaps best known as secretary of the Royal Agricultural Society of England from 1887 to 1905.

Himself a Suffolk man, born at Bury St. Edmunds in 1856, Clarke had a special interest in East Anglia, and contributed largely to the enrichment of its archæology, literature, and folklore. In especial he showed himself an adept in unearthing the truth and in demolishing many of the erroneous statements that had found their way into past records. This same power marked his treatment of agricultural history and literature when, as the first Gilbey lecturer, he gave, in 1896, his series of lectures at the University of Cambridge, from which, in 1894, he had received the degree of Hon. M.A. Indeed, one may say that he was the first serious student of this subject since Arthur Young.

After service in the Local Government Board, and then as assistant secretary in the Share and Loan Department of the Stock Exchange, Clarke was selected in 1887, out of 106 candidates, to be secretary of the Royal Agricultural Society of England in succession to the late H. M. Jenkins. As secretary of the Society he distinguished himself by his great activity and powers of organisation. He had great ideals as to the position which such a Society as his should occupy as the leading authority both at home and abroad, and such he worked constantly to make it. For more than eighteen years he acted in this capacity, receiving the honour of knighthood in 1898. Later, however, came the disastrous days (1903–6) arising from the decision of the Council to abandon the peripatetic Shows and to have a permanent Show-ground at Park Royal, and this resulted in Clarke's resignation in 1905. He then returned to the City, and was associated, to the close of his active career, with various commercial enterprises.

Following on the death of his wife in 1918, Clarke was struck down with a paralytic seizure, and for the last four years of his life was unable to leave his room. But he retained to the end the clearness of intellect, and the interest in all around him, that had marked his active days.

Though he could never be called an "agriculturist," Clarke contributed largely to its history and literature, and the Journal of the R.A.S.E. contains many admirable reports of his, chiefly memoirs of noted agriculturists, such as Philip Pusey, Sir James Caird, the Duke of Richmond, etc., besides the "History of the Board of Agriculture," "Agriculture and the House of Russell," etc. To the series of King's Classics he contributed, in 1903, a new edition of "The Chronicles of Jocelin of Brakelond," an account of monastic life in the days of Abbot Samson, and he made many other contributions to archæological, historical, and folklore societies. He was an original member of the "Confrères"; and one of the "Sette of Odd Volumes"—being the "yeoman" in that body, and president in 1898. He was also a past-president of the Chartered Institute of Secretaries. Clarke was, in addition, a gifted musician, a brilliant conversationalist, and a man of much reading and wide general knowledge.

J. A. Voelcker.

Current Topics and Events.

BY Clause 9 of the "Fees (Increase) Bill," the Government proposes to confer upon the Trustees of the British Museum a power which they have never sought and which, we are certain, they do not desire—a power to charge fees for admission to the Exhibition Galleries both at Bloomsbury and South Kensington. Of course, if the power is granted by Parliament, the Treasury will take good care that the Trustees exercise it. The precise proposal is to charge a fee of 6*d*. on Monday, Tuesday, Thursday, and Friday. How much better will anyone be for this? The probable receipts seem to us to be ridiculously overestimated by the Geddes Committee, since they only allow for a reduction in the number of visitors of less than one-half. Speculation on such a matter is rather idle. We know only that a charge of 6*d*. on three week-days at the Victoria and Albert Museum brought an average yearly return of 1000*l*. Against a possible income of, say, 1200*l*., have to be set expenditure on the installation of turnstiles and a considerable diminution in the receipts from the sale of publications, which has been greatly extended of late in both sections of the Museum. But this sort of haggling is beside the mark. The condemnation of this retrograde proposal depends on no nicely calculated less and more, but on the disservice that will thereby be done to popular education in its widest and highest sense. The nation will lose and the Museum will lose, for we may be sure that gifts in money and in kind will not flow so readily to a half-closed establishment. It seems, too, as though the Government would lose whatever popular support it now possesses. The British Museum has become in a very real and living sense a national possession, and the nation will refuse to be robbed of its free enjoyment.

THE reluctance to discuss the monetary value of their services is a tradition which dies hard among the brain-workers in this country and abroad, and is in large measure responsible for the unenviable position of many salaried workers during and since the War. In the legal and medical professions, which occupy a legalised privileged position and are further safeguarded by the needs and the attitude of the community, professional unity is possible and demands for improved conditions of service and better remuneration for these classes are generally successful. The success of medical men in this country in particular has given an impetus to other professional workers towards combination, and various organisations now exist having for their avowed object the improvement of the economic position of the professional classes. In France, after approaching first the Confédération Générale du Travail, and later the General Association of Employees—both organisations of manual workers—the brain-workers have decided to form their own independent Confédération des Travailleurs Intellectuels. It is already in a position to exert considerable influence in the Chamber of Deputies and the Senate, and its success has provoked the creation of similar bodies in several other European countries. In this country there is an organisation, the National Federation of Professional Technical, Administrative, and Supervisory Workers, founded in 1920, having similar aims. Hitherto it has not been able to obtain the support of the medical, legal, engineering, teaching, or scientific associations. These may join the federation later, but, in the first instance, they will probably find it better to form their own federation. The time is certainly opportune for a movement to be made in this direction.

THE sum of 1,000,000*l*. provided for agricultural research and education under the Corn Production Acts (Repeal) Act, 1921, has now been provisionally allocated for the furtherance of various schemes, and the details are outlined in the current issue of the Journal of the Ministry of Agriculture. The suggested grants cover a wide field, and in several cases are intended to be supplemented by certain moneys raised by the institutions benefiting therefrom. Dairying, silver-leaf research, and fruit growing are to be aided in various centres by the provision of building and maintenance funds, and a scheme is under consideration for the establishment of an Animal Pathology Research Station at Cambridge University. Support is also being given to the National Poultry Institute scheme, with special provision for research in various directions, for commercial experiments and for higher instruction in poultry keeping. On the educational side additions are being made to the research scholarships and travelling fellowships, the advisory services are to be completed and strengthened, while a considerable sum has been provisionally allocated for grants in aid of capital expenditure at university departments of agricultural colleges. County agricultural education will benefit in a similar way. The approximate allocation under the above headings is as follows: Research and Advisory work, 465,000*l*.; Higher Agricultural Education, 84,000*l*.; County Agricultural Education, 170,000*l*.; Scholarships for the sons and daughters of Agricultural workers, 117,000*l*.; Miscellaneous Schemes, 74,000*l*. Some re-arrangement of the above sums may, however, prove to be necessary as the schemes are more fully investigated and begin to be worked out.

THE Retail Pharmacists' Union, in a recent announcement with regard to the subject of the accurate dispensing of medicines, describes the training required for the profession of pharmacy. The announcement is, however, headed with the words "The Chemist," and this has led Mr. A. Chaston Chapman, president of the Institute of Chemistry, to suggest again that the time has come for the pharmacist to relinquish the use of the term "chemist" in favour of those who definitely practise chemistry. Mr. Chapman points out that "the Institute of Chemistry, as the representative chartered professional body of chemists, numbers upwards of 4000 fellows and associates, whose qualification demands a four years'

university course, or the equivalent, and the majority of whom are engaged in the many branches of industry on which the science has a bearing. In other countries the strict equivalent of the word 'chemist' signifies, as it should, one who professes chemistry, and not in any case the pharmacist, druggist, or dispenser of medicines."

THE summer meeting of the Institution of Electrical Engineers will be held at Manchester and Liverpool on June 5-8. Visits have been arranged to important electrical works in the locality.

A CONFERENCE of the Women's Engineering Society will be held at the University of Birmingham on April 11-14. Particulars can be obtained from the general secretary, Miss C. Haslett, 26 George Street, Hanover Square, London, W.1.

IN the new edition of Zittel's "Grundzüge der Paläontologie," lately published, Profs. Broili and Schlosser refer to the tooth of the supposed ape-man, Hesperopithecus, from Nebraska, U.S.A., as being a problematical specimen. They state that it may perhaps be the first milk-molar of a primitive horse.

THE Geological Department of the British Museum (Natural History) has just acquired the palæobotanical collection of Dr. Dukinfield H. Scott. It comprises more than 3000 microscope slides, chiefly of British Carboniferous plants, on which most of Dr. Scott's own researches have been based. It is a direct continuation of the Williamson collection which was acquired by the Museum in 1896.

IT is stated in the *Chemical Age* of March 10, that at the annual meetings of the American Chemical Society to be held next month, Prof. F. G. Donnan and Principal J. C. Irvine will be among the British delegates. The subjects for discussion will include motor fuels, the history of coal tar dyes, insecticides and fungicides, and the chemistry of cellulose.

IT is stated in a Press dispatch from Oklahoma City appearing in *Science*, that an amendment prohibiting the purchase of books or copyrights teaching the theory of the evolution of the human race was inserted in the State Free Text Book Bill which passed the lower house of the legislature on February 21. Only one dissenting vote was cast against the anti-Darwinian section.

THE Mueller medal and fund have been awarded to Mr. J. H. Maiden, Government Botanist of New South Wales and director of the Botanic Gardens, Sydney, in recognition of his botanical work. The medal was founded in memory of the late Baron von Mueller, Government Botanist of Victoria, and is awarded at each meeting of the Australasian Association for the Advancement of Science, which, in 1923, sat at Wellington, New Zealand. It has been awarded previously for botany, zoology, geology, and ethnology.

PROF. HORACE LAMB, late professor of mathematics in the Owens College and University of Manchester; Lord Meston of Agra and Dunottar, formerly Lieut.-Governor of the United Provinces of Agra and Oudh; and Mr. G. Gilbert Scott, Royal Academician, have been elected members of the Athenæum Club under the provisions of Rule II. of the club, which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

A SYMPOSIUM and general discussion on alloy resistance to corrosion will be held at the Department of Applied Science of the University, Sheffield, on Friday, April 13. The meeting is being organised jointly by the Faraday Society, the Sheffield section of the Institute of Metals, and the Manchester Metallurgical Society, and the scope of the discussion will include the new non-corrodible, non-ferrous alloys, such as stainless nickel silver and the nickel chromium alloys, as well as stainless iron and steel. A general introduction to the discussion will be given by Prof. C. H. Desch. Further particulars may be obtained from Mr. G. R. Bolsover, Brown-Firth Research Laboratory, Princess Street, Sheffield, or from the secretary of the Faraday Society, 10 Essex Street, Strand, London, W.C.2.

FARMERS' Clubs, Chambers of Agriculture, and other bodies or individuals interested in agriculture are invited to visit the headquarters of the National Institute of Agricultural Botany, Huntingdon Road, Cambridge, during the coming summer. They will be able to see trials of new varieties of wheat and barley in progress on the trial ground, and a collection of different varieties of various farm crops growing in the field. The buildings of the Institute will also be open to inspection; these include the Official Seed Testing Station for England and Wales, where testing of seeds is always being carried out. The most interesting period for inspecting the Institute is from June to August, and all who wish to take advantage of the invitation should communicate with the director of the Institute, Mr. W. H. Parker.

MR. T. SHEPPARD, the energetic Curator of the Hull Municipal Museum, by the publication of a series of pamphlets describing the collections in his charge, has done much to popularise the study of science and archæology, and has given an example to those in charge of similar collections. A recent publication is a list of the specimens of natural history, antiquities, and applied art. The museum dates from 1823, and the specimens collected by the Literary and Philosophical Society finally passed to the Hull Municipal Museum in 1902. Since then the collections, particularly of local scientific objects and antiquities, have been largely extended, and the museum now holds a high place among similar institutions. Its value has been largely increased by Mr. Sheppard's continuous efforts to bring the collections to the notice not only of local visitors but of those from a distance.

THE British Non-Ferrous Metals Research Association has adopted a somewhat novel way of communicating the results of its recent investigations

to its members. Lectures are arranged at one or more centres to which only the members of the Association itself are admitted. Two objects are served in this manner: first, early confidential communication of the results of the research is assured to those who have given it financial support; and secondly, the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work. This private lecture system has so far been applied to two subjects. Dr. W. Rosenhain has reported on the investigation on copper, and the influence upon its properties of small quantities of impurities, which is being carried out for the Association by Dr. D. Hanson and others at the National Physical Laboratory; and Mr. E. A. Bolton has described work on the cause and prevention of red stains on brass, which he is carrying out at the University of Birmingham.

THE Staff Association of the British Museum (Natural History) held, on March 8 in the Museum Board Room, a scientific reunion which was attended by about seventy members and visitors. Round the room were arranged a large number of interesting objects. Among the geological exhibits may be specially mentioned the portions of the fossilised skeleton of Baluchitherium, a gigantic perissodactyl ungulate from Baluchistan, recently described by Mr. Foster-Cooper. This species is closely related to the rhinoceros, and is the largest land mammal at present known. An exhibit of the fauna of submarine cables attracted much attention, particularly the portion of a cable, brought up from a depth of 750 fathoms, showing a shark's tooth broken off in the wire sheath. A series of mounted specimens of animals acquired by the aid of the Rowland Ward bequest were shown. The flattened crystal of diamond and the well-formed ruby crystal, both formerly in the John Ruskin collection, were on view. It being the intention of the Trustees to adapt a bay in the Central Hall for the purpose of displaying the South African elephant in its natural surroundings, Capt. Guy Dollman had prepared a model on a one-eighth scale to demonstrate the effect; artistically designed and executed and efficiently lighted, this model was exhibited, and proved very popular. Messrs. C. Baker demonstrated their most recent microscopes and accessories.

AN International Air Congress will be held in London on June 25-30 this year under the presidency of the Duke of York, when opportunities will be provided for the reading and discussion of papers on every aspect of air matters. The Congress will be divided into four groups (each again divided into sub-groups) which will meet simultaneously. Group A will deal with methods of research, aerodynamics, controllability, structural methods, materials, and alighting gear. Group B is subdivided into sections on fuels and lubricants, motive-power plant, air-screws. Group C will discuss air transport and navigation problems, and in Group D airship design and construction will be discussed. Further particulars can be obtained from Lt.-Col. W. Lockwood Marsh, General Secretary, International Air Congress, London, 1923, c/o The Royal Aeronautical Society, 7 Albemarle Street, London, W.1, England.

UNDER the title of "The Claim of Antiquity," the Councils of the Societies for the Promotion of Hellenic and Roman Studies and of the Classical Association have issued an interesting bibliography of books for those who know neither Latin nor Greek. It provides a list of the best books, originals or translations, dealing with the general subject of classical literature; the most important authors; philosophy and religion; history; geography; science; art and archæology; and social life, giving the prices of each publication. The volumes published in the excellent Loeb Library have done much to spread the knowledge of classical literature among those who are ignorant of or have forgotten their classical learning, and the present publication, compiled by experts, will do much to advance the objects which these classical societies have in view. It will furnish an acceptable addition to all school libraries.

THE Secretary for Mines invites applications for a research post under the Safety in Mines Research Board. Candidates must possess high general scientific qualifications and experience in engineering, with, if possible, a knowledge of coal mining. The person appointed will be required to advise on questions of research on the safety problems of coal mining, to prepare programmes of research, and to organise and superintend research work. Applications for the position must reach the Under-Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1, by, at latest, April 30.

THE tricentenary of the birth of Blaise Pascal occurs on June 19, and preparations have been made for celebrations in France on July 8-9. The President of the French Republic will attend the meetings, the chief of which will be a commemoration gathering, to be addressed by the Minister for Public Instruction and other members of the French Academy. There will also be a meeting at the summit of the Puy de Dôme, when a member of the Academy of Sciences will speak on the famous experiment carried out there, at Pascal's suggestion, of observing the barometric height at the summit and comparing it with that at the base of the mountain. A difference of three inches in the height of the mercury column was observed, giving Pascal justification for his conclusion that the column of mercury in the barometer is supported by the pressure of the atmosphere.

AT the annual general meeting of the Geological Society held on February 16, the following officers and members of council were elected:—*President:* Prof. A. C. Seward. *Vice-Presidents:* Dr. J. W. Evans, Mr. R. D. Oldham, Dr. H. H. Thomas, and Prof. W. W. Watts. *Secretaries:* Mr. W. C. Smith and Mr. J. A. Douglas. *Foreign Secretary:* Sir Archibald Geikie. *Treasurer:* Mr. R. S. Herries. *Other members of council:* Dr. C. W. Andrews, Mr. F. N. Ashcroft, Prof. P. G. H. Boswell, Prof. W. S. Boulton, Dr. Gertrude L. Elles, Dr. J. S. Flett,

Dr. F. H. Hatch, Prof. O. T. Jones, Mr. W. B. R. King, Dr. W. D. Lang, Prof. S. H. Reynolds, Sir Aubrey Strahan, Sir Jethro Teall, and Mr. H. Woods.

AT the general meeting of the Asiatic Society of Bengal on February 7, the following officers and members of council were elected :—*President* : Dr. N. Annandale. *Vice-Presidents* : Sir Asutosh Mukhopadhyaya, Mr. Mahamahopadhyaya Haraprasad Shastri, Dr. J. Coggin Brown, and Lieut.-Col. J. D. W. Megaw. *General Secretary* : Mr. Johan van Manen. *Treasurer* : Prof. C. V. Raman. *Philological Secretary* : Dr. D. R. Bhandarkar. *Joint Philological Secretary* : Mr. S. Khuda Bukhsh. *Natural History Secretaries* : (*Biology*) Dr. P. J. Bruhl and (*Physical Science*) Mr. P. C. Mahalanobis. *Anthropological Secretary* : Ramaprasad Chanda. *Medical Secretary* : Major R. Knowles. *Honorary Librarian* : Dr. T. O. D. Dunn. *Honorary Numismatist* : Mr. C. J. Brown. *Other Members of the Council* : Dr. Upendra Nath Brahmachari, Mr. Kumar Sarat Kumar Roy, Sir R. N. Mookerjee, Mr. Pramatha Nath Banerjee, and Dr. W. A. K. Christie.

THE Australian National Research Council is making preparations for holding an important Pan-Pacific Science Congress in Australia in August next. The sympathy and support of the Commonwealth Government has been secured, and it is expected and sincerely hoped that scientific workers representing all the countries bordering, or having interests in, the Pacific will send representatives to this congress. Already the Commonwealth Government has issued cordial invitations to the countries concerned, inviting them to join in making this congress a success. It is well known that in international matters the Pacific must play an important part in the near future, and a fuller knowledge of its peoples, its products, and its natural phenomena, from a scientific point of view, is urgently desirable. The first Pan-Pacific Science Congress was held at Honolulu in August 1920, and it is proposed that the Australian meeting should be opened at Melbourne on August 13, 1923, and on August 23 be transferred to Sydney, and terminate there on September 3. Arrangements are being made to deal with the following subjects : (*a*) agriculture and veterinary science ; (*b*) anthropology and ethnology ; (*c*) biology, including botany, entomology, zoology ; (*d*) geography and oceanography ; (*e*) geology ; (*f*) hygiene and climatology ; and (*g*) physics, including geodesy, geophysics, radiotelegraphy, and seismology. Among the office-bearers are the following : Australian National Research Council—Sir David Orme Masson, The University, Melbourne (*President*) ; R. H. Cambage, Royal Society, Sydney (*Hon. Secretary and Treasurer*) ; Prof. A. C. D. Rivett, The University, Melbourne (*Joint Hon. Secretary*). Pan-Pacific Committee — Sir Edgeworth David, The University, Sydney (*Chairman*) ; E. C. Andrews, Mines Department, Sydney (*Hon. Secretary*).

THE projection of light in optical lanterns and kinema apparatus, discussed before the Illuminating Engineering Society on February 20, is a problem that evidently deserves more study. It appears from the results of recent tests that in most optical lanterns only about six per cent. of the light furnished by the source is usefully applied on the screen. In the kinema projector, with its small aperture and shutter, the percentage is even less. Moreover, even the light reaching the screen is not all profitably used, for much of it is reflected on to walls and ceilings and never reaches the eyes of the audience. Some attempts to utilise gas-filled incandescent lamps in place of arcs were also described, and the results of investigations seem fairly promising. Other items of interest in the discussion included a demonstration by Major Adrian Klein of his new colour-projector, and a three-phase alternating current arc shown by Mr. J. Eck. From a scientific point of view the Klein projector is particularly interesting, as the colours are not produced by means of filters, but by the aid of a train of prisms. When these spectrum colours are projected on painted scenery very vivid changes are produced.

THE annual report of the Meteorological Committee to the Air Council for the year ended March 31, 1922, has recently been issued. It is the sixty-seventh year of the Meteorological Office and the second report submitted to the Air Council instead of to the Treasury as formerly. The meteorological service now comprises many meteorological organisations which in past years have been carried on separately and independently. In all, the total staff aimed at to complete the organisation is 375. Retrenchments undertaken, however, by all Government departments have led to some modified programmes for the meteorological service, and reductions in the staff have taken place instead of the wished-for augmentation. The total whole-time staff of the Meteorological Office and its out-stations has changed during the year from 266 to 261. The year has seen a great increase in the interest of seamen in weather information, and the report mentions that it is greatly to be regretted that this increased interest should coincide with conditions which have made it imperative to reduce rather than to extend the activities of the Marine Division. Data now being received are gradually getting back to pre-war conditions, when it was equally felt that excessive observations were costly. For forecasting work the report states that, although certain messages are still received by cable, almost all European countries have now adopted the use of wireless telegraphy, and it is growing evident that it will shortly be possible to dispense entirely with the exchange of messages by cable. Much information is given relative to aviation and the upper air, new developments entailing much organisation. The British Rainfall Organization is now controlled by the Meteorological Office, and among many other branches of work may be mentioned atmospheric pollution and the oversight of attached and subsidiary observatories.

THE Journal of the British Science Guild for February contains a summary of the proceedings at the annual dinner in May last year. In proposing the toast of the British Science Guild, Sir Arthur

Mayo-Robson mentioned the interesting fact that Lord Curzon had distributed 500 prospectuses of the Guild's "Catalogue of British Scientific and Technical Books" to His Majesty's Consuls abroad. He also pointed out the thirst for scientific knowledge that was developing in various parts of the Empire he had recently visited, where fruitful opportunities for the work of the Guild appear to exist. Among others who spoke, Mr. H. G. Wells pleaded for a wide view of science, which should not be regarded as a monopoly for any nation, though they naturally hoped that the British Empire would make a worthy contribution to the general store of knowledge. The late Mr. F. W. Sanderson, whose genius as a schoolmaster is the subject of appreciatory editorial reference, emphasised the value of scientific methods in schools in developing a desire among boys to "get at the truth." He added that a catalogue of the British Scientific Products Exhibition had been of great interest to the boys. Other contributions to the journal cover wide ground. There are extracts from recent articles in the press on the Guild's national appeal. Prof. Flinders Petrie and Admiral Ballard have contributions on "The Science of Sailing." Dr. J. A. Harker deals with "The Fixation of Nitrogen," Mr. A. P. M. Fleming with "Radio-Telephony," and Mr. Leon Gaster with "Illuminating Engineering." Dr. R. S. Clay furnishes a note on "The British Pianoforte Industry." As usual the Journal also contains a series of readable notes illustrating the application of science in daily life.

COMMANDER HILTON YOUNG makes to us the suggestion that insects may be able to appreciate the proximity of a solid body by detecting the pressure differences which would be set up by air currents impinging on the latter. He asks whether this possibility has been examined, and a distinguished naturalist to whom we submitted the inquiry states that various entomologists have referred vaguely to insects being affected by changes of air pressure. Forel speaks of the sensitiveness of insects to slight movements in the air and to slight vibrations in his "Le Monde social des fourmis," vol. 2 (1922), and Folsom in his "Entomology" (1906) suggests that the sensillum placodeum may be affected by air pressure. Another work by Forel, "Sensations des insectes" (1886), and Berlese's "Gli Insetti," should also be consulted.

THE firm of Mr. C. Baker, of 244 High Holborn, London, W.C.1, has issued the January number (No. 77) of its well-known classified list of second-hand instruments and scientific works. The catalogue is arranged in sections, each confined to a specific class of apparatus, and contains a number of useful items. Those in need of physical apparatus, microscopes, cameras, etc., would do well to consult this list.

MANY students to whom Dr. A. Holmes's "Petrographic Methods and Calculations" is of interest and value will be glad to learn that the work, hitherto available only in one volume, will in future be obtainable in three separate parts dealing respectively with Specific Gravity, Separation and Determination of Minerals, and Detrital Sediments; Thin Sections; and Chemical Analyses and their Interpretation. The publishers are Messrs. Thomas Murby and Co., 1 Fleet Lane, E.C.4.

MESSRS. H. K. LEWIS AND CO., LTD., 28 Gower Place, London, W.C.1, are now issuing monthly lists of additions to their scientific and technical circulating library, instead of quarterly lists as previously. Every effort is made to meet the needs of workers in laboratories connected with the manufacturing industries, and the latest works on scientific research on all kinds of raw material and manufacturing processes are freely added to the library. These may also be seen in the technical books department, or a list will be sent to any inquirer.

WITH the assistance of prominent specialists in many parts of the world, Mr. Jerome Alexander, 50 East 41st Street, New York City, is preparing a comprehensive book on "Colloid Chemistry: Theoretical and Applied." British contributors include Dr. E. F. Armstrong, Prof. H. Bassett, Sir W. M. Bayliss, Dr. E. F. Burton, Mr. W. B. Hardy, Prof. F. G. Donnan, Mr. F. E. Lloyd, and Dr. A. E. Dunstan. Mr. Alexander invites any one who may have information of interest on experimental facts and practical applications of colloid chemical principles to send him a brief statement for inclusion in the book.

MESSRS. LONGMANS AND CO. have in the press "Friction," by Dr. T. E. Stanton, of the National Physical Laboratory, in which work the attempt is made to deal concisely with the whole subject of the mechanical friction which exists between bodies in contact, solid, liquid, or gaseous, under forces producing, or tending to produce, their relative motion. Attention is given to friction due to the flow of fluids over solid surfaces, with special reference to the dimensional theory; also to the lubrication theories of Osborne Reynolds, Michell, and Sommerfeld, and to the recent researches at the National Physical Laboratory on lubrication. The section on solid friction includes the theories of rolling friction and of the stability of structures on soft earth, together with the results of some modern experiments on materials used for brake blocks, and the final chapter is devoted to a discussion of Reynolds's theory of the relation between the heat transmitted to solid surfaces by fluids flowing over them and the frictional resistance of the surfaces due to the flow, and an examination of the experimental data bearing on this theory.

THE spring announcement list of Messrs. Chapman and Hall, Ltd., contains many books of scientific interest, among which are: "Vital Factors of Foods: Vitamins and Nutrition," by C. Ellis and Dr. Annie Louise Macleod, aiming at furnishing all essential facts regarding vitamins, and at bringing together the literature on the subject; "Perfumes and Cosmetics: with Special Reference to Synthetics," by W. A. Poucher; and "Electric Lift Equipment for Modern Buildings," by R. Grierson, which deals with the selection, installation, operation, and maintenance of modern electric passenger, goods, and service lifts. The same publishers will also issue a new and completely revised edition of "Electrical Engineering Practice," by J. W. Meares and R. E. Neale, in two volumes, the first of which will be ready shortly.

Research Items.

THE PYRAMIDS OF MEROE AND THE CANDACES OF ETHIOPIA.—A new chapter in the history of Egypt has been disclosed by the work of the Harvard-Boston Expedition in the Sudan, of which a summary is given by Prof. G. A. Reisner in *Sudan Notes and Records*, vol. v. No. 4. About 900 B.C. a Libyan family occupied Napata and seized the roads from Egypt to the mines and the southern markets. Ethiopia was then a province of Egypt, and for the first time they made it an independent kingdom and Egypt one of its provinces. They were not negroes, but of a mixed brown race which had previously lived in Ethiopia. For about 80 years they ruled 3000 miles of the Nile valley, and they were finally driven back to Ethiopia, ruling at Napata and building their pyramids there. In the end the branch settled at Meroe became the more powerful, and this kingdom persisted uninterrupted for another 650 years. Thus it has fallen to the lot of the expedition to trace the history of this family through more than twelve centuries.

HEAD-HUNTING IN PAPUA.—In the March issue of *Man* Mr. E. B. Riley gives an account of the method of preparing the heads of enemies practised at the village of Dorro in Papua. After the flesh and brains are removed a piece of rattan cane is fixed to the bottom of the mummified skull to take the place of the lower jaw and to act as a support for the packing of the neck. It was difficult to ascertain why the lower jaw is not replaced. The explanation seems to be that they prefer to hang this up in the house, and keep it as a mark or token of the owner's prowess in war, when the mummified head is discarded on account of natural decay; but the lower jaw is sometimes replaced, being tied to the zygomas, as in the case of the rattan cane above described. Finally, the head is dried, being fixed on a wooden framework over a fire lighted for that purpose, and the hair is pulled out on the second day as decomposition of the skin advances. Following this paper is a description by Dr. A. C. Haddon of stuffed human skulls from the Fly River District, Papua, two of which are preserved in the Cambridge and Manchester Museums.

CRIMINAL TRIBES OF INDIA.—The problem of dealing with the nomadic, predatory tribes of India has been considered for many years by the Imperial Government. All sorts of repressive measures have been put in force; the tribes have been proclaimed and attempts have been made to segregate them in settlements under police control. This system has always broken down, and these people, including the Sansias of the Punjab, the Doms of the United Provinces and Bihar, the Yerukalas and Korachas of Madras, have continued to be a pest to the country, and much violent crime was committed by them. Some twenty years ago a proposal was made by the Salvation Army to take charge of these people, and the result of the experiment is described in a paper by Commissioner Booth Tucker, read before the Royal Society of Arts (vol. lxxi. No. 3661). The Salvation Army has collected some of these people in settlements, each in charge of a European, where the more respectable members act as police, industries are taught, and efforts made to raise their moral character. In the debate which followed the reading of this paper several experienced Indian administrators, including Sir E. A. Henry, Sir John Hewitt, and Lord Pentland, bore testimony to the success of the experiment, which may be said to have solved one of the most difficult problems of Indian administration.

FATIGUE IN LAUNDRY WORK.—Miss May Smith is to be congratulated upon her recent Report (No. 22) to the Industrial Fatigue Research Board (H.M. Stationery Office, price 2*s.* 6*d.*), embodying "Some Studies in the Laundry Trade." Owing to the great variety of articles dealt with in laundries, the measurement of output, so as to serve as an index of the relations between working conditions and the human factor, proved unusually difficult. Nevertheless, she has been able to show that there is a reduction in efficiency in laundries towards the end of the day, which tends to be greater during a ten-hour than during a nine-hour day. These conclusions are strikingly corroborated by the data afforded by the interposition of "dotting" tests, which, in addition, reflect passing variations in the health and mental state of the worker. Miss Smith finds clear evidence of the beneficial effects on efficiency which occur after a fifteen minutes' rest pause has been introduced into the morning spell, but the greatest influence on the laundresses' output appears to be due to the vast individual differences in the workers' efficiency. Apparently the atmospheric conditions of laundries compare very unfavourably with those in potters' shops, boot and shoe factories, and cotton-weaving sheds. But when conducted under good conditions, Miss Smith believes that laundry work is not detrimental to the health of the workers. The variations in health due to excessive standing, faulty movements, and improperly designed machinery receive attention, and recommendations are made in regard to supervisors, the provision of seating, unsuitable footwear, change of occupation, etc.

OUR OLDEST SETTLEMENT IN AFRICA.—Dr. Frank Dixey has followed up his physiographic description of the colony of Sierra Leone (see NATURE, vol. 105, p. 689, 1920) by a complete petrographic survey of the main promontory (Quart. Journ. Geol. Soc. London, vol. 78, p. 299, December 1922). The peninsula forming the colony proper has been carved out of a remarkably uniform and unusually large stock of norite, the fine-grained character of which indicates that the present surface follows that of a dome of intrusion. Veins of coarser norite, and some of aplite, cut this mass, which is regarded as post-Cambrian, but of ancient date. The only strata on its surface are post-Pliocene gravels. This extensive occurrence of basic igneous rock furnishes further evidence of the existence of a West African petrographic province of strongly magnesian character.

SURVEYS OF THE SAHARA.—A new map of the western Sahara, between the Atlas to the north, and the Senegal and Niger to the south, and the meridian of Paris on the east, is published in *La Geographie* for January. The map, which is on a scale of 1 : 2,000,000 is based on information collected by the French military posts in the Algerian Sahara, Mauretania, and the Sudan, and particularly the explorations of Capt. Augiéras who, in addition to various journeys in the Sahara between 1913 and 1917, crossed the desert with a small column in 1919–20 from Algeria to Senegal. This crossing, which is briefly described in an article accompanying the map, was from the French outpost of Tabelbala, south of Colomb Bechar, in a south-westerly direction to the outpost of Atar, whence by a circuitous route Bogue on the Senegal was reached. This entailed, from post to post, a total march by camel of some 1500 miles, which was accomplished, excluding rests, in 78 days. In such a survey there must obviously be inaccuracies and Capt. Augiéras regrets his inability to get more satisfactory longitudes, but the

map shows great improvements on former maps of this part of the Sahara.

DISTRIBUTION OF ICE IN ARCTIC SEAS.—The publication by the Danish Meteorological Institute of "The State of the Ice in the Arctic Seas, 1922," directs attention to a somewhat unusual year, but unfortunately information is almost entirely lacking from Siberian waters and very scanty from the Beaufort Sea. By April the extent of pack in the Barents Sea was much smaller than usual. Bear Island, which had been free from ice all winter, was clear and open water almost reached to Novaya Zemlya. The edge of the ice continued to retreat. In July the whole west coast of Novaya Zemlya was clear, and in August Franz Josef Land was probably accessible by open sea. Early in the year conditions in Spitsbergen were about normal. In May and early June an unusual amount of ice drove round the South Cape before continuous easterly winds, but this resulted in the west coast being practically free from ice for the remainder of the summer. On the north coast conditions were particularly favourable, and a vessel reached lat. 81° 29′ N. Some sealers circumnavigated Spitsbergen, a feat that is not possible in most years. In the Greenland Sea the belt of pack lay more westerly than usual, and though the east coast of Greenland does not appear to have been clear of ice, open water touched the coast in about lat. 74° N. during August. Jan Mayen and the coast of Iceland were free from pack from May onwards throughout the summer. On the Newfoundland banks both pack and icebergs were abundant in early spring, but July was clearer than usual. In Davis Strait the winter ice was thinner and the "west ice" less abundant than usual. In Bering Strait conditions were fairly normal, but along the north coast of Alaska the pack pressed hard and navigation was much hindered.

EARLY HISTORY OF THE BLACK CURRANT.—The *Gardeners' Chronicle* has recently commenced a very interesting series of notes under the heading "Early Botanic Painters." In the issue of February 17, the figures of the Black Currant reproduced from the paintings by Jean Bourdichon (1457–? 1521) are extremely interesting, and raise the query whether the cultivation of the black currant may not be of longer date than is usually supposed. R. G. Halton of the East Malling Research Station has recently described existing varieties of the Black Currant, and to judge from his brief account of its early history (*Journal of Pomology*, vol i. No. 2, p. 68), it receives scant notice from the earlier chroniclers of horticultural effort.

A NEW CULTURE MEDIUM FOR BACTERIAL COUNT WORK.—For bacterial counting work, in which the plating method is used, a first essential of accuracy is that the medium used in plating should give uniform results. There are two respects in which a medium should display this uniformity. In the first place, it should be reproducible, that is to say, different batches of medium should give similar results. In a medium recently developed at Rothamsted (H. G. Thornton, *Annals of Applied Biology*, vol. ix. p. 241, 1923), this reproducibility has been achieved by using pure chemical compounds as food constituents and especially by selecting those compounds that were found not to alter the reaction of the medium during sterilisation. In the second place, parallel platings of a suspension of organisms made on a *single* batch of medium should develop the same number of colonies (within the limits of random sampling variance). Uniformity in this respect involves the independent development of each colony on the plate, and on agar media this is frequently prevented by the development of bacteria that form rapidly spreading colonies which interfere with the development of other bacteria. A special study was therefore made of a common "spreading" organism with a view of limiting its growth. It was found that the organism spread over the agar surface by active motility and that the factors controlling its spread were (1) the existence of a surface film of water on the agar, and (2) the rate of multiplication previous to the drying of this film. In the present medium this rate of multiplication has been much reduced, so that spreading colonies are greatly restricted.

SILKWORM DISEASES IN INDIA.—The subject of silkworm diseases is not a new one in India, but notwithstanding the fact that sericulture is probably a much older industry in that country than in Europe, there are no corresponding early records of disease, The whole problem is very fully discussed in a recent memoir by Dr. A. Pringle Jameson (Report on the Diseases of Silkworms in India, Calcutta, 1922. pp. 165 and 8 plates). It appears that all the recognised diseases are prevalent, and those of the mulberry, muga, and eri worms are the same. Pebrine is only of importance in mulberry worms: losses are still heavy, mainly because the majority of rearers use unexamined eggs or "seed." Muscardine is almost confined to mulberry worms and is a most serious complaint, whole rearings being frequently lost. Flacherie is of less importance in mulberry worms, while grasserie is stated to cause loss to all species. Conditions in India make the control of disease considerably more difficult than in temperate countries, but there is no reason why the industry should not be placed upon a surer footing. The crux of the whole question lies in the "ryot," and, if improvement is to be effected, the village rearer must be instructed as to the causes of disease and induced to go in for better methods of rearing. Since the industry is carried on by cottagers, the latter should be encouraged to use disease-free "seed." The extension of the Government nursery policy will avail little unless the rearer can be induced to educate himself to adopt better methods. The most important work of the Government sericultural officers should be instruction and supervision, while sericultural schools should be established. The sericultural department officials themselves should conduct research work on a practical scale, and an attempt should be made to provide them with the chief literature on this subject in order that they may keep abreast with sericultural research. Improvements are to be looked for from the work of the provincial sericultural departments being extended among the villages.

FIBRES FROM THE TROPICS.—A noticeable feature of journals recording activities in tropical agriculture is the interest at present being taken in the subject of fibre production. The *Tropical Agriculturalist*, issued from Peradeniya, records promising experiments with cotton, and in its December issue (1922) devotes considerable space to a paper by E. Mathieu, superintendent of the Government Plantation, Kuala Kangsar, upon the cultivation of the "Kapok" tree, *Eriodendron Anfractuosum*. In the fruits of this plant, hairs grow freely on the inner side of the valves of the capsule but not upon the seeds themselves, so that the separation of the fibre from the seed is a relatively easy matter. The export of this fibre from Java in 1912 exceeded 10,000 tons, and owing to the increasing demand from Europe and America, its cultivation seems likely to extend in Ceylon.

The same number of this journal has a note by A. P. Waldock upon the "akund" fibre, obtained from the shrubs *Calatropis gigantea* and *C. procera*, which the writer considers may have industrial possibilities as a village industry. In *Industrial India*, vol. i. No. 12, the possibilities are discussed of the "roselle" fibre, obtained from the bark of *Hibiscus Sadariffa*, particularly var. *Altissima*, which is said to have given good yields of fibre in Malaya, in regions with rainfall between 90 and 120 inches. For dry tropical regions there is "sisal," the fibre from the leaf of *Agave rigida*, var. *sisalana*. In *Tropical Life* for January Major L. A. Notcutt begins an interesting discussion of the possibilities of the cultivation and extraction of sisal, more particularly with reference to the problem whether the East African product may hope to compete with the Mexican in cost of production. At present our knowledge with all these fibre plants as to what conditions in cultivation favour maximum fibre development in the plant is entirely empirical, but such recent researches as those of Dr. W. L. Balls and H. A. Hancock (Proc. Roy. Soc., 93 B, 426-439, 1922) upon the growth of the cotton hair, and the numerous investigations upon cotton and flax, now being published in the Journal of the Textile Institute, arouse hopes that we may soon have a deeper insight into the problem of wall formation and thickening in the plant, and this should prove the first step towards the control of cultivation with the view of facilitating the formation of fibre.

FORAMINIFERAL SANDS IN CORSICA.—Messrs. E. Heron-Allen and A. Earland (Bull. Soc. Sci. hist. et nat. de la Corse, 1922, p. 100, Bastia) find that the red sands of the Gulf of Ajaccio, which were supposed to owe their colour to derivation from adjacent granite rocks, are in reality largely composed of foraminifera. Some ten per cent. of their volume is composed of the rose-pink *Polytrema miniaceum*, a species having a wide distribution in the Mediterranean, with which Mr. Heron-Allen was concerned in his recent report for the *Terra Nova* expedition. The authors, in an inserted fly-sheet, show that they have much cause to complain (as was remarked in the famous "Printers' Bible") that printers have persecuted them without cause.

DEPOSITION OF SILICA IN SEDIMENTARY ROCKS.—In such cases as the famous Devonian cherts of Rhynie, or the silicified forest of Arizona, geologists have urged the probability of an invasion of silica in solution from volcanic magmas. In suitable climatic conditions, however, much silica must be set free during laterising processes, and this may wander far from its original source. In the Proceedings of the Rhodesia Scientific Association, vol. 20, p. 9, 1922, Mr. H. B. Manfe records the interesting case of the silicification of a fairly recent freshwater shale at the base of the Kalahari Sands at Gwampa. Mr. T. B. Lawler of Princeton University (*Amer. Journ. Sci.*, vol. 205, p. 160, 1923) describes the sheets of chalcetory that traverse the Oligocene strata of S. Dakota, passing alike through the sands and the included fossils. He attributes the vertical cracks in which they have been deposited to the squeezing out of water during the settling down of the beds, as the humid conditions of Oligocene times in the Dakota area were succeeded by an arid climate in the Miocene period.

EARTHQUAKE PERIODICITY AND TIDAL STRESSES.—Recent numbers of the Bulletin of the Seismological Society of America (vol. 12, 1922, pp. 49-198) contain a memoir by Mr. Leo A. Cotton on earthquake periodicity with special reference to tidal stresses in the lithosphere. A welcome feature is the sympathetic examination of Perrey's neglected laws (of greater frequency about the syzygies, perigee, and the lunar passages of the meridian); the author considers that the first and second are supported by a high degree of probability, while the third is unsound. The second part of the memoir deals with the effects of tidal stresses in the earth's crust, with special reference to the geological aspects of the subject, such as the position of the originating faults. The author considers 316 world-shaking earthquakes from 1899 to 1903, and shows that earthquakes are more frequent when the sun or moon is near the horizon, and that there is a very high maximum of frequency when the sun and moon are so situated that they exert their tidal stresses in the same direction.

METEOROLOGY AT LIVERPOOL.—Results deduced from the meteorological observations taken at the Liverpool Observatory, Bidston, in the years 1920 and 1921, have recently been published by the Mersey Docks and Harbour Board. The report and discussion was prepared by Mr. W. E. Plummer, director of the observatory. Observations are supplied three times daily to the Meteorological Office, which also receives monthly and annual returns. Daily results are given for the two years and the total and means are grouped for each month and each year. For 1920 the mean atmospheric pressure was 29·942 in. (printed in error as 29·924 in.); the mean was above 30 in. in 5 months. The mean air temperature was 49·6° F., which is 0·5° F. above the normal, the absolute maximum was 78° F. and the minimum 21° F. The total rainfall was 33·34 in., which is 4·82 in. more than the normal; the duration of sunshine was 1257 hours, which is 222 hours less than the normal. For 1921 the mean barometric pressure was 30·045 in., which is more than a tenth of an inch higher than in 1920; in a similar report for Southport especial mention was made of the exceptionally high barometric pressure which characterised 1921. The mean at Liverpool was above 30 in. in 7 months. The mean air temperature was 51° F., which is 1·9° F. above the normal; the absolute maximum was 86° F. and the minimum 28° F. The total rainfall was 22·47 in., which is 5·95 in. less than the normal; the duration of sunshine was 1585 hours, which is 99 hours more than the normal. The general modification of scales for the several elements which is being uniformly adopted by the Meteorological Office is not as yet being followed at the Liverpool Observatory.

THE SCATTERING OF LIGHT BY LIQUIDS.—When a beam of ordinary light passes through a liquid its intensity gradually diminishes according to the exponential law owing to the scattering of the light by the molecules of the liquid. The light scattered in a direction transverse to the beam should be completely polarised. According to a paper in the March issue of the *Philosophical Magazine*, Prof. C. V. Raman and Mr. Rao have examined nine liquids to determine to what extent the theories of scattering are in agreement with the facts, and find that the Einstein-Smoluchowski theory is the most satisfactory. According to it the scattering should be proportional to the compressibility and absolute temperature of the liquid and inversely proportional to the fourth power of the wave-length of the light used. They find that the transverse light is only partially polarised, but, on applying the correction specified by Cabannes, which is due to the non-symmetrical molecules, the theory gives correctly the amount of the scattering. As the critical temperature of the liquid is approached, the scattering becomes very large and the polarisation of the scattered light more complete.

The Indian Science Congress.

THERE is a real danger that the severe retrenchment in public expenditure now in progress in India may lead to a curtailment of activities in those departments in which such restriction is least desirable, namely, the educational and scientific services devoted respectively to the training of workers and the investigation and development of the resources of the country. It was therefore very opportune that the presidential address delivered at the Indian Science Congress which has completed its tenth session at Lucknow (January 8-13) emphasised the danger of apathy towards scientific knowledge and the immense problems bearing upon the welfare of India still awaiting solution. The president, Sir M. Visvesvaraya, himself a distinguished engineer and for many years the successful administrator of one of the largest and most progressive of the Indian States, rightly laid stress on the appalling state of destitution in which quite 100 million out of the total population of 320 million in the country live, and the necessity for scientific research to increase the food supply, raise the standard of living, develop resources and train the people for citizenship. The address contained constructive suggestions towards stimulating research, promoting co-operation and concentration of effort and making the results of scientific work both in India and abroad more readily available.

The sectional presidents dealt with a variety of subjects and their addresses were mostly of a general character. A few words regarding each must suffice, and those who are interested will no doubt refer to the complete report which will before long be published by the Asiatic Society of Bengal. In his discourse to the Section of Physics and Mathematics, Dr. S. K. Banerji reviewed recent theories regarding the origin of cyclones and discussed in particular the cyclones of the Indian seas, their origin, movements and disappearance. He favoured the view that counter currents having their origin in differences in temperatures over large geographic areas initiate the conditions that give rise to a system of gyrating winds in these storms, and that the condensation of water vapour supplies the energy necessary to maintain them for a long period of time. Dr. Meldrum in a brief opening address to the Section of Chemistry made out a case for regarding the study of this subject as a liberalising influence.

Mrs. Howard in her address to the Botanical Section dealt with the rôle of plant physiology in agriculture and indicated a number of directions in which botanical research is desirable, such as the factors underlying high quality in agricultural produce, the scientific interpretation of field experiments, the precise nature of various agricultural practices which come under the head of mutilations, the relations between physiology and the incidence of disease, and the basis of acclimatisation and change of seed. It was suggested that investigators in the Indian universities would find in these subjects many problems of great scientific interest and practical importance.

Dr. Pillai in his address to the Section of Agriculture epitomised recent researches in soil science. Prof. G. Matthai gave the Section of Zoology a very interesting survey of recent oceanographical research, with special reference to the Indian Ocean, dealing very fully with the physical and chemical factors influencing marine life and its distribution. Especially noteworthy was the reference to recent work on the colour of the light that penetrates by transmission and scattering into the depths of clear ocean water and its possible influence on the coloration of marine fauna and the development of their powers of vision. In the Section of Geology, Dr. Pascoe dealt with the palæography of Burma. Major Acton discoursed on the aims and economic value of medical research to the section devoted to this subject. The importance and interest attaching to the study of cultural anthropology was well emphasised by Dr. J. J. Modi in the section over which he presided.

A general survey of the work of the Congress indicates that scientific investigations in India are to a considerable extent directed by the special needs of the country, and indeed perhaps even more attention should be given than at present to subjects such as the chemistry of Indian natural products and problems arising therefrom. As an example of the kind of work being accomplished at present in this direction may be mentioned an interesting paper by J. L. Simonsen and M. Gopala Rao in which they showed that an exceedingly small proportion of pyrogallol added to Indian turpentine inhibits its tendency to oxidation for some months and thus adds greatly to its value. The practical side of research was also emphasised in a symposium of the Sections of Agriculture, Botany and Chemistry, in which a whole morning was devoted to the discussion of the nitrogen problem in Indian agriculture, and in another joint meeting, of the Sections of Botany and Agriculture, devoted to the improvement of fodder and forage in India. The same tendency is also found strongly reflected in the proceedings of some of the sections, notably in those just mentioned and in the Section of Medical Research.

Fundamental research as distinguished from applied science was strongly represented in the physics section of the Congress, and this was largely owing to the influence of the Calcutta school which has grown up during the past few years. Among some of the papers which dealt with new fields of research may be mentioned one by Mr. K. Seshagiri Rao on the scattering of light in fluids at low temperatures. A remarkable fact elicited by recent work (see Proc. Roy. Soc., November 1922, p. 159) is that the light transversely scattered in liquids which at ordinary temperatures is very imperfectly polarised increases in intensity and at the same time becomes more and more completely polarised as the temperature is raised towards the critical point. In Mr. Seshagiri Rao's work, the study of the scattering is carried down to low temperatures, and an effect of the opposite kind is noticed. The quantitative results promise to throw light on the nature and magnitude of the thermal agitation of the molecules at low temperatures. An analogous investigation by Mr. Lalji Srivastava on the scattering of light in crystals was also presented to the Congress.

There is scarcely space to refer here in detail to the numerous other papers dealing with subjects so varied as vortex motion in fluids, formation of ripple-marks, earthquake coda, chromatic emulsions, acoustics of the pianoforte, whispering galleries, theory of band-spectra, temperature ionisation of gases, and α-ray tracks in argon and helium, to mention only a selection, presented to the section at Lucknow. A reference may, however, be made to a paper which evoked a most animated discussion at the meeting, that is one by the writer putting forward a new theory of the well-known blue colour of clear ice in glaciers (see NATURE, January 6). In reply to some of the points raised, attention was directed to the very remarkable fact that during the process of artificial crystallisation involved in the manufacture of ice, the suspended matter originally present in the water is rejected by the crystals as they form and accumulates in a pocket. Ice which shows the blue opalescence is quite free from colloidal matter of any kind.

C. V. RAMAN.

The Exploitation of the Sea.

TWO very important documents bearing on the subject of the rational exploitation of fishing grounds have recently become available. The first is the report to the Minister of Agriculture and Fisheries of the British delegates who attended the meeting of the International Council for the Exploration of the Sea, held at Copenhagen in September last. The other is the Report of the Danish Biological Station (xxix., 1922). Both papers are of very great interest.

The British official report emphasises the practical nature of the work of the Council and gives an account of its organisation. There are four sections (hydrography, plankton, statistics, and fish). The work of the fish section is carried out by committees, and those which deal with the investigation of the herring, cod and haddock, and of the biology of the Atlantic slope are of great interest to British workers. Programmes of the investigations adopted by these committees are given in the report. One important committee, that on the plaice fisheries, has now completed its work, and the recommendations made by it have been approved by the Council and are given in full. These are that the parts of the North Sea situated (1) between the Continental coast and the 12-fathom line from N. lats. 52° to 56°, and (2) between the 12-fathom and the 15-fathom line, be closed to steam trawlers and motor vessels of more than 50 h.p., the inner zone throughout the entire year and the outer one during the months July to March. No size-limits with respect to the fish caught are recommended. The Council recognises the difficulty of enforcing these measures without the sympathetic support of the fishing industry, but it regards this as a matter for the concern of the governments of the participating countries. It is considered that the adhesion of Germany to such a scheme of regulation will be essential. The Council advises the continuance of observations and the review of the whole proceedings after three years have elapsed.

The meaning of the impoverishment of a plaice fishing ground is examined by Dr. C. G. J. Petersen in the second of the reports noticed. Since 1893 this distinguished Danish zoologist has studied the fisheries in the Limfiord and in the adjacent seas. In 1893 the old styles of plaice fishing were superseded by newer and more efficient methods, and Dr. Petersen thought then that this meant "the end of the golden day for the fishing industry," and he had similar thoughts about the North Sea plaice fisheries. Now he confesses that later developments have shown that he was wrong. What has occurred in the two areas is much the same; the quantities of plaice taken per day's fishing by the old types of vessels were much greater than those now being taken by the newer boats fitted with much more efficient gear. Why? In both areas there was an "accumulated stock" of fish. Vessels of low fishing capacity could do well on such grounds.

How to remedy this "impoverishment"? There are two theories of regulation: (1) to raise more young plaice either by protecting the breeding fish so as to allow them to reproduce at least once in their lifetimes, or by artificial hatching, and (2) to legislate and otherwise deal with the fishery so as to increase the *growth-rate* of the plaice, because it is not merely a vast quantity of fish on the grounds that is desirable but rather an increased rate of production of plaice-flesh. An overcrowded ground may harbour small old plaice or young and relatively big ones. Plaice which do not grow at all consume from three to four times their own weight of food. In the Baltic there are fish of 32-36 cm. in length which are 4-5 years old as well as others of the same sizes but of 9-18 years old. The best policy is so to regulate the fishing as to increase the proportion of the younger, more rapidly-growing fish.

How to do this? The conditions in the North Sea illustrate the difficulty—and the remedy. If the Dogger Bank were an island surrounded by shallow water, vastly more plaice would grow to good marketable sizes than do now. As it is, the fishing is probably too intense and plaice are caught more rapidly than they can migrate out from the overcrowded grounds just off the Continental coasts. The restocking of the deeper parts, where the fish will grow well, from the nurseries (where they grow slowly) must keep pace with the depletion of these grounds. This means two kinds of measures: (1) size-limits in fishing, and (2) transplantation, both being modified according to the circumstances. If young plaice do not migrate out into favourable parts of the North Sea they must be assisted. Dr. Petersen himself made successful transplantation experiments in the Limfiord long ago, and more recently, English investigators have shown, beyond all doubt, that the same measures were practicable, and sure to be highly successful, in the North Sea.

The rationale of a continued and still more intensive exploitation of the fishing grounds is indicated by the scientific investigations. The transplantation experiments show which are the favourable grounds; growth-rates are known, and the work now in progress by the English investigators is giving results of value in regard to the supplies of food on the various grounds. The difficulties belong only to the practical working of the regulatory measures. Something like a scientific "nationalisation" of the deep-sea fishing industry appears to be necessary in the interest of an increased food supply, should the apprehensions of a failing stock be justified. It seems like a revolutionary proposal to suggest that permission to exploit the offshore fishing grounds should become necessary and that this permission should be accompanied by certain conditions, yet something of the kind may have to come in the near future. Meanwhile the scientific work in progress is affording the data whereby such proposals can materialise when the administrations are ready. J. J.

Solar Radiation.

VOLUME IV. of the Annals of the Astrophysical Observatory of the Smithsonian Institution contains the investigations on solar radiation made by the director, Prof. C. G. Abbot, assisted by F. E. Fowle, L. B. Aldrich, and others. The work in the Northern Hemisphere has been transferred from Mt. Wilson to Mt. Harqua Hala, Arizona; that in Chile from Calama to Mt. Montezuma. In 1914 pyrheliometers were taken up to a height of 25 km. by small balloons. The atmospheric pressure was 3 cm. of mercury; the value of the solar constant indicated was 1·84 calories per cm.^{2}, in good agreement with the adopted value.

Mr. Clayton compared the variations of solar radiation measured in 1913–14 with the temperature records in various parts of the world; he found a

correlation that was positive in the Tropics and Polar regions, negative in the Temperate zones. He also found that the temperature in Argentina was correlated to the short-period variations of radiation observed in Chile, and he suggests that these changes have a tendency to recur in periods of 12 and 22 days. They are interpreted as being due to varying transparency of the solar atmosphere. Measures of the brightness of Saturn indicated similar variations, but with a time-interval proportional to the difference of longitude of Saturn and earth. This would be explained by the solar regions of high or low radiation being carried round by the sun's rotation.

The excess of radiation at sunspot maximum is explained by the greater activity of solar convection currents at that time; these bring hot matter from the interior to the surface, which more than balances the loss of heat in the spots themselves.

The mean state of transparency of the solar atmosphere is measured by observations of the radiation at different distances from the centre of the disc. The contrast between centre and limbs is found to be greatest when the solar spot activity is greatest. On the other hand, the short-period increases of radiation are associated with less contrast between centre and limb.

The work also gives information on the transparency to radiation of different layers of our own atmosphere. "The atmosphere above 11 km. contributes more than half the radiation of the earth viewed as a planet. . . . Nearly the entire output of radiation of the earth to space, more than $\frac{3}{4}$, arises from the atmosphere and clouds."

The albedo of a large white cloud in the sunshine was measured from a balloon above it and found to be 78 per cent. Prof. H. N. Russell's discussion of Müller's observations of the albedo of Venus gave the value 59 per cent. It is concluded that the clouds on Venus while general are not thick enough to give full cloud reflection except for oblique rays. The albedo of the earth seen from space is estimated as between 43 and 45 per cent.

Botulism in Scotland.

THE Scottish Board of Health has issued a very clear and interesting report on the circumstances attending the deaths of eight persons from botulism at Loch Maree in Ross-shire last year, and none of the vivid tragedy of the occurrence is lost in the telling by Dr. G. R. Leighton.

On August 14, 1922, a number of guests stopping in the hotel went out for the day, and within a week six of them, as well as two of the attendant ghillies, were dead. Once some sort of food poisoning was suspected, the distribution of the fatalities between these living in the hotel and those living in their own homes in the neighbourhood at once implicated luncheon, the only meal taken in common, as the source of the poison, and further inquiries appeared to bring particular suspicion on a glass jar of wild-duck paste out of which about a dozen of the sandwiches had been made. The empty jar was fortunately recovered, and Mr. Bruce White, at the University of Bristol, was able to show that the small fragments of paste left in it were intensely poisonous to mice, and from them to isolate the *Bacillus botulinus* itself. One of the ghillies was not hungry enough to eat all his sandwiches and took one home with him; when he fell ill next day and rumour suggested something wrong with the lunch his friends buried the sandwich, which was retrieved later and shown by animal experiment to be extremely toxic. A guest also failed in his appetite and threw the most part of a sandwich to a wagtail on the lake shore; a month later Dr. Leighton found the decayed remains of a small bird among the stones.

There has, indeed, seldom been an outbreak of food poisoning in which the facts were so clear and so plainly verified. The only point of interest which the report fails to elucidate—and perhaps the facts could not be ascertained with complete accuracy—is how many people ate any of the poisonous paste without having symptoms: it seems likely that there may have been about five.

As has lately been shown by Dr. K. F. Meyer of the University of California (NATURE, January 20, p. 95) *B. botulinus* is a widespread common inhabitant of the soil, and may often be found on fruits, vegetables, and other food-stuffs. Taken with food in any numbers that are reasonably possible it is harmless, and in this way differs sharply from the food poisoning bacilli of the Gaertner and Aertrycke group, which multiply inside the body and cause illness by producing a definite infection. *B. botulinus* is poisonous only if it has been able to grow for some time under favourable conditions outside the body and produce large quantities of its potent toxin; man is poisoned by the toxin, not infected by the bacillus. Laboratory experiments show that the resting spores are exceptionally difficult to kill by heating. Considering, indeed, the wide distribution of the bacillus in Nature, the rarity of botulism is a remarkable testimony to the care with which potted meats and so on are usually prepared. Really efficient sterilisation is a secure preventive. The difficulty is that the glass containers, which the public æsthetically prefers, cannot be heated to a sufficiently high temperature without an undue proportion of breakages. There seems to be no good reason why they should not be prohibited and tins made compulsory.

Building Construction Research.

THREE reports on investigations connected with house construction and allied subjects have recently been issued by the Department of Scientific and Industrial Research.[1]

In the first of these, Mr. W. H. Wainwright gives some details of the cost of cottage building, and at the present time, when the cost of building is a very vexed subject and development schemes have to be very carefully debated owing to financial stringency, such information should be valuable. It is only by careful analysis in the matter of outlay that organisation can be improved and economy effected, and those engaged in large building works will find in these tables much interesting matter. The diagrams are partly compiled from data collected by the Ministry of Health; some are calculating graphics which should save time and do something to popularise graphic methods among technicians, while others show the rise and fall of prices in labour and materials from 1914 to 1922 and are of general application.

Mr. Weller in his editorial introduction anticipates

[1] Department of Scientific and Industrial Research. Building Research Board: Special Report No. 6, "A Graphical Cost Analysis of Cottage-Building." By W. H. Wainwright. Pp. iv+8+20 diagrams. 2s. 6d. net. Building Research Board: Special Report No. 5, "Building in Cob and Pisé de Terre: a Collection of Notes from Various Sources on the Construction of Earth Walls." Pp. iv+40. 2s. net. Fuel Research Board: Special Report No. 4, "Tests on Ranges and Cooking Appliances." By A. H. Barker. An Extract from the Report of the Building Materials Research Committee. Pp. vi+55+15 figs. 2s. 6d. net. (London: H. M. Stationery Office, 1922.)

an obvious criticism that the basis of calculation may be of changing value owing to changed conditions by stating that the percentage cost of materials in a cottage in 1914 and 1921 was found practically identical. From the diagrams the increased cost of a cottage due to variation in the market price of a material can be at once ascertained. We imagine that variations in human output are a good deal less amenable to graphic representation. Apart from this, however, a great deal of useful matter on relative costs and methods of calculation will remain truly recorded in this publication.

The notes which constitute the report on cob and *pisé* building form an interesting epitome of a subject which came into great prominence during and after the war, when bricks were prohibitive in price and the bricklayer was laying them at a minimum rate never contemplated. It is very unlikely that the methods of building described will ever become general, though in special local circumstances they will continue to have value.

The contributors to these notes write quite dispassionately, a fact which adds greatly to the value of the concise information given. Various methods used are explained in detail with dimensioned sketches of the simple shuttering and tools used in this construction, while photographs of cob and *pisé* cottages show how satisfactory a home it is possible to produce, even for two-storied buildings, direct from natural earths. Walls, which may be of lumps from a mould or formed *in situ*, are one or two feet in thickness and the houses are said to enjoy a very equable temperature and to remain dry, but a brick or concrete foundation about a foot high is necessary. The recent times of stress have produced a great many new types of building, but if we are to judge from American experience it would seem that, taking capital and current cost over a decade, the ordinary brick still holds its own against later competitors.

Houses or cottages having been constructed, it is necessary to provide heating appliances, and range-makers and others will find much useful information in the third of these reports. The necessity for the conservation of fuel energy during the war provided the stimulus for this useful investigation. It is common knowledge that the kitchen range is, in most houses, the main and most wasteful coal consumer, and it is surprising that range-makers have not before now turned their attention to the production of more efficient designs. This may be due partly, as the author points out, to the incompatibility of running economy and initial low cost of apparatus, but if capital and current costs were simply tabulated the purchaser would soon realise the ultimate cheapness of a range designed to utilise more heat units.

The purposes of a range for boiling, baking, water heating, and perhaps warming, render, the report tells us, a really economical design impossible, and attention should therefore be directed to the consideration of any means for separating these functions which might be practicable at least in large establishments. These functions were tested independently both from a broad physical and also from a purely culinary standpoint. Considered as separate functions, only 2½ per cent. of the heat is transmitted to the oven, 12 per cent. to heating water, and 1-5 per cent. to the hot plate, as an average for commercial ranges. These figures were very largely increased in appliances designed during the tests. It has been stated that market conditions preclude the commercial success of many improved types of range.

Diseases of Plants in England in 1920–21.[1]

By Dr. E. J. BUTLER, C.I.E.

MOST countries in the civilised world have been forced within the last twenty years to take steps to protect their crops from the menace of foreign parasites. During that period, with the growing recognition of the aid that science can give to agriculture by studying the cause and control of plant diseases and pests, has come a great increase in knowledge of the dangers of unrestricted traffic in plants. Many instances have occurred to prove how real is the risk of introducing plant parasites from other countries and how difficult to guard against. America has been the chief sufferer, but it is sufficient to mention gooseberry mildew and wart diseases of potato to show that England has not escaped. Distances, as measured in time and in the amenities of transport, are constantly contracting between the continents, and the interchange of living plants—with their parasites—goes on in ever-increasing volume. Quarantine restrictions, at first imposed in a few special cases, have extended until at present the exporting seedsman or nurseryman is faced with barriers to his trade which are often extremely hampering. It is easier for a human being to enter the United States to-day than for a potato, unless it is accompanied by a sheaf of health certificates; while total prohibition of certain categories of plants is not uncommon.

Correspondingly heavy responsibilities have fallen on the official plant pathologists of the various countries. Produce for export has to be inspected and certified, and imports from each country have to be scrutinised for possible dangers. As an essential foundation for efficiency in what may be called the "Plant Protection Service," it is obviously necessary to know what diseases already exist in one's own country and what may be introduced from each of the countries from which imports are received. Plant disease surveys have been developed in nearly all the more advanced countries, that of the United States being the most complete, as is natural in view of the vast interests involved. So far as the fungous diseases are concerned, it is to Mr. A. D. Cotton, mycologist to the Ministry of Agriculture, that is due the organisation of the English survey. The present report is the third of the series for which he has been responsible, and will be the last in view of his appointment as keeper of the Herbarium, Royal Botanic Gardens, Kew. It is also by far the most complete that has yet appeared and is second to none in any European country.

The report covers the two years 1920 and 1921. These years offered an extreme contrast in their meteorological features, and not the least valuable of the results of the survey is the way in which the differences in the two seasons are reflected in the incidence of particular diseases. Potato blight, a lover of cool and damp conditions, was rampant in 1920, but could not withstand the hot, dry summer of 1921. The attack of crown rust on oats in Wales was unprecedented in the former year and singularly slight in 1921. The mildews, on the other hand, were unusually bad in 1921, and common scab of potatoes,

[1] Ministry of Agriculture and Fisheries. Report on the Occurrence of Fungus, Bacterial and Allied Diseases on Crops in England and Wales for the years 1920–21. (Miscellaneous Publications, No. 38.) Pp. 104. (London: H.M. Stationery Office, 1922.) 3s. net.

a disease that has recently been shown to prefer warm soils, established a record in virulence.

One may hope that the accumulation of such facts (of which the report contains many), and their correlation with the weather charts which are attached, will enable trustworthy forecasts of the intensity of particular diseases to be issued. It is unnecessary to emphasise the practical value of this to the grower.

Another point of the highest practical interest, and one that is best brought out by the methodical records of a survey, is that of varietal resistance to specific diseases. Such a year as 1920 is invaluable in establishing the behaviour of different varieties of potatoes to blight under optimum conditions for the latter. Kerr's Pink, for example, appears at or near the top of nearly all the lists of blight-resistant potatoes that are also immune to wart disease.

Equally valuable are the records of new crop parasites. No less than 136 names have been added to this report as compared with that for 1919, and several of these are diseases not previously known to occur in the country.

The report deserves a wide circulation at home and abroad, as it presents in a handy and convenient form a remarkably complete summary of the fungous and allied troubles with which the British grower has to contend.

Wave-power Transmission.

AN interesting paper has recently been presented to the North-East Coast Institution of Engineers and Shipbuilders, by W. Dinwiddie, on wave-power transmission. Wave-power machines are classified under three heads: (1) Continuous waves, where the generating plunger moves with simple harmonic motion. (2) Impulse waves, in which a single harmonic motion is transmitted in wave form at regular intervals, greater than the period of the motion itself. (3) Sychronous and asychronous motors, monophase or polyphase, in which direction research is proceeding.

Liquids such as oils and water are at present the media used, while the transmission of impulse along a steel wire has been used. A reciprocating pump plunger of small stroke is oscillated at a high speed at one end of a closed pipe line. Waves of compression and expansion are propagated through the pipe line. If the pipe line is completely closed at the other end, very high pressures can be generated in the pipe line; but if a plunger similar to the pump plunger is placed there, this will move in synchronism with the pump plunger, and is therefore able to do work on some type of machine. To prevent excessive rise of pressure in the pipe line when the sychronising plunger is stopped, capacity analogous to a condenser in an electric circuit is put in the pipe line, and if all machines are cut off a stationary wave is formed and theoretically no energy is given to the system by the generator. It is desirable that connexions to machines along the pipe line shall be made at $\frac{1}{4}$ wave-length points. Machines tapped in at half wave-length points along the pipe will be self-starting and stable in running, while those at the quarter wave-length and three-quarter wave-length will not be self-starting. If, however, a machine is started at half wave-length along the pipe, then a machine at a quarter wave-length will start; and if a machine is started at a wave-length along the pipe, then machines at a quarter and three-quarter wave-length will start. That this is so can be seen by examining the changes of pressure that take place at these points, when there is a stationary wave, and when there is a progressive wave superimposed on the stationary wave.

The principle has been successfully applied to controls on aeroplanes, to the working of rock-drilling machines, and to riveters. A description of the special transmission pipes to resist the high pressures generated, and the mechanism for rotating the rock drill, is given in the paper.

University and Educational Intelligence.

ABERDEEN.—The University Court has agreed to refit the Botanical Museum in Old Aberdeen, prior to the occupation of the new botanical department which is at present being built there. It has also agreed to make provision for increased laboratory accommodation for the department of chemistry.

CAMBRIDGE.—Mr. T. M. Cherry, Trinity College, has been elected to an Isaac Newton studentship, and the tenure of the studentship of Mr. W. M. H. Greaves, St. John's College, has been renewed for one year.

Smith's prizes have been awarded to Mr. J. C. Burkill, Trinity College, for an essay on "Functions of intervals and the problem of area," and to Mr. A. E. Ingham, Trinity College, for an essay on "Mean value theorems in the theory of the Riemann Zeta-Function." Rayleigh prizes have been awarded to Mr. E. F. Collingwood, Trinity College, for an essay on "The formal factorisation of an integral function of finite integral order," to Mr. W. R. Dean, Trinity College, for an essay on "The elastic stability of a plane plate," to Mr. E. C. Francis, Peterhouse, for an essay on "The Denjoy-Stieltjes integral," to Mr. C. G. F. James, Trinity College, for an essay on "The analytical representation of systems of space curves," and to Mr. M. H. A. Newman, St. John's College, for an essay "On discontinuities of functions of a single real variable."

The subject proposed for the Adams prize for the period 1923–4 is "The physical state of matter at high temperatures." Investigation is suggested of the statistical equilibrium of an assemblage of atoms in various ionised and quantised states together with free electrons and radiation. The essay may deal, however, in any way with the simplifications or the complications which appear in the properties of matter at high temperatures.

The Special Board for Oriental Studies will proceed to the election of the Eric Yarrow student in Assyriology early next term.

The Board of Research Studies in publishing its third report announces that the number of research students has risen to 179. Of these about two-thirds are working on the scientific side; chemistry and physics have the largest number, followed by botany, agriculture, and biochemistry.

Grants from the Gordon Wigan fund have been made to Prof. Punnett for plant-breeding experiments, to the Museum of Zoology for cases, to Prof. Gardiner for a centrifuge and incubator, to Mr. Harker for sections of rocks, and to Prof. Seward for sections of fossil plants.

DURHAM.—The council of Armstrong College, Newcastle-upon-Tyne, invite applications for the chair of philosophy. The latest date for the receipt of applications and testimonials is May 1. They should be sent to the Registrar.

LONDON.—The following doctorates have been conferred:—*Ph.D. in Science:* Mr. M. V. Gopalaswami of University College for a thesis entitled "Economy in Motor Learning"; Mr. A. M. Mosharrafa of King's College for a thesis entitled "The Quantum Theory of Spectral Series"; Mr. W. S. G. P.

Norris of the Imperial College (Royal College of Science) for a thesis entitled "The Formation and Stability of Spirane Hydrocarbons"; and Edith H. Usherwood of the Imperial College (Royal College of Science) for a thesis entitled "(i.) The Formation of Heterocyclic Rings involving Reactions with the Nitroso- and Nitro-groups in their various Tautomeric Modifications; (ii.) Experiments on the Detection of Equilibria in Gaseous Tautomeric Substances."

A post-graduate scholarship in science of the yearly value of 125*l.*, for two years, is being offered to Bedford College graduates for award in June next. Further information will be furnished upon application, by the Secretary of the College, Regent's Park, N.W.1.

MANCHESTER.—Mr. R. S. Adamson has resigned his post as senior lecturer in botany on his appointment to the Harry Bolus chair of botany in the University of Cape Town.

Mr. C. R. Christian has been appointed temporary demonstrator in pathology.

The Court of Governors has authorised the conferment of the following honorary degrees: *D.Sc.*: Prof. Niels Bohr, Copenhagen; Prof. F. G. Hopkins, Cambridge; and Mr. W. B. Worthington, president of the Institution of Civil Engineers, 1921–1922.

WE have received from the newly constituted University of Lithuania, Kaunas (Kovno), a copy of a bilingual—Lithuanian and English—calendar. The University, which was opened in February 1922, has the following faculties: theology and philosophy, humanities, law, mathematics and natural sciences, medicine, and technical science (engineering, chemical technology, architecture, etc.). It has 45 professors, 37 docents, and 35 members of the junior teaching staff, while there are more than a thousand students. It appeals to cultural institutions to help in the establishment of a library by sending books and other publications.

LOUGHBOROUGH COLLEGE celebrated its first presentation day on March 10, when the College diploma was conferred on some 250 students of the following departments: mechanical and civil engineering (69), electrical (31), automobile (32), pure and applied science (10), commerce and economics (88), training of teachers (31). The Minister of Labour, Sir Montague Barlow, who presented the diplomas and gave an address, remarked that the College is carrying out a very interesting experiment in undertaking a course which combines very closely theoretical studies and practical experience. This feature, to which we directed attention in our issue of October 21, p. 562, aims at securing for engineering students advantages comparable with those which a School Hospital gives to medicals. An essential principle of management of the instructional factory is that the output should be saleable. During the war the College trained more than 2300 munition workers, and at its close inherited the fine buildings erected for this work as well as valuable engineering equipment. Among the post-war students have been more than 500 enrolled under the scheme of grants for higher education for ex-service students; 237 of them have taken the diploma, and of these 138 have been satisfactorily placed in employment. The number of private fee-paying students enrolled is 343. There are students from Australia, South Africa, India, and many foreign countries. The College aims at a normal enrolment sufficient to enable the productive work scheme to be carried on as a commercial and economic enterprise.

Societies and Academies.

LONDON.

Royal Society, March 15.—J. A. **Carroll**: Note on the series-spectra of the aluminium sub-group. In contradistinction to the alkali metals, the highest terms in the known series-spectra of the elements of the aluminium sub-group are the common limits of the sharp and diffuse series, and not the limits of the principal series. Measurements of the ionisation and resonance potentials for thallium suggested that there might be a yet undiscovered principal series in the far ultra-violet, the limit of which would be the greatest term and would correspond with the normal state of the thallium atom. Against this is the absence of positive evidence of such a series, and the easily reversible nature of the lines of the subordinate series in the arc spectra. Evidence as to the normal state of the atoms is afforded by an investigation of the absorption spectrum of the cool vapour of one of the elements in question, *e.g.* thallium. The lines were members of the subordinate series, thus confirming the original series arrangement. The results accord with the latest developments of Bohr's theory.—W. E. **Curtis**: The structure of the band spectrum of helium.—II. Seven of the doublet bands previously examined by Fowler have been studied in detail. The structure of the bands, in the main, is in agreement with the requirements of the quantum theory; some discrepancies are discussed in connexion with Kratzer's half-quantum hypothesis. Values for the moments of inertia of the molecules concerned are derived by a graphic method. Several perturbations are recorded (the first examples in this spectrum) and their significance is discussed.—G. C. **Steward**: Aberration diffraction effects. Diffraction theory would indicate that the image of a luminous point, given by a symmetrical optical system, should be a system of luminous rings, and this was investigated by Airy in 1834; geometrical theory leads to a consideration of several types and orders of aberration, and the modification of the "ideal" diffraction pattern produced by these geometrical aberrations is discussed. The method adopted depends upon the Eikonal function of Bruns. Aberration diffraction effects are dealt with, assuming that the stops of the optical system are circular, with centres upon the axis of symmetry. Other stops used, namely, the usual circular aperture, but with the central portion stopped out, one (or two parallel) narrow rectangular aperture, and a semi-circular aperture are also considered.—Lord **Rayleigh**: Further observations on the spectrum of the night sky. Specially designed spectrographs having a working aperture of $f/\cdot 9$ are described. The northern and southern horizons have been photographed simultaneously on the same plate, and the aurora line recorded almost down to the horizontal direction in each. There is no marked difference of intensity between them. The negative nitrogen bands appear fairly often in photographs taken in the north of England, but similar spectra taken in the south of England do not show them. They are always strong in the Northern Lights in Shetland. Two bright lines or bands in the blue and violet were always observed, the approximate positions, determined on the *very* small scale spectra, being 4200 and 4435. Their origin is not known. In addition, there is the aurora line 5578, also of unknown origin, and the dark Fraunhofer lines H and K.—Lord **Rayleigh**: Studies of iridescent colour, and the structure producing it. IV.—Iridescent beetles. Some of the iridescent beetles which have striking metallic colours show band systems in the spectrum of the reflected light.

That from *Pelidnota sumptuosa* shows a central maximum bordered on either side by subordinate maxima in exactly the way that reflection from a uniformly spaced assemblage of 34 thin plates would require. In the spectrum from one of the golden beetles, *Callodes parvulus*, the bands are accounted for on the supposition of two assemblages, each consisting of several reflecting planes, the distance between the assemblages being about 8μ.—J. W. **Nicholson**: Oblate spheroidal harmonics and their applications.—J. W. **Nicholson** and F. J. **Cheshire**: On the theory and testing of right-angled prisms.—J. C. **McLennan** and D. S. **Ainslie**: On the fluorescence and channelled absorption spectra of caesium and other alkali elements. Caesium exhibits a fluorescence and a channelled absorption spectrum in the neighbourhood of $\lambda = 8000$ when the vapour of the element is traversed by white light. In the absorption spectrum, bands separated by intervals that were simple multiples of 24 Å were found. Like sodium, potassium exhibits channellings in its absorption spectrum, in the neighbourhood of the second member of its doublet series. Indications have been obtained of channelling in the absorption spectrum of lithium in the near ultra-violet region.—W. **Stiles**: The indicator method for the determination of coefficients of diffusion in gels, with special reference to the diffusion of chlorides. The coefficient of diffusion increases at a greater rate per degree rise in temperature the higher the temperature; the relation between coefficient of diffusion and temperature in gels is thus not linear as is usually assumed for free diffusion in water. The coefficient of diffusion decreases with increasing concentration of gel and increases with decreasing concentration of the diffusing salt. Empirical expressions are given for these relationships.—H. T. **Flint**: A generalised vector analysis of four dimensions. An account is given of an invariant vector calculus in a notation which is the natural generalisation of that of Gibbs. Contravariant and covariant vectors are related by means of an operator—the extended idem-factor, and tensors are introduced as dyadics and polyadics. The expressions familiar in the tensor calculus of Riemann and Christoffel appear very simply in the analysis. Separated points are connected by the geodetics, and a simple definition of parallelism at two points leads at once to the Weyl parallel displacement relations.

Geological Society, February 28.—Prof. A. C. Seward, president, and, afterwards, Prof. W. W. Watts, vice-president, in the chair.—S. Hazzledine **Warren**: (1) The late glacial stage of the Lea Valley (Third Report). One new section found occurred at the level of, and in the area occupied by, the Middle or Taplow Terrace, whereas all the other sections were in the Low Terrace. It consisted of a bed of seed-bearing clay, in the middle of an old gravel-pit partly built over. The Taplow deposits yield a fairly temperate fauna and flora. The site is close to the head of a small streamlet, and it is assumed that the Arctic plant-bed is of Low-Terrace or Ponders-End date, and that it represents the silting of a stream which flowed across the Taplow Terrace. According to a report on the Arctic flora by Mrs. E. M. Reid and Miss M. E. J. Chandler, there is nothing to distinguish the flora from that of the previously-described localities of the Lea Valley. (2) The *Elephas-antiquus* bed of Clacton-on-Sea (Essex), and its flora and fauna. The deposit fills a deep, narrow, steep-sided, river-channel which apparently flowed into the Thames when that river occupied the deep channel now submerged off the coast of Essex. The Clacton bed yields evidence of an abundant flint-industry which is one of the best-known representatives of the Mesvinian series. This is of Late Chellean or Early Acheulean date, although it shows no cultural connexion with those industries, but it may be the precursor of Mousterian. The deposit is also rich in mammalian remains. Appended to the paper are detailed reports on the palæontology.

Linnean Society, March 1.—Dr. A. Smith Woodward, president, in the chair.—J. N. **Halbert**: Notes on the Acari, with descriptions of new species.—C. F. M. **Swynnerton**: Aspects of African woodland formations. Rain-forest, coppice, and thicket due to grass-fires, the means of prevention from injury by such fires, and the preservation of the forests by careful nurture, were dealt with.

Aristotelian Society, March 5.—Prof. A. N. Whitehead, president, in the chair.—E. S. **Russell**: Psychobiology. Physico-chemical method is applicable to many of the phenomena of life, but it fails of complete success because it cannot take account of the individuality and striving of the living thing, nor its flexibility of response. Also it cannot take into consideration, as an active factor, the past history of the organism, for it must regard past history as completely summed up in present state. The true alternative to the materialistic view is not vitalism, but a psychobiological view based upon a monadistic philosophy. Both the movements and the morphogenetic responses of the organism must on this view be interpreted as actions of a living individuality, carried out in response to its own sensed environment, in pursuance of the fundamental conative impulses which are the core of its being.

Zoological Society, March 6.—Sir S. F. Harmer, vice-president, in the chair.—Mr. **Caldwell**: A case of apparent melanism in Tippelskirch's Giraffe (*Giraffa camelopardalis tippelskirchi*).—H. G. **Cannon**: A note on the zoæa of the land-crab, *Cardisoma armatum*.—Miss L. E. **Cheesman**: Notes on the pairing of the land-crab, *Cardisoma armatum*.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—VIII. Carnivora.—T. H. **Ring**: The elephant-seals of Kerguelen Land.—R. **Kirkpatrick**: On the tunicate *Rhizomolgula globularis* Pallas. No. 24. Results of the Oxford University Expedition to Spitsbergen, 1921.

Society of Public Analysts, March 7.—Mr. P. A. Ellis Richards, president, in the chair.—A. **Lucas**: The examination of firearms and projectiles. A particular weapon may sometimes be recognised by the rifling marks imprinted on a bullet, while the nature of the fouling left in the barrel after the weapon has been fired may afford information as to the nature of the original powder and also, in some cases, the period that has elapsed since the last discharge. The composition, dimensions, and markings on bullets, slugs, etc., are described, and directions are given for the reproduction of rifling marks and for the chemical analysis of projectiles.—R. C. **Frederick**: The interpretation of the results obtained in the analysis of potable waters.—S. B. **Phillips**: Determination of the purity of vanillin. After reviewing the various methods proposed from time to time the author described two processes for estimating vanillin—one volumetric, and the other gravimetric.

EDINBURGH.

Royal Society, March 5.—Prof. F. O. Bower, president, in the chair.—F. O. **Bower**: The relation of size to the elaboration of form and structure of

the vascular tracts in primitive plants. Measurements of the diameters of the whole part (stem or petiole) and of the conducting tract (stele or meristele) in many living and fossil plants show that increasing size is accompanied by increasing complexity of structure. There is a tendency in the various organs of plants to decentralise their conducting tracts as the part enlarges, and to advance them in greater or less degree towards the periphery of the transverse section. This decentralisation is carried out homoplastically, with details differing in the several parts affected, in various primitive organisms. It is not inherent in any one organ. The final result may be a convergence of structure in different plants, and in different parts of the same plant. This is illustrated (i.) by the solenostele, (ii.) by the zygopterid petiole, (iii.) by the Dipterid petiole, (iv.) by the petiole of Anachoropteris. Stellation of the stele or of the xylem, medullation, decentralisation of the stele, and finally its disintegration, so far as they are functions of increasing size, must lose grade for comparative purposes.—Miss Margery **Knight**: The life history and cytology of *Pylaiella litoralis*. Development and the reproductive processes were described. This involved a detailed cytological study of the organism. In particular it is shown that there is no obligate relationship between cytological features, somatic characters, and reproductive organs. The object of the paper is to emphasise this fact, and thereby to reopen discussion on the value of cytological characters in phyletic study.—A. **Steuart**: An electric clock, with detached pendulum and continuous motion. The speed of the driving electric motor is controlled by a pendulum, without throwing any work on the latter. A gravity arm acts on the pendulum, and then short-circuits a resistance in the motor armature circuit. The motor raises the gravity arm, and so replaces the resistance. A powerful turret clock and a silent regulator clock were demonstrated.

SHEFFIELD.

Society of Glass Technology, February 21.—Prof. W. E. S. Turner, president, in the chair.—W. W. **Warren**: Organising for production from pot furnaces. The function of a furnace is to melt glass. For most purposes, circular gas furnaces, either regenerative or recuperative, are to be preferred to those of rectangular shape. Among the advantages of working to a time-table in the matter of founding and working during definite periods are: (*a*) the responsibility devolved on the producer and furnacemen to have glass ready in time for their co-workers; (*b*) mixing, filling pots, and all labour subsidiary to glass-making work smoothly in an appointed groove. Informal talks with the men's committee, with a blackboard for illustrating points and explaining figures, rarely failed to convince them that foreign competitors' methods and prices were a challenge to business sport. But if there were rewards at the end of the production programme, the men must share.—F. W. **Hodkin** and Prof. W. E. S. **Turner**: The effect of boric oxide on the melting and working of glass.—Violet **Dimbleby**, S. **English**, and Prof. W. E. S. **Turner**: Some physical properties of boric oxide-containing glasses. Prof. Turner presented these two papers. The new British chemical glass, American pyrex glass for chemical ware and cooking ware, and various forms of illuminating glasses, all contain boric oxide. Although the addition of boric oxide to a silicate glass brought a marked increase in the durability, this beneficial effect only holds good up to a certain point. Similar inversions in other properties, *e.g.* in the thermal expansion, the annealing temperature, the density, and refractive index, had also been found.

Official Publications Received.

Imperial Earthquake Investigation Committee. Seismological Notes No. 3: The Semi-Destructive Earthquake of April 26, 1922. By F. Omori. Pp. 30+18 plates. (Tokyo.)

The Carnegie Foundation for the Advancement of Teaching. Seventeenth Annual Report of the President and of the Treasurer. Pp. vii+211. (New York.)

Annual Report of the Department of Fisheries, Bengal, for the Year ending 31st March 1922. Pp. iii+8+2. (Calcutta: Bengal Secretariat Book Depot.) 4 annas.

Lick Observatory Bulletin No. 343: An Investigation of the Spectra of Visual Double Stars. By Frederick C. Leonard. Pp. 169-194. (Mount Hamilton, California.)

State of California: Fish and Game Commission. Twenty-seventh Biennial Report for the Years 1920-1922. Pp. 139. (Sacramento: California State Printing Office.)

Shirley Institute Memoirs. Vol. 1, 1922. Pp. v+174. (Didsbury, Manchester: Shirley Institute.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 10, Part 5: Experimental Studies on the Developing Eggs. By T. Inukai. 1: Age and Environment in Amphibia. Pp. 107-140+2 plates. Vol. 10, Part 6: Spectro-Chemical Studies on some Biochemical Color Reactions. By Tetsutaro Tadokoro. Pp. 141-189+6 plates. (Tokyo: Maruzen Co. Ltd.)

University of London: University College. Report of the University College Committee (February 1922–February 1923) with Financial Statements (for the Session 1921–22) and other Documents for Presentation to the Senate. Pp. 104. (London: Printed by Taylor and Francis.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1922. Pp. 210. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, MARCH 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (6).

MONDAY, MARCH 26.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. J. J. B. Coles: Relativity and Christian Philosophy.

INSTITUTE OF ACTUARIES, at 5.—P. N. Harvey: The Scheme of National Health Insurance considered in relation to the Valuations of Approved Societies as at December 31, 1918.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. H. Mummery, and B. Grellier: Multiple Dentigerous Cysts.—Mrs. Mellanby: Diet, Dental Structure and Caries.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. Christy: The Waterways of the Sudd Region, Bahr el Ghazal.

TUESDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at St. Bartholomew's Hospital), at 5.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Frank Baines: The History and Repair of the Roof of Westminster Hall.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—P. J. Waldram and J. M. Waldram: Window Design and the Measurement and Predetermination of Daylight Illumination.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. W. Barthold: The Nomads of Central Asia.

WEDNESDAY, MARCH 28.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. Greenly: Further Researches on the Succession and Metamorphism in the Mona Complex.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—Demonstrations and Exhibits:—J. W. Atha and Co.: The New Zeiss Photographic Eye-piece, "Phoku."—J. H. Barton: A New Research Microscope of Original Design.—R. and J. Beck, Ltd.: A Microscope specially suitable for the Examination of Large Surfaces of Paper and of Prints and Engravings.—The Edison Swan Electric Co. Ltd.: The Ediswan Pointolite Lamp, 30, 100, 500, and 1000 c.p. in Operation; The Working of the Alternating Current Pointolite Lamp.—Ogilvy and Co.: A New Stereoscopic Magnifier giving Large Field of View and Long Working Distance.—M. P. Swift: Professor Shand's Recording Micrometer which is designed to facilitate the Quantitative Estimation of Minerals in Rocks.—At 8.—J. Strachan: The Manufacture of Containers and Papers used for the Wrapping of Foodstuffs.—H. B. Wrighton: The Microscope in Metallurgical Research.—S. R. Wycherley: Microscopy in the Examination of Manufactured Paper.

PUBLIC LECTURE.

SATURDAY, MARCH 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: The Natural History of Lobsters and Prawns.