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Animal Mechanism.

THE presidential address of Sir Charles Sherrington to the British Association at Hull directs our thoughts to problems of the mechanism of vital processes, especially to those of the nervous system. It is evident that the obstacles which we meet with in our progress to better understanding of what happens in those complex systems which we call "living" have greatly occupied the attention of the learned president, and those of us who are struggling on our way will be grateful for his helpful and stimulating outlook. We shall do well to take careful note of his remarks.

The great difficulty which continually presents itself to us is the conception of any physiological process as a whole. We find out, often at the expense of much labour, some isolated facts, but the integration of these facts to explain the complete mechanism remains beyond our powers. Take the case of muscle. We discover that muscular contraction and relaxation are associated with a change from glycogen to lactic acid and back again. But how is the energy of the chemical reaction converted to that of tension, which is the really important matter? It is easy to say that it is through changes in surface tension on longitudinally arranged elements, but we soon meet with further difficulties. It may be remarked that more work is needed on the electrical properties of surfaces and especially as to the effect of electric charge on the rate of passage of ions through membranes which are themselves charged. The problem in the nervous system shows itself in the form of finding out what happens in the centres between the receipt of an afferent "sensory" impulse and the motor reaction to it. How is the impulse directed into some particular channel and prevented from passing into another? Why does it go sometimes one way, and at other times in another way? What is it that stops it after it has been set going? The president is careful to point out that when the physiologist says "why" he means "how," and we must not forget this.

It will be realised that one of the most important and difficult problems, especially suggested in the last of the questions put above, is that of inhibition. Is it possible to account for all the phenomena on the basis of difference in rate, refractory period and decrement as affecting the transmission of a nervous impulse? The article on "Spinal Reflexes" by Prof. Alex. Forbes in *Physiological Reviews* gives us a very valuable account of what can be done in this way. On the other hand, is there evidence for the existence of something essentially different between excitation and inhibition? When a nervous impulse arrives at a muscle cell or a neurone in activity, is there some structure in which it ends that causes it to stop abruptly the process going on? In other words, are there two opposite processes of excitation and inhibition, similar in nature but opposite in sign? We come across the old problem of duality, of some philosophical interest. The question as to the existence of positive and negative electricity, as in the nucleus and electrons of an atom, is a cognate one, and we are reminded of the frequent physiological opposition between anions and cations.

With respect to the hope or probability of further progress in the explanation of vital processes, Sir Charles Sherrington directs attention to the justification that what has already been done gives us in believing that "further application of physics and chemistry will furnish a competent key" to many mechanisms. Although we may not be able to construct such mechanisms ourselves, we may understand the principles on which they work, somewhat as a man may be able to explain how an electro-motor works, notwithstanding that he may not have the skill to make one. There are, however, other things, more particularly concerned with growth and development, which we, as yet, are a long way from comprehending. What it is that makes a living creature a united whole and "how the mind is connected with its bodily place" belong to these. The question is asked, "Can we suppose a unified entity which is part mechanism and part not?"

The latter part of the address is devoted to some important relations of the physiology of the brain to the doctrines of psychology and sociology. We must not leave out of consideration the combination of individuals into social organisms, "new in the history of the world." Man must feel that to rebel against this great supra-individual process "would be to sink lower rather than to continue his own evolution upward."

There are many apposite points brought out in the discussion on the "mental" functions of the brain. We know that the integrity of certain parts of the brain is essential for mental activity, while what we call the lower levels are non-mental. Since we step from one world to another, as it were, when we pass from a nerve impulse to a psychical event, we might expect that there would be some striking change of structure when we cross the boundary between the non-mental and the mental regions of the brain. But we find the "same old structural elements." "The structural interconnexions are richer, but that is merely a quantitative change." Another difficult problem is the position of psychical events in the energy balance-sheet of the body. Do they take their place in obeying the first law of energetics? But the whole of this discussion must be read in the address itself to be properly appreciated.

The United States Chemical Foundation.

EARLY in July last, President Harding instructed the Alien Property Custodian of the United States to demand the return of all patents, trade marks, etc., which had been sold to the Chemical Foundation, on the ground that "the sale was made at so nearly a nominal sum that there is reason to believe that this government has not faithfully observed the trust which was implied in the seizure of this property." The birth of the Foundation was the subject of much abuse in Germany, and now a resolution of the third German-American National Conference, with Mr. G. S. Viereck as chairman of the resolutions committee, declares that "we greet with satisfaction the first steps of the administration to correct the iniquities committed by the custodian of alien enemy property." Meanwhile, the consternation produced among chemists of the United States by the President's action will be readily understood.

The Chemical Foundation was established in 1919, and purchased 4000 patents from the Alien Property Custodian for a sum of 250,000 dollars. It is a privately managed enterprise, with well-known men of high character as voting trustees, and the president, Mr. Garvan, is not salaried. The Foundation was generally commended at the time of its inception, and its affairs appear to have been conducted on altruistic principles and without profit. Non-exclusive licences have been granted in order to break monopolies and to benefit consumers; licences to the Government have been free, and on others the royalties have been low. To illustrate the beneficial effect of this policy, it has been stated that under the German monopoly the cost of salvarsan was 4·50 dollars per dose to the physician, and 2·50 dollars per dose in quantity to the Government, whereas now the price has fallen to 1·50 dollars and about 30 cents, respectively.

A reasonable conclusion to draw from such evidence is that although the original price paid by the Foundation for the patents may have been "nearly a nominal sum" if regarded as a monopoly price, it was nevertheless a fair competitive price. Action is being taken by the American Chemical Society, which represents some 15,000 men and women working in educational institutions, research laboratories, and industrial plants, who regard the Chemical Foundation as the nucleus of organic chemical industry in the United States. The society, through a committee which does not include dye-makers or chemical manufacturers, is seeking a conference with President Harding for the purpose of presenting information which it believes he cannot have received before adopting such revolutionary procedure.

Galton's Centenary.

Francis Galton, 1822–1922: A Centenary Appreciation. By Karl Pearson. (Department of Applied Statistics, University College, London. Questions of the Day and of the Fray, No. 11.) Pp. 23. (London: Cambridge University Press, 1922.) 2*s.* net.

PROF. KARL PEARSON does not think that this generation is likely to do justice to the part Sir Francis Galton played in the spread of human knowledge and in its application to the future of the human race. His own appreciation he would have others share, and he whips them with scorpions as an inducement. As he says, "the time is hardly suited to impressing on the majority of men a conviction of the futility of most of their aims, of the depths of their ignorance of what makes for progress, and of the unsatisfying nature of their present pleasures."

The welcome appreciation begins with an account of Victorian science, the science of Darwin, Lyell, Hooker, Faraday, and other giants, which, he says, little men belittle—for it is impossible to appreciate Galton unless we bear in mind that he was the product of the Victorian epoch. Endowed with a fine inheritance, Francis Galton had the advantage of broad training and wide experience, very different from the early specialisation of to-day; "he had far more mathematics and physics than nine biologists out of ten, and more biology than nineteen mathematicians out of twenty, and more acquaintance with diseases and anomalies than forty-nine out of fifty biologists and mathematicians together." Darwin awoke him from "the torpor of tribal dogmas," and turned his widely interested mind to the problems of evolution. Along both observational and experimental lines, he began to study sweet-peas, moths, and man. "In his notebook on the sweet-pea experiments occur the first correlation table, the first regression curve, and the first numerical measure of the intensity of heredity, *i.e.* that between mother and daughter plant." From Mendel's peas has arisen the greater part of modern genetics; from Galton's there sprang the correlational calculus, solidly founded in "Natural Inheritance" published in 1889.

Darwin had suggested, contrary to his usual method of keeping to observed facts, the hypothesis of "pangenesis," that hereditary particles or gemmules given off from the various structures of the body are concentrated in the reproductive cells, and influence the development of these into new individuals. Galton suggested an experimental test, transfusing the blood of different kinds of rabbits to see if the offspring were influenced. The results showed that the transfusion had no effect on the offspring, and Galton tacitly discarded pangenesis. But continued reflection led him, as it also led Weismann, to the idea of germinal continuity. We believe that the idea of parent and child being successive representatives of the same "stirp" or germ-plasm had occurred, more or less clearly, to two or three other biologists before either Galton or Weismann; but Prof. Karl Pearson seems to find something "little" in directing attention to historical anticipations. There is no doubt, however, that "Galton's idea of the 'stirp,' better known under the name given to it by its later German propounder [we should say, 'independent discoverer'], the 'continuity of the germ-plasm,' has played a very large part in modern theories of heredity." It has indeed enabled biologists to understand for the first time clearly why like *must* tend to beget like.

From the fundamental idea of germinal continuity there arose in Galton's mind two broad principles, (1) that bodily modifications, or "acquired characters" in the technical sense, are not likely to be transmitted; and (2) that the differences in the characters of the offspring produced by a difference of stirp are immensely more important than those which can be produced by differences of environment. From his study of identical and non-identical twins he concluded that "nature" is indefinitely stronger than "nurture." We confess to sympathy with what Prof. Pearson calls the platitude that "nature" and "nurture" are inseparably correlated as two essential components of one resultant. Moreover, we feel sure that Galton was naturalist enough to know that improvements in "nurture" may determine the meshes of the sieve in relation to which germinal fluctuations and mutations—better and worse changes in "nature"—are sifted.

It is plain, however, that pondering over the relative evolutionary values of "nature" and "nurture" led Galton to the question which dominated the rest of his life: what evolution may mean for man. What Pasteur was along one line, Galton was along another, a pioneer in the biological control of life. Can man's constitution—in modern phraseology, his gametic composition—be improved, by mating best with best, and fit with fit, and by refraining from sowing tares with wheat? Or may we hope to effect some progress by amelioration of "nurture"—environmental, nutritional, and functional? For improved "nurture" may prompt, for all we know, progressive germinal variations; may determine the survival or elimination of variations; may, in viviparous organisms, count for much in the ante-natal life; and may, in mankind, have an almost hereditary influence on the amelioration of the social *milieu.* Galton's view was that the improvement of the human *breed* was the promiseful line of evolution, but we cannot think of him as failing to appreciate the manifoldness and the subtlety of nurtural influences, both on the individual and on the race.

Prof. Pearson gives us in his masterly appreciation a useful tonic. "The laws of evolution are open to our study, let us once understand them, and man can elevate man as he has developed his domestic animals —such was the gospel of Galton." Here we are all agreed, Galton was a great man of science and also a social reformer; and it is a satisfaction to all men of goodwill that he continues to live with such vigour in the Laboratory which he founded. The appreciation has as its frontispiece a beautiful sketch of Sir Francis Galton in 1910, in his "still unexhausted exuberant youth."

Modern Dietetics.

Vitamins and the Choice of Food. By Violet G. Plimmer and Prof. R. H. A. Plimmer. Pp. xii + 164. (London: Longmans, Green and Co., 1922.) 7*s.* 6*d.* net.

THE old view that a diet was satisfactory, provided that it contained a certain amount of protein and had a sufficient calorie value, has, as is now well known, been modified in two very essential particulars. The quality of the protein is of the first importance; it must supply the particular amino-acids required by the consumer, and must supply them in the proper amount. Further, there must be present the vitamins, the exact nature and function of which are still unknown, but which are essential for growth and health.

It is to these two aspects of the subject that the present work is chiefly devoted, the authors having set themselves the task of producing an account suitable for the general reader. In this they have been on the whole successful, although occasionally the superabundance of facts renders the matter difficult of assimilation. After an introduction dealing with the general principles of dietetics, the subject of the vitamins and their discovery is developed on orthodox lines. The important question of quality of protein, led up to and illustrated by an account of pellagra, is then treated, and the book concludes with two very interesting chapters on the effect of partial deficiencies in the food and errors in selection of food. In an appendix are given a table of distribution of the vitamins in food-stuffs and lists of food-stuffs rich in each of the three vitamins, followed by a very useful series of notes on food-stuffs, from which a good idea of the efficiency of a diet can be easily and rapidly obtained. The book is well produced and contains a number of interesting illustrations.

It is an inevitable consequence of the rapid progress which is being made in this branch of dietetics that the position with respect to some of the matters dealt with has changed considerably since the book was printed. This is notably the case with regard to rickets, the very recent work of McCollum and of Korenchevsky on experimental rickets in rats, and the remarkable discovery of the preventive and healing effect of sunlight on this disease, having come too late for inclusion. Similarly, the large part played by atmospheric oxidation in the inactivation of the antiscorbutic vitamin is not made clear.

The gospel preached by the authors is the orthodox one that safety is to be found in fresh natural food-stuffs, and it is wisely pointed out that instinct, often believed to be a guide to the choice of food, is no longer so under the conditions of modern civilisation. White bread, for example, almost universally preferred in this country, is far inferior in vitaminic potency to whole-meal or "germ" bread, and no instinctive need is felt for green vegetables and salads. The choice of food must be guided by knowledge, and it is pointed out that the distribution of food within the family is often conducted on quite erroneous principles.

> "Children are supposed to be sufficiently nourished if they have bread and jam and plenty of puddings with little meat or butter. It is unfortunately the custom to give to the father or wage-earner the best food, whereas his requirements for heavy manual work are actually better satisfied by the high energy value of bread, jam, and margarine. The child needs the wherewithal to grow, that is protein and vitamins in addition to calories."

It is in the provision of fresh vegetables to supplement the staple diet of bread, margarine, and meat, all very poor in vitamins, that the chief value of the allotment movement lies (as pointed out by Drummond), and it is to be hoped that the great extension of this system which was called forth by the necessities of the war will be maintained and still further increased in the scarcely less strenuous times of peace.

Even natural food-stuffs, however, are by no means constant in their content of vitamins. Little is known as yet of the cause of the variations in vegetable products at different periods of growth and under diverse conditions, but that wide variations occur has been definitely proved. In products derived from animals this variation is still more marked, and the authors rightly lay stress on this fact, pointing out that the potency of materials such as animal fats, and above all milk, depends upon the diet of the animal from which it is derived.

"The milk of cows at grass contains more A-factor than the milk of the same cows on their winter food. . . . At certain times of the year a child receiving fresh whole cow's milk may for this reason only be getting a small amount of this vitamin. . . . Breast-feeding is no protection against rickets if the mother's food is poor in A-factor."

The provision of fresh natural food-stuffs, although greatly to be desired, is a matter of much difficulty, especially in large towns, and is often impossible when military expeditions or explorations in barren regions have to be undertaken. Then the problem of preserving food-stuffs without destruction of their vitamins becomes of great interest and importance. The chief methods for the prolonged preservation of food are canning or bottling and drying, and a considerable amount of investigation has already been directed to the question how far these methods of treatment affect the vitamins. Up to the present, however, sufficient attention has not been paid to the influence of oxidation in these processes. The results so far obtained vary very much with the nature of the material employed. Thus vegetables on drying, as a rule, undergo a considerable loss of antiscorbutic power, that of cabbage being reduced by drying in the air at 37° to about 5-10 per cent. of the value of the fresh material. (The authors are not quite clear on this point, the somewhat misleading statement being made that "cabbage has been successfully dried by a special process devised by Holst and Fröhlich.") Retention of antiscorbutic power by material in the dry state seems to depend on the complete absence of moisture.

Heat sterilisation as applied in bottling and canning processes affects the antiscorbutic more than the other two vitamins, but the influence of oxidation is very great. However, it has been found in practice that a material originally rich in the vitamin, like the tomato, will withstand the commercial process and yield a powerfully active product, canned tomatoes having been successfully used for the prevention of scurvy. Again, lemon-juice in presence of the natural oil of the rind retains its potency for long periods. There seems, indeed, to the writer, to be no insuperable difficulty in the way of the provision of preserved foods containing at all events a large proportion of their original vitaminic potency. Much further investigation on this subject, on strictly quantitative lines, is, however, required, and at present each case must be separately examined, no generalisation being as yet justified. It is, moreover, not beyond the bounds of probability that some method will before long be found of enriching cheap edible oils so that they may supply vitamin A as well as energy at a reasonable cost.

Interesting problems are suggested by almost every page of this book, and it cannot fail to be of great value in disseminating sound doctrine on a subject concerning which there is now widespread ignorance.

Germany and English Chemical Industry.

Englands Handelskrieg und die chemische Industrie. Von Prof. Dr. A. Hesse und Prof. Dr. H. Grossmann. Band 1. Pp. iv+304. Band 2: Neue Folge. *England, Frankreich, Amerika.* Pp. iv+344. Band 3: *Dokumente über die Kali-, Stickstoff- und Superphosphat-Industrie.* Herausgegeben von A. Hesse, H. Grossmann, und W. A. Roth. Pp. iv+204. (Stuttgart: F. Enke, 1915–1919.) 98 marks.

THIS work consists of a series of translations of lectures, speeches, and articles by English, French, American, Russian, and Italian chemists, and by certain publicists like Lord Moulton, and by public bodies as the British Science Guild, which appeared at the outbreak of the Great War, or immediately prior to it. In addition, a number of utterances by public men and others, of more or less importance, have been culled from newspapers and the periodical press to support what is the apparent purpose of the publication, namely, to insinuate that the real motive which impelled England to participate in the war was her distrust and jealousy of Germany's industrial pre-eminence, especially in the chemical arts, and her consciousness that she was losing the world's markets owing to Germany's greater technical skill and scientific knowledge, and her better business organisation and financial methods. This idea is implied in the title of the work. It has been sedulously propagated in Germany that the real author of the war was England, and that it was solely to her diplomacy that the catastrophe was brought about—an explanation, and it may be added an exculpation, which doubtless commends itself to the soul of the Teuton.

There is, of course, no necessity to refute an implication which is notoriously at variance with the facts, and is certainly not held by ordinarily well-informed people, even in Germany. But it is characteristic of German mentality that it should have been seriously entertained even in 1915, when the first volume of this work was issued, and that persons of the position of its editors should have been found to support it.

The translations of the English lectures and addresses, most of which have appeared in the recognised journals dealing with applied chemistry, seem to have been well rendered, although exception may occasionally be taken to the comments and explanatory notes which the editors have appended. But it is more particularly to the tone and purport of the introductory matter which prefaces the several volumes, and for which they are solely responsible, that exception is chiefly to be taken.

At the same time there is an element of unconscious humour about the whole production. In view of the hardihood with which they reproduce, for the benefit of German readers, the many strictures on German commercial methods with which they have been visited, one is tempted to suggest that their knowledge of our national literature might have disposed the editors to prefix as a motto on their title-page the lines:

O wad some power the giftie gie us
To see oursels as others see us!
It wad frae monie a blunder free us
And foolish notion.

But possibly these strictures are really considered by them as implying a compliment to what they regard as their business acumen, but what other people are apt to characterise as "slimness."

Railway Electric Traction.

Railway Electric Traction. By F. W. Carter. Pp. viii+412. (London: E. Arnold and Co., 1922.) 25*s*. net.

THE problems of electric traction on railways deserve special study at the present time. In the past, electrification has been adopted, as a rule, only when abnormal difficulties, such as the existence of a long tunnel, busy urban traffic, very steep gradients, or a very high price for fuel, had to be overcome. It will be remembered that, largely as the result of a tunnel accident attributed to an accumulation of noxious gases, the New York authorities insisted that practically all lines entering the city should be electrified. The underground railways of London, the Simplon tunnel, and the Belt line tunnel of the Baltimore and Ohio Railway, electrified so long ago as 1895, are further examples. The Norfolk and Western Railroad, a heavy goods line, was electrified because of its long and steep gradients. For the same reason the Chicago Milwaukee and St. Paul Railway, which crosses the Rocky Mountains, had to electrify several of its sections. The development of electric railways in Switzerland, in Sweden, in Bavaria, and in Italy is mainly due to the high price of fuel in these countries.

It does not follow, however, that electric traction should be used only when special difficulties have to be overcome. When steam operation is a commercial success, the justification of electrical operation must be that it provides increased transport facilities with no increase in the rates. With steam operation individual power generation is employed, whereas with electrical operation the power is developed in bulk at central stations. In the electrical system a breakdown at a vital point may stop traffic over a wide area, and to obviate this risk a large amount of capital has to be expended in stand-by plant. In several cases, however, it is more advantageous for the railway to purchase its power from a "bulk supply" station. A disadvantage of a steam locomotive is that it consumes fuel so long as it is in commission; whether it is inside or outside the shed, and whether it is at rest or in motion. Tube-cleaning, oiling, and overhauling also occupy a considerable time. The electric locomotive, on the other hand, takes power only when running, and the time spent in inspection, overhauling, and cleaning is insignificant. Experience shows that for a given service the number of electric locomotives required is less than half the number of steam locomotives, but to make the comparison fair it has to be remembered that each electric locomotive must be debited with its share of the working costs of the central station.

The advisory committee of the Ministry of Transport has decided in favour of the direct current system, with a line pressure of 1500 volts, but multiples or submultiples of this pressure may be used. The French, Belgian, and Netherlands governments have come to a like decision. There are, however, thoughtful advocates of single-phase and polyphase systems. Luckily the difference in cost of the various electric systems does not exceed about one, or at the most two, per cent. of the total cost of running the railway. Although from many points of view standardisation of systems is desirable, yet we think that at the present time the carrying out of the single-phase system adopted by the London and Brighton Railway and the direct current system of the North Eastern Railway will be for the benefit of the country.

In the volume under notice the author gives an excellent discussion of the mechanical and electrical problems which traction engineers have to consider. He points out that the bad riding qualities of a locomotive are due to one or both of two general causes, namely, the constraint of the wheels to follow other courses than those towards which they naturally tend, and the setting up of resonant oscillations under the control of the springs. The phenomena of "nosing" and "rearing" he ascribes to the former cause, and those of "rolling" and "pitching" to the latter.

The book can be recommended to the traction engineer, who will find not only a good account of the most modern practice, but also many original dynamical discussions which have a direct bearing on his everyday work. It will well repay study.

Our Bookshelf.

(1) *Hampshire.* By T. Varley. (Cambridge County Geographies.) Pp. xi+212. (Cambridge: At the University Press, 1922.) 3*s*. 6*d*. net.

(2) *Munster.* Pp. xii + 176. (3) *Ulster.* Pp. xii + 186. (The Provinces of Ireland.) Edited by George Fletcher. (Cambridge: At the University Press, 1921.) 6*s*. 6*d*. net each.

(4) *A History of the County of Bedford.* (The Victoria History of the Counties of England.) Part 1, *Geology and Palæontology.* Pp. 36. (London: Constable and Co. Issued in parts, 1920.) 3*s*. 6*d*. net.

(1) MR. VARLEY'S volume is one of the excellent series of the Cambridge County Geographies. The general plan of the series is followed, successive chapters being devoted to different aspects of the county, relief, geology, hydrography, natural history, climate, people, place-names, occupations, history, architecture, and so forth, concluding with a gazetteer of towns and villages. There are a number of illustrations and coloured orographical and geological maps. The maps include the Isle of Wight, which otherwise is outside the scope of the book, but unfortunately they stop short at the county boundaries. This seems to be a needless curtailment of their usefulness. The volume is an excellent handbook to the county and is full of information, but it certainly would be improved by an index. Two criticisms may be offered, which apply rather to the scheme of the series than to this useful volume in particular. The treatment of England by counties can never be completely satisfactory, as it inevitably cuts across geographical regions. Thus the omission of eastern Wiltshire cuts out part of the Avon valley, while the inclusion of the northern slope of the Hampshire downs includes a fragment of country that would be better treated with Berkshire. The other criticism refers to the use of the term geography, as applicable to the book. Since the series claims to be geographical, there should be more correlation of various distributions than is actually the case in the pages; causal effects are not sufficiently emphasised. This is particularly the case with regard to the distribution of population and the sites of towns.

(2) and (3) These volumes are on much the same plan, but they do not claim to be geographies, although in some respects the two volumes are more geographical than the English one. The coloured maps are not strictly confined to the area under consideration, and the regions treated being large, if not always naturally defined, lend themselves to more satisfactory treatment. There is no gazetteer of towns and villages, but a full index to each volume. The books should find a wide acceptance in giving a trustworthy and impartial account of Ireland.

(4) The well-known Victoria History is now published in parts, each of which may be purchased separately. It is thus possible to obtain a full but concise memoir on the geology, botany, zoology, occupations, etc., of each of the counties, furnished with coloured maps by Bartholomew. The separate parts for some thirty counties are now on sale. Many readers whose interests do not embrace all aspects of county lore will be grateful to the publishers for this means of making accessible the scholarly articles of the Victoria History.

A Synopsis of the Accipitres (Diurnal Birds of Prey). Part 1 (Vultur to Accipiter). Part 2 (Erythrotriorchis to Lophoaetus). Part 3 (Herpetotheres to Pernis). By H. Kirke Swann. Second edition, revised and corrected throughout. Pp. 1-63, 65-122, 123-178. (London: Wheldon and Wesley, Ltd.) 6*s*. each part.

THE work issued in 1920 as "A Synoptical List of the Accipitres" has now reappeared in an enlarged and revised form under the above title. The new edition affords original descriptions of a number of new sub-species; includes others which have appeared elsewhere; gives the type-species of each genus; the type localities of each species; and, alas, further changes in nomenclature. The Synopsis will be most appreciated by those who have some knowledge on the subject, for the extreme brevity of its descriptions of the ordinal, generic, specific, and sub-specific characters will not be of much help to the general student. The diagnostic characters of the species are restricted to adult plumages, and leave untouched the immature stages, which are the most difficult of all. The treatment of the geographical range of the various forms is also very brief.

A monograph of the Accipitres is an admitted desideratum, and as Mr. Kirke Swann has evidently devoted much attention to their study, perhaps he will supply the want. Such a treatise dealing with the plumages, distribution and life-histories would be much appreciated, especially as the birds of this order are among the most attractive and interesting of the class Aves.

Life-histories of North American Gulls and Terns. Order Longipennes. By Arthur Cleveland Bent. Bulletin No. 113. (Smithsonian Institution, United States National Museum.)

THIS is the second instalment of an important work on the life-histories of North American birds—the first of which, dealing with the order Pygopodes, has already been noticed in NATURE.

In this volume Mr. Bent, who possesses an intimate personal knowledge of the birds of the order Longipennes, gained during extensive travels as well as in the laboratory, has been fortunate in securing the co-operation of a number of field-naturalists; and their combined experiences, supplemented by important published matter, has resulted in a remarkable series of life-histories of the fifty species of gulls and terns which are members of the Nearctic avifauna.

Under the description of each of the birds there are sections devoted to habits, nesting, eggs, young, plumages, food, behaviour, and distribution. All of these are treated in an interesting manner, and are made further attractive by a series of beautiful coloured plates, 38 in number, depicting the eggs of each species; while a second series of 77 plates, from photographs, illustrate breeding colonies, sitting-birds, nests, chicks in down, half-feathered young, and haunts. The work, apart from the absence of coloured figures of the adult birds themselves, is wonderfully complete, and is a valuable contribution to ornithological literature.

The Individual and the Community. By R. E. Roper. Pp. 224. (London: G. Allen and Unwin, Ltd., 1922.) 8*s.* 6*d.* net.

MR. ROPER has produced a thoughtful and, in many respects, a stimulating book. He is a whole-hearted evolutionist, who regards the failure of post-war reconstruction as arising from the fact that our statesmen have resorted to outworn precedents while neglecting the teachings of evolution. There is, he maintains, a wilful confusion of State and community. A community he defines as "an association of two or more human beings for common (though not of necessity identical or similar) purpose or advantage in their evolution." Immediately the common purpose ceases, the community also ceases. Taking each of the principal States of Europe in turn, Mr. Roper shows that, owing to the division which has been made and is perpetuated by the financial-governing class between themselves and the working-governed class, none of them constitutes a community in his sense. The imposition of the will of one section of society upon another which is involved in our modern system of government by the majority is therefore fundamentally wrong. The difficulty is old, and if in practice we have made no very essential advance beyond the compromise expressed in Rousseau's distinction between *le volonté de tous* and *le volonté général,* it is an advantage that it should be kept before our minds by the clear vision of writers such as Mr. Roper.

Metric System for Engineers. By C. B. Clapham. (Directly-Useful Technical Series.) Pp. xii+181+3 charts. (London: Chapman and Hall, Ltd., 1921.) 12*s.* 6*d.* net.

THE author's justification for his book is that "even among those who use the millimetre in drawing-office or workshop there are probably few who feel confident in calculating with metric units," and his object is to explain the metric system and to state in full how to convert from the English units to metric units, and *vice versa.* Incidentally there is given an excellent account of the vernier and other devices used by engineers for accurate measurement. The book should be of great use in industrial life: the conversion tables are very exhaustive.

A brief survey is offered of the controversy which has been raging for so long round the question whether the metric system should or should not be introduced compulsorily in this country. It is claimed that this survey is not a piece of propaganda work in favour of the change, but the arguments given *pro* and *con* do much to support the view, that a good deal of the opposition to the enforced use of the metric system in England is attributable to mere conservative objection to change. Mr. Clapham's book is itself one of the best arguments in favour of the change—why should the Englishman be condemned to waste so much time and energy in making conversions and in looking up tables of equivalents? S. B.

Wild Bush Tribes of Tropical Africa. By G. C. Claridge. Pp. 314. (London: Seeley, Service and Co., Ltd., 1922.) 21*s.* net.

MR. CLARIDGE'S "Bush Tribes" are the Ba-Congo of Northern Angola, and the country the inhabitants of which he describes stretches from the Congo on the north to St. Paul de Loanda in the south, and from the Kwilu and Kwangu rivers in the east to the Atlantic. He writes of the native with sympathy, but, for the most part, despises his customs: he rarely fails to stigmatise them as "degrading," "disgusting," or worse when he has an opportunity. Notwithstanding this drawback, as it must seem to those who wish to study native custom impartially, the author has given a full and careful account of Ba-Congo culture, and his collection of folk-lore is both interesting and useful. The most important part of his book deals with fetishism, and, in particular, with the N'Kamba fetish of the women, which controls their most important function, that of child-bearing. The men are rigorously excluded from the rites of this fetish. A "Death and Resurrection" secret society, which effects "cures" by death and rebirth, is described from information supplied by a native, but here unfortunately the author's prejudice colours the narrative to such an extent that considerable knowledge of similar societies is required to disentangle the facts.

Readable School Physics. By J. A. Cochrane. Pp. xi+131. (London: G. Bell and Sons, Ltd., 1922.) 2*s.* 4*d.*

A TEACHER who loves his subject will find matter of interest for his pupils even in its most prosaic parts. "This book," writes Mr. Cochrane in an interesting Preface, "is an attempt to humanise Elementary Physics without popularising it." We are of opinion that in this task the author has achieved very considerable success. Theory has been given the main prominence. Experiments have not been described unless to elucidate principles. References to the makers of scientific history are frequent, and are reinforced by a number of interesting plates which include portraits of Newton, Pascal, Boyle, Galileo, and Joseph Black. The pupil's own experience is brought into connexion with physical principles as often as possible. Part 1, which might have been called Mechanics instead of Hydrostatics since it includes chapters on volume, weight, and density (not to mention surveying), occupies about two-thirds of the book, the remainder being devoted to what is certainly a "readable" account of the elementary principles of heat.

Ions, Electrons, and Ionising Radiations. By Dr. J. A. Crowther. Third Edition. Pp. xii+292+ii pls. (London: Edward Arnold and Co., 1922.) 12*s.* 6*d.* net.

THE first edition of Dr. Crowther's useful manual has already received notice in these columns (August 12 1920, p. 740.). The fact that a third edition has been called for so soon is sufficient evidence that the book has been appreciated. The material has been thoroughly revised and the various tables of constants brought into accord with the best data obtainable. Siegbahn's work on X-ray spectra and Aston's work on positive rays receive notice, and an account is given of Sir Ernest Rutherford's recent work on the problems of atomic structure and of Bohr's theory. We have no hesitation in recommending this volume to readers desiring a systematic account of the latest developments in physics.

Letters to the Editor.

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

The British Association.

THE Association is to consider whether it will once more adventure into the outer regions of the Empire. That such transgress is desirable I am satisfied and so stated most definitely in the lecture I gave in 1915, at the Royal Institution, on our Australian excursion. In the interest of the younger scientific generation and of our Empire, it is of the utmost importance that we should roam over the world and discover its amenities—but the effort must be wholehearted, whenever it be made. The one failure of our Australian expedition was the insufficient support of the younger men.

It is a question whether, at the present time, when the cost of travel is so high, it will be desirable to attempt a new expedition—the chance that it will be well supported by the young men is not great. The Society of Chemical Industry could carry only a very small party last year to Canada. Therefore, the choice of a region that shall not be too distant is desirable, if the decision be to travel.

Properly speaking, the Association should go further westward, to British Columbia, north of the C.P.R., to visualise its potentialities and gain some idea of its conditions. To recommence the cycle at a middle point such as Toronto seems undesirable, at present. Montreal is the natural and would be the proper point of redeparture and discovery. It has also the advantage that it is the centre of the only region on the American continent where freedom still prevails and men are thought to be capable of taking care of themselves. It is the duty of science to protest and erect some barrier against the advancing wave of spurious puritanism which so affects Americans and now so threatens the freedom of mankind. The recent all but successful attempt to ban Darwinism in every shape and form is sufficient proof of what may happen.

HENRY E. ARMSTRONG.

Bohr and Langmuir Atoms.

CHEMISTS feel a difficulty in explaining molecular combination in terms of electrical attraction between the apparently revolving electrons which seem to compose the peripheral parts of an atom; and they naturally prefer a more static arrangement. Indeed, it is not easy to explain the stability of molecules in terms of any kind of purely electrical attraction between the atoms composing them: and yet, ever since Faraday, there has been an instinctive feeling that electrical attraction and chemical affinity are one and the same.

The facts of spectroscopy seem to insist on a system of revolving electric charges, while the facts of chemical combination seem to demand forces which can be treated statically; so it has been suggested that internal electrons are responsible for the radiation, while external electrons control the chemical forces. But the stability of chemical compounds can scarcely depend on loosely held external electrons, which, moreover, ought to be revolving just as much though not so fast as the inner ones.

May not a reconciliation be found by abandoning the idea of electrical attraction between atoms as the major chemical force, and substituting for it the interlacement of the magnetic fields which inevitably accompany rapidly revolving electric charges. The orbital motion of the electrons responsible for chemical affinity, so far from constituting a difficulty, gives us a clue; for in every magnet electrons are rapidly revolving, and yet magnetic force is static. The clinging together of nails or needles near a magnet is all due to revolving electrons. Working with magnetised steel spheres, tetrahedra, and other shapes, some one with the ingenuity of Dr. Langmuir or Prof. Bragg might succeed in building up structures or models of adequate chemical significance.

The difficulty about substituting a magnetic field for an electric one, as accounting for the facts of chemical affinity, is no doubt the double polarity. But, on the other hand, this inevitable feature gives greater scope as well as greater complexity, and may ultimately be found to be an advantage; in fact, I am beginning to think that the constitution of bodies cannot be explained without it. The phenomena which long ago suggested "normal- and contra-valence" would fall into line. The stability of chemical combination would be all that could be desired, and the electrons in each atom would be peacefully engaged in giving their spectroscopic evidence (so well interpreted by the genius of Prof. Bohr), unharassed in their movements and perturbations by having to associate themselves with any electric field other than that of their own nucleus. Their magnetic linkages would be a sort of unconscious extra.

The undoubted phenomenon of ionisation would have to be developed independently, along with other known facts about gross positive and negative electric charges, but in the formation of stable chemical molecules we should not have to appeal to ionic charge. Moreover, certain molecular groupings, held together by magnetic forces, might be found readily susceptible to ionisation, especially when subject to bombardment, or when packed close together in a liquid.

I do not suppose that magnetic attraction as the equivalent of chemical affinity is any new idea, but I suggest that it has been inadequately developed, and that it seems capable of effecting a reconciliation between the extraordinarily ingenious schemes—apparently opposed, and yet both containing elements of truth—of which the names at the head of this letter may be regarded as principal types.

OLIVER LODGE.

The Acoustics of Enclosed Spaces.

SINCE writing the letter published in NATURE of August 19, p. 247, my attention has been directed to a paper on "Sound Proof Partitions" by Prof. R. F. Watson (University of Illinois Bulletin for March 1922). The paper contains a valuable experimental investigation on one aspect of the subject, but much remains to be done.

I take this opportunity of correcting an error which seriously affects the numerical results I gave for the sound transmitted through walls. In applying the optical equations, I forgot for the moment that the intensity of reflection in the case of sound does not only depend on the refractive index but also on the relative densities of the two bodies concerned. Even if the refractive indices were equal, so that the sound would proceed in the same direction, there would still be a powerful reflection if the densities were very unequal. In the equation I gave, $1-\mu^2$ should be replaced by $a-\mu^2a^{-1}$, where a is the ratio of the densities. When sound passes from air to a solid body the second term is in general negligible, and the transmitted intensity depends almost entirely on the ratio of the densities. If we take the case of a partition of wood having a density half that of water, calculation then shows that at normal incidence about 4 per cent. of the sound is transmitted if the thickness be 1 cm. Reducing the thickness to 2 mm., the intensity of the transmitted sound increases to 50 per cent., and rises to 80 per cent. if the thickness is only 1 mm.

What I desired to emphasise in my previous letter is that the diminution in the sound transmitted with increasing thickness is not necessarily due to any absorption, but is explained by the effect of the reflection at the second surface which, when the thickness is small compared with the wave-length, neutralises the reflection at the first surface. This does not appear to be sufficiently appreciated, and some of the conclusions drawn in Prof. Watson's paper require correction accordingly. The effect of the second surface is also of importance when total reflection ought to take place according to the usual formulæ at the first surface. With a thickness less than a wave-length, part of the sound is transmitted. This case has been treated by Lord Rayleigh ("Collected Works," vol. vi. p. 71).

ARTHUR SCHUSTER.

The Annelids of Iceland and the Faroes.

THIS is a subject about which very little has hitherto been known. In discussing the part which white ants play in the economy of nature Prof. Henry Drummond compared them with earthworms. He referred to Darwin, and said that in "Vegetable Mould" a reference was made to the existence of earthworms in Iceland. I cannot find any such allusion. It is true that a few worms have been recorded for Iceland and one for the Faroes. I am fortunately in the position to add somewhat to our knowledge. My son, Dr. J. Newton Friend, having recently returned from an expedition in those islands, I have had the privilege of examining his collection of annelids. The following are the results:

The common earthworm (*Lumbricus terrestris*, L.) flourishes in Iceland. I examined twenty-three specimens, twenty of which were perfectly adult. Not one of them differed in any particular from the type as found in England. I hoped to find spermatophores, but in this matter disappointment was experienced. The specimens were collected near Reikjavik at the beginning of August, and were just in the right condition for laying their cocoons.

The red earthworm (*L. rubellus*, Hoffm.) was also found. Though adult it was smaller than our English specimens usually are, and the dorsal surface was of a darker brown colour. I have often found similar specimens, however, in the British Isles, so that they are in no sense to be looked upon as a variety.

The purple worm (*L. purpureus*, Eisen=*L. castaneus*, Sav.) has already been recorded, alike for Iceland and the Faroes. Thus each of the three common species of European Lumbrici is now known to be a denizen of Iceland. To these may be added two species of the genus Dendrobaena. One of these (*D. rubida*, Sav.) is best known by the variety usually named the gilt-tail, a denizen of ripe manure and decaying leaves. The other (*D. octoedra*, Sav.), although widely distributed geographically, is not a common species in Great Britain. Up till the present, then, five species only of the Lumbricidae have been recorded.

The shores of Iceland, if they could be worked as Claparede worked the Hebrides, would doubtless yield a variety of forms, especially the red-blooded pot-worms or pachydrilids. None of these, so far as I am aware, has been up till the present placed on record, but *Clitellio arenarius*, O. F. M., well known on our English coasts, is reported for the coasts of Iceland.

I can find no records for the Faroes except the purple worm already noted. It is, therefore, with peculiar pleasure that I am able to add two new members to the list. These are both enchytraeids, and were collected in peaty earth near a stream some two miles inland from Thorshaven. One of these was a pachydrilid (*Lumbricillus lineatus*, O. F. M.). I have written fully on the synonymy in the *Irish Naturalist*, and my conclusions are supported by the more recent investigations of the American helminthologist, Welch.

The other enchytraeid is of the white-blooded kind (*Mesenchytraeus oligosetosus*, Friend). It was found some time ago among gleanings made in Jersey, and described by me in the *Zoologist*. I have more recently found a striking variety of this worm, or an allied species, near Birmingham. The Faroes material agreed with the Jersey. The worm is about a third of an inch in length, and belongs to the group which has enlarged setae on the segments which contain the spermathecae. It may also be noted that I found one of the commoner opalines parasitic in the Faroese enchytraeids. Our list therefore stands thus: *Mesenchytraeus oligosetosus*, Faroe Is.; *Lumbricillus lineatus*, Faroes; *Clitellio arenarius*, Iceland; *Dendrobaena rubida*, Iceland; *Dendrobaena octoedra*, Iceland; *Lumbricus purpureus*, Faroes and Iceland; *Lumbricus rubellus*, Iceland; *Lumbricus terrestris*, Iceland.

Addendum (Aug. 16).—A further investigation with pocket lens has resulted in some interesting additions to the foregoing list:

Achaeta minima Southern, only 1 mm. in length, but agreeing exactly in all particulars with the material from Ireland. The intestine contained peaty soil with a number of diatoms.

Marionina (*Chamaedrilus*) *sphagnetorum* (Vejd.).—Very slender, but true to type. White (colourless) blood. I stated my reasons in these columns some time ago for transferring this species to the genus Chamaedrilus.

Dorylaimus obtusicaudatus Bastian. A fine female nematode, about 2½ mm. long. All from the Faroes.

HILDERIC FRIEND.

Cathay, Solihull.

On the Reality of Nerve-Energy.

THE expression "nerve-energy" is widely used both by non-technical writers and by medical and physiological authors as well.

What the former mean by it is of no particular moment; but in medical and physiological literature it should connote something quite definite, if indeed the existence of nerve-energy is admitted at all. There seems a doubt whether its existence is to be admitted in a formal sense, for although certain physiologists use the expression nerve-energy as a convenient term, the thing itself is not discussed in their text-books, nor does it find a place in the indexes.

If nerve-energy has no place in the scheme of things vital as conceived by modern physiologists, then the term ought not to be used by them just because it is occasionally a very useful one. When they do use it, it means no more than "innervation."

The subject is full of difficulties, one of which is our having to reckon with the use of the still vaguer terms "vital energy" or "biotic energy." To narrow the problem, let us in the meantime exclude "vital" energy altogether, since, *as an expression*, it must include nerve-energy.

Now it is well known that one or two writers have, years ago, stated their belief in the reality of nerve-energy; of such are Sir William Hale White and Prof. Macdougall, then of Oxford, now of Harvard. Dr. Hale White in 1886 (*Lancet*, July 24) suggested the term "neurorheuma," and Macdougall in 1903 "neurine" for just the same thing as is understood by "nerve-energy." These terms were introduced to supply suitable technical terms (in place of the popular "nerve-energy") to designate a reality among the other forms of energy. Macdougall's term "neurine" has not been more readily adopted, because he associated it with a theory of inhibition which has occasioned much criticism.

Adopting for the moment Hale White's "neurorheuma," it means "flow in a nerve." But flow of what? Surely of nerve-energy. Some physiologists would not say so: they would reply—flow of nerve-impulses. Naturally, for nerve-impulses are the only things which do or can flow in nerves. Now nerve-impulses are real, and as they are the only things which flow in nerves, and nerve-energy is in nerves; then nerve-energy is but a synonym for nerve-impulses. This is exactly what Dr. White intended, for he insisted that nerve-energy was but one kind of energy amid several other kinds, heat, light, electricity, etc.

In itself nerve-energy is clearly *sui generis*, because the neurons (nerve cells and fibres) to which it is exclusively related are themselves histologically *sui generis*.

Now no one would teach that the nerve-fibres are the sources of the impulses they transmit; it is the cell-bodies which alone can be dynamogenic. The problem of the transmutation of nerve-energy into some other form of energy must in the meantime be left unattacked.

If energy there be, the cells are the only sources transmitting it to the fibres. Nerve-energy must be capable of existing both in the potential and kinetic states. Such indeed seems to be the truth, for it may be regarded as potential in the cells and kinetic in the fibres. But in the last analysis, what is this potential energy but that liberated by the metabolism of the nerve-cell, one aspect of the oxidations and reductions going on there? No physiologist would deny the reality of the existence of this fundamentally chemical energy of the neurone; but what is it if it is not nerve-energy?

Nerve-impulses (nerve-energy) being *sui generis* must make their measurement very difficult, if not impossible, except in terms of some other form of energy.

Now the most measurable thing which nerve-impulses do is to produce electric current. Why is the E.M.F. of this current not a sufficiently good measure of nerve-energy? It is sometimes assumed that we can measure the intensity of nerve-impulses by the muscular, cardiac, glandular, or other "work" which they evoke. It is true that feeble innervation will give rise to feeble muscular effort, violent to violent. But caution is necessary in drawing deductions as to the potential of the feeble and violent innervations respectively.

The feeble muscular effort may be feeble because only a few muscular fibres are excited, the strong because many; and all the while the actual E.M.F. of the nerve-impulses which excited the feeble effort may be the same as that of those which excited the violent.

The violent neural antecedent may be one that, involving many nerve-cells in the commotion, "fires off" many muscle-fibres, while the feeble neural antecedent involves few; but the E.M.F. of the nerve-impulses in both cases may be the same. The work of Keith Lucas would lead us to this conclusion.

But all this does not affect the doctrine of the *reality* of nerve-energy. Nerve-energy is real although its measurement is difficult and may be impossible. We believed in the reality of animal heat, electricity, and light long before we were able to measure these by calorimeters, galvanometers, and photometers. Nerve-impulses impinging on a muscle stir it to activity or quell it to inactivity, so that they must be at least as real as the muscular energy excited or quelled respectively. Similarly nerve-impulses impinging on a nerve-cell cause it to transmute its potential nerve-energy into nerve-impulses.

Contrary to what the phrase would imply, Müller's "specific nerve-energy" does not throw any light on our problem. The phrase is antiquated though it embodies an important truth. What Müller had in mind was the oneness of the central result with the many forms of the peripheral stimulation.

Unless nerve-energy is a reality, neurasthenia becomes meaningless. Now although the term "neurasthenia" may not connote a definite clinical entity, yet fatigue of the nervous system both in its acute and chronic forms is a fact. From *a priori* considerations alone there must be fatigue of neural origin as of any other. The partial solution of the granules of Nissl has been asserted to be the histological counterpart or basis of fatigue of neuroplasm, but whether or not this be correct, a state of functional disability must be capable of being induced in neurones. Surely fatigue means diminution of some sort of energy: muscular fatigue is a reality, why not neural? Physiologists doubt the "fatigueability" of nerve-fibres which are but conductors, but no neurologist doubts the "fatigueability" of nerve-cells. This must, in other words, be nothing else than the diminution of the potential and quantity of the energy of neurones. All the following writers have used the expression "nerve-energy" or "nerve-force": the late Dr. Hughlings Jackson, the late Dr. Clouston, the late Sir William Osler, the late Dr. Weir Mitchell, the late Dr. Frederick Taylor; and of living writers, Sir William Bayliss, Profs. Halliburton, Howell, and Starling, and Sir Frederick Mott.

In closing let me make one or two suggestions as to how nerve-energy might be measured.

1. The increase of conductance in the skin under the influence of descending nerve-impulses as measured in the psycho-galvanic phenomenon (Waller, Golla).

Surely the magnitude of this is causally related to that of the antecedent nerve-energy liberated?

Even if this be proved to be a glandular phenomenon, we have the essentials of quantitative estimation in it.

2. Measure the E.M.F. of the current of action, say, in the cortical visual centre as the result of feeble and of strong retinal stimulation respectively.

3. Estimate the pressures or other stimuli necessary to suppress certain reflexigenous tendencies.

D. FRASER HARRIS.
Dalhousie University, Halifax, N.S.

Noctiluca as an Enemy of the Oyster.

IN view of the serious problems which have of late been engaging the attention of oyster culturists, involving as they do the whole future of the industry, and in connexion with which a considerable amount of scientific investigation has been carried out, the following preliminary note of observations made by

Mr. H. P. Sherwood, assistant naturalist to the Ministry, may be of interest.

Experiments in oyster culture in tanks are being carried out by the Ministry at Conway on a large scale, and have been in progress for several years. In order to throw light on the frequent failure of spat settlement under natural conditions, and the remarkable success which has almost uniformly attended the breeding experiments in the Conway tanks, special attention has been directed to the identification of enemies of the embryo oyster. Some six weeks ago large numbers of *Noctiluca miliaris* were noted in the Conway estuary, which has since contained this organism in varying quantity. Laboratory experiments were carried out, and Mr. Sherwood noted a remarkable and rapid diminution in the numbers of oyster embryos placed in aquaria in the presence of Noctiluca. He afterwards found that many of the Noctilucas contained from one to four oyster embryos. The embryos were seen at the outset in, or in close proximity to, the peristome and mouth, later becoming scattered through the substance of the Noctiluca, enclosed in distinct food vacuoles.

Mr. Sherwood has made a long series of confirmatory observations, and the actual ingestion of the embryos has now been repeatedly observed, including the transference of the embryo to parts remote from the mouth.

Many exceedingly interesting observations with regard to the mechanism of ingestion, etc., have been made, but a full description would be out of place in a short communication. It may, however, be noted that the tentacle of Noctiluca appears to take no active part in the process of ingestion. The behaviour of the embryos suggests that their movements, and therefore power of escape, are inhibited after contact with the oral groove, either by entanglement of the cilia with mucus, or by actual paralysis induced by the action of some " stinging " mechanism. Further investigation is required, however, before any definite deductions can be drawn.

When it is considered that Noctiluca often occurs in the sea in enormous numbers, and that each Noctiluca can dispose of at least as many as four oyster embryos at a time, the importance of this observation will be apparent. I am informed that great quantities of Noctiluca have recently been observed in the vicinity of the oyster beds at Orford.

Another observation recently made by Mr. Sherwood, in connexion with the disappearance of oyster spat, is of interest. Not only has he found oyster embryos in the stomachs of adult oysters, but also has found the stomach of a " black sick " oyster, taken from a tank in which there was no free-swimming spat, crammed with embryos in the same stage of development as those found in the gills of the parent oyster. It would thus appear that the oyster is not only a cannibal, but also even devours its own young before extrusion.

The very interesting observations made by Dr. J. H. Orton (NATURE, August 5, p. 178) on the ingestion of oyster embryos by *Aurelia aurita* throw further important light on the question of failure of oyster spat fall.

R. W. DODGSON.

Ministry of Agriculture and Fisheries,
Fisheries Experiment Station,
Castle Bank, Conway, August 18.

Defoliation of Oaks.

IN view of the deplorable effect of repeated defoliation of oaks by the larvæ of *Tortrix viridana*, as noted by Mr. E. W. Swanton in NATURE for August 19, p. 250, it may be useful to remind planters that there are two distinct races of British oak (*Quercus robur*, Linn.), to which some botanists have assigned specific rank as *Q. pedunculata*, Ehrh., and *Q. sessiliflora*, Salisb. The latter, known in the vernacular as the durmast oak, prevails as an *indigenous* growth in the western and north-western parts of Great Britain, throughout the English Lake District, and in Ireland. In eastern England and Scotland and in midland and southern England the pedunculate oak predominates, but not exclusively, for I have found that the old trees in Merevale Park, Warwickshire, survivors of the ancient Forest of Arden, are durmast, while such oaks as have been planted there are pedunculate.

The timber of these two varieties (or species) are of equal quality, the durmast being of straighter growth than the other; but there is an important and well-marked difference in their relative susceptibility to the ravages of Tortrix. The Hon. Gerald Lascelles, late deputy surveyor of the New Forest, directed my attention to this many years ago. " I have seen," he said, " a sessile oak standing out in brilliant foliage when every other oak in the wood around was as bare of leaf as in winter."

Subsequent careful observation in all parts of the country has fully confirmed Mr. Lascelles's statement. Unfortunately, the durmast forms and ripens acorns far less frequently than the pedunculate oak; hence the difficulty of obtaining durmast seedlings and plants from nurserymen, and the vast preponderance of the pedunculate oak in British and Irish plantations.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire, N.B.

Black Coral.

PROF. HICKSON, in his interesting article on Black Coral (NATURE, August 12, p. 217), alludes to the remains of Noah's Ark as quoted by Josephus from Berosus and others. It is said in Josephus (*loc. cit.*) that " the remains of the timber were a great while preserved." There is in the Monastery at Etchmiadzin a small piece of Noah's Ark carefully framed. It was given by an angel to a monk named James, who had wandered on Ararat in search of it for seven years (see J. B. Telfer, " The Crimea, etc.," 1876, p. 250). So far as I could see, when I examined it in 1898, it was neither wood nor fossil wood, but asbestos. This does not render improbable the occurrence of bitumen in the neighbourhood, but why does Prof. Hickson assume that the amulets were bracelets? In default of evidence that Noah utilised the Ark for dredging, there does not seem any reason to connect him with black coral.

F. A. BATHER.

Metallic Coloration of Chrysalids.

IN NATURE of November 3, 1921 (vol. 108, p. 302), a letter of mine appeared on the " Metallic Coloration of Chrysalids." During the present year I have had the opportunity of observing some very fine examples of the chrysalids of *R. urticæ*, in which the gilding extended over the whole surface. It may be of interest, as bearing on the origin of the colour, to note that when the gilding was very gently scraped, the gold first turned to green and then to blue. In the course of a few days the scraped area assumed the same appearance as the whole chrysalid does after the butterfly has emerged, namely, a yellowish white.

A. MALLOCK.

9 Baring Crescent, Exeter, Aug. 24.

The British Association at Hull.

THE British Association meetings are now in progress, and notwithstanding a slight difficulty which threatened to arise in obtaining rooms for the unusual influx of visitors, this has been removed and things are running smoothly. The Local Committee has endeavoured to improve the appearance of the city as much as possible by elaborate signposts, and metal signs on the electric standards, indicating the positions of the various meeting rooms and sectional lecture halls. Thus the usual appearance of a town visited by the British Association being transformed into a bill-posting station, has been avoided. Similarly, in the Reception Room and in other places, are gaily coloured artistic banners and signs in profusion, in addition to which the Parks Committee has made the rooms gay with plants and blooms.

Various corporations and public bodies in the east of Yorkshire have risen to the occasion, and, with the co-operation of the North-Eastern Railway Company, an elaborate system of special trains has been arranged to convey the members to different parts of this attractive county.

The Corporation of Scarborough is entertaining four hundred members; the Yorkshire Philosophical Society is entertaining the same number of members in the York Museum, where an official welcome will be given by the Lord Mayor; the Corporation of Harrogate is also entertaining four hundred members; Bridlington is entertaining 250, and Beverley 100. These are in addition to arrangements made in Hull itself, which include a river trip to Spurn Point in the s.s. *Brocklesby*, kindly lent by the Great Central Railway Company, on which occasion the members will be entertained by the Local Committee.

There is also a garden party in Hymers College grounds (the old Botanical Gardens), where the members will be entertained by the Hull Literary and Philosophical Society, the Local Committee, and the Governors of the College.

Various firms in Hull and district (Messrs. Reckitt and Sons, the Humber Portland Cement Company, Earle's Cement Company, The British Oil and Cake Mills, Needler's Confectionery Works, the Olympia Oil Mill, Selby, and the Hull Fishing Vessel Owners' Association) are showing parties round their respective places and providing refreshment, etc.

On account of the wealth of suitable lecture and committee rooms, the work of the various sections is running smoothly, and the new Guildhall with its fine reception room, banqueting hall, etc., makes admirable headquarters, while the reception room is in easy access of the various offices placed at the disposal of the general and local officers of the association.

An experiment has been tried in the provision of an artistic numbered badge for each member, for the purpose of identification, and also for admission to the various functions of the association in place of, or in addition to, the familiar membership ticket, which, like many innovations for the Hull meeting, has been made a convenient size.

The Hull Tramways Committee has granted free tram-rides to the wearers of badges, to the great convenience of the visitors. T. S.

REPORT OF THE COUNCIL.

A number of important matters is referred to in the report of the council presented to the meeting of the general committee on September 6. Sir Ernest Rutherford was nominated by the council as president of the Association for the meeting to be held at Liverpool next year.

During the year covered by the report, the Association received from Sir Charles Parsons the generous gift of 10,000*l*. War Stock for general purposes and also a legacy of 450*l*. from the late Mr. T. W. Backhouse. A very welcome gift was one of 75*l*. from Mrs. Sidney Brown to form "the John Perry's Guest Fund" for use by the general treasurer in case of emergency connected with guests of the Association. There is frequent need for financial help such as a fund of this kind may supply, and it is to be hoped that other benefactors will be forthcoming to increase the modest amount now available for this purpose. Certain it is that no more appropriate memorial to the late treasurer of the Association, Prof. John Perry, could be established than such a fund would afford. On account of the expanding activities of the Association, professional men who are not members are often invited to give addresses or read papers to one or other of the sections, but under present conditions sectional secretaries have no power to pay even out-of-pocket expenses to such men or offer hospitality to them. The least the Association should do in such cases is to pay railway fares and entertain the special visitors as guests.

Provision of a similar kind is made by the establishment of the "British Association Exhibitions" now offered to students not above the standing of B.Sc., nominated by the senate of each of twenty universities and university colleges, and covering the railway fares of such students and their membership if not already regular members. The Local Executive Committee at Hull has kindly supplemented this aid by an offer of financial support and hospitality for such nominees. What is wanted now is to give power to each organising committee of the sections to offer like facilities to two or three leading workers in particular fields to attend meetings for the purpose of expressing their views on aspects of science seen more distinctly from outside the scientific world than within it.

The council has made some important recommendations with regard to the Conference of Delegates and the Corresponding Societies Committee. It has been agreed that the conference at Hull should consider, in the first place, what steps should be taken to induce local societies to group themselves round local (*i.e.* district) sub-centres for the interchange of information and for the more economical publication of the results of research.

The Corresponding Societies Committee is to prepare a general survey of local scientific societies, including information as to existing federations and local unions.

Mr. W. Whitaker has been nominated as president of the Conference at the Hull Meeting.

The following new members of council are nominated: Rt. Hon. Lord Bledisloe, Dr. W. E. Hoyle, and Mr. A. G. Tansley, leaving two vacancies to be filled by the general committee without nomination by the council.

Some Aspects of Animal Mechanism.[1]

By Sir C. S. SHERRINGTON, G.B.E., Sc.D., D.Sc., LL.D., Pres.R.S., President of the Association.

IT is sometimes said that science lives too much in itself, but once a year it tries to remove that reproach. The British Association meeting is that annual occasion, with its opportunity of talking in wider gatherings about scientific questions and findings. Often the answers are tentative. Commonly questions most difficult are those that can be quite briefly put. Thus, " Is the living organism a machine ? " " Is life the running of a mechanism ? " The answer cannot certainly be as short as the question. But let us, in the hour before us, examine some of the points it raises.

Of course for us the problem is not the " why " of the living organism but the " how " of its working. If we put before ourselves some aspects of this working we may judge some at least of the contents of the question. It might be thought that the problem is presented at its simplest in the simplest forms of life. Yet it is in certain aspects more seizable in complex animals than it is in simpler forms.

Our own body is full of exquisite mechanism. Many exemplifications could be chosen. There is the mechanism by which the general complex internal medium, the blood, is kept relatively constant in its chemical reaction, despite the variety of the food replenishing it and the fluctuating draft from and input into it from various organs and tissues. In this mechanism the kidney cells and the lung cells form two of the main sub-mechanisms. One part of the latter is the delicate mechanism linking the condition of the air at the bottom of the lungs with that particular part of the nervous system which manages the ventilation of the lungs. On that ventilation depends the proper respiratory condition of the blood. The nervous centre which manages the rhythmic breathing of the chest is so responsive to the respiratory state of the blood supplied to itself that, as shown by Drs. Haldane and Priestley some years ago, the very slightest increase in the partial pressure of carbon dioxide at the bottom of the lungs at once suitably increases the ventilation of the chest. Dovetailed in with this mechanism is yet another working for adjustment in the same direction. As the lung is stretched by each inbreath the respiratory condition of the nervous centre, already attuned to the respiratory quality of the air in the lungs, sets the degree to which inspiration shall fill them ere there ensue the opposite movement of outbreath. All this regulation, although the nervous system takes part in it, is a mechanism outside our consciousness. Part of it is operated chemically; part of it is reflex reaction to a stimulus of mechanical kind, though as such unperceived. The example taken has been nervous mechanism. If, in the short time at our disposal, we confine our examples to the nervous system, we shall have the advantage that in one respect that system presents our problem possibly at its fullest.

To turn therefore to another example, mainly nervous. Muscles execute our movements; they also maintain our postures. This postural action of muscles is produced by nerve-centres which form a system more or less their own. One posture of great importance thus maintained is that of standing, the erect posture. This involves due co-operation of many separate muscles in many parts. Even in the absence of those portions of the brain to which consciousness is adjunct, the lower nerve-centres successfully bring about and maintain the co-operation of muscles which results in the erect posture; for example, the animal in this condition, if set on its feet, stands. It stands reflexly; more than that, it adjusts its standing posture to required conditions. If the pose of one of the limbs be shifted a compensatory shift in the other limbs is induced, so that stability is retained. A turn of the creature's neck sidewise and the body and limbs, of themselves, take up a fresh attitude appropriate to the side-turned head. Each particular pose of the neck telegraphs off to the limbs and body a particular posture required from them, and that posture is then maintained so long as the neck posture is maintained. Stoop the creature's neck and the forelimbs bend down as if to seek something on the floor. Tilt the muzzle upward and the forelimbs straighten and the hind limbs crouch as if to look at something on a shelf. Purely reflex mechanism provides all kinds of ordinary postures.

Mere reflex action provides these harmonies of posture. The nerve-centres evoke for this purpose in the required muscles a mild, steady contraction, with tension largely independent of the muscle length and little susceptible to fatigue. Nerve-fibres run from muscle to nerve-centre, and by these each change in tension or length of the muscle is reported to the activating nerve-centre. They say " tension rising, you must slacken," or conversely. There are also organs the stimulation of which changes with any change of their relation to the line of gravity. Thus, a pair of tiny water-filled bags is set one in each side of the skull and in each is a patch of cells endowed with a special nerve. Attached to hairlets of these cells is a tiny crystalline stone the pressure of which acts as a stimulus through them to the nerve. The nerve of each gravity-bag connects, through chains of nerve-centres, with the muscles of all the limbs and of one side of the neck. In the ordinary erect posture of the head, the stimulation by the two bags right and left is equal, because the two gravity-stones then lie symmetrically. The result, then, is a symmetrical muscular effect on the two sides of the body, namely, the normal erect posture. But the right and left bags are mirror pictures of each other. If the head incline to one side, the resulting slip, microscopic though it be, of the two stones on their nerve-patches makes the stimulation unequal. From that slip there results exactly the right unsymmetrical action of the muscles to give the unsymmetrical pose of limbs and neck required for stability. That is the mechanism dealing with limbs and trunk and neck. An additional one postures the head itself on the neck. A second pair of tiny gravity-bags, in which the stones hang rather than press, are utilised. These, when any cause inclining the head has passed, bring the head back at once to the normal symmetry of the erect posture. These same bags also manage the posturing of the eyes. The eye contributes to our orientation in space; for example, to perception of the vertical. For this the eyeball, that

[1] Presidential Address delivered at the Hull Meeting of the British Association on Sept. 6.

is the retina, has to be postured normally, and the pair of little gravity-bags in the skull, which serve to restore the head posture, act also on the eyeball muscles. Whichever way the head turns, slopes, or is tilted, they adjust the eyeball's posture compensatingly, so that the retina still looks out upon its world from an approximately normal posture, retaining its old verticals and horizontals. As the head twists to the right the eyeball's visual axis untwists from the right. These reactions of head, eyes and body unconsciously take place when a bird wheels or slants in flight or a pilot stalls or banks his aeroplane; and all this works itself involuntarily as a pure mechanism.

True, in such a glimpse of mechanism what we see mainly is how the machinery starts and what finally comes out of it; of the intermediate elements of the process we know less. Each insight into mechanism reveals more mechanism still to know. Thus, scarcely was the animal's energy balance in its bearing upon food intake shown comfortably to conform with thermodynamics than came evidence of the so-called "vitamins"—evidence showing an unsuspected influence on nutrition by elements of diet taken in quantities so small as to make their mere calorie value quite negligible; thus, for the growing rat, to quote Prof. Harden, a quantity of vitamin A of the order of $\frac{1}{500}$ milligram a day has potent effect. Again, as regards sex determination, the valued discovery of a visible distinction between the nuclear threads of male and female brings the further complexity that, in such cases, sex extends throughout the whole body to every dividing cell. Again, the association of hereditary unit-factors, such as body colour or shape of wing, to visible details in the segmenting nucleus seemed to simplify by epitomising. But further insight tends to trace the inherited unit character not to the chromosome itself, but to balance of action between the chromosome group. As with the atom in this heroic age of physicists, the elementary unit once assumed simple proves, under further analysis, to be itself complex. Analysis opens a vista of further analysis required. Knowledge of muscle contraction has, from the work of Fletcher and Hopkins on to Hill, Hartree, Meyerhof, and others, advanced recently more than in many decades heretofore. The engineer would find it difficult to make a motive machine out of white of egg, some dissolved salts, and thin membrane. Yet this is practically what Nature has done in muscle, and obtained a machine of high mechanical efficiency. Perhaps human ingenuity can learn from it. One feature in the device is alternate development and removal of acidity. The cycle of contraction and relaxation is traced to the production of lactic acid from glycogen and its neutralisation chiefly by alkaline proteins; and physically to an admirably direct transition from chemical to mechanical effect. What new steps of mechanism all this now opens!

But knowledge, while making for complexity, makes also for simplification. There seems promise of simplification of the mechanism of reflex action. Reflex action with surprising nicety calls into play just the appropriate muscles, and adjusts them in time and in the suitable grading of their strength of pull. The moderating as well as the driving of muscles is involved. Also the muscles have to pass from the behest of one stimulus to that of another, even though the former stimulus still persist. For these gradings, coadjustments, restraints, and shifts, various separate kinds of mechanism were assumed to exist in the nerve-centres, although of the nature of such mechanisms little could be said. Their processes were regarded as peculiar to the nerve-centres and different from anything that the simple fibres of nerve-trunks outside the centres can produce. We owe to Lucas and Adrian the demonstration that, without any nerve-centre whatever, an excised nerve-trunk with its muscle attached can be brought to yield, besides conduction of nerve impulses, the grading of them. That is remarkable, because the impulse is not gradable by grading the strength of the stimulus. The energy of the impulse comes not from the stimulus, but from the fibre itself. But Lucas and Adrian have shown, however, that it is gradable in another way. Though the nerve impulse is a very brief affair—it lasts about $\frac{1}{1000}$ second at any one point of the nerve—it leaves behind it in the nerve-fibre a short phase during which the fibre cannot develop a second impulse. Then follows rapid but gradual recovery of the strength of impulse obtainable from the fibre. That recovery may swing past normal to super-normal before returning finally to the old resting state. Hence, by appropriately timing the arrival of a second impulse after a first, that second impulse may be extinguished, reduced, increased or transmitted without alteration. This property of grading impulses promises a complete key to reflex action if taken along with one other. The nervous system, including its centres, consists of nothing but chains of cells and fibres. In these chains the junctions of the links appear to be points across which a large impulse can pass, though a weak one will fail. At these points the grading of impulses by the interference process just outlined can lead, therefore, to narrowing or widening their further distribution, much as in a railway system the traffic can be blocked or forwarded, condensed or scattered. Thus the distribution and quantity of the muscular effect can be regulated and shifted not only from one muscle to another, but in one and the same muscle it can be graded by adding to or subtracting from the number of fibres activated within that muscle. As pointed out by Prof. Alexander Forbes, it may be, therefore, that the nerve impulse is the one and only reaction throughout the whole nervous system, central and peripheral,—trains of impulses colliding and over-running as they travel along the conductive network. In this may lie the secret of the co-ordination of reflexes. The nerve-centre seems nothing more than a meeting-place of nerve-fibres, its properties but those of impulses in combination. Fuller knowledge of the mechanism of the nervous impulse, many of the physical properties of which are now known, a reaction which can be studied in the simplest units of the nervous system, thus leads to a view of nervous function throughout the system much simpler than formerly obtained.

Yet for some aspects of nervous mechanism the nerve impulse offers little or no clue. The fibres of nerve-trunks are, perhaps, of all nerve-structures those that are best known. They constitute, for example, the motor nerves of muscle and the sensory nerves of the skin. They establish their ties with muscle and skin during embryonic life and maintain them practically unaltered throughout the individual's existence, growing no further. If severed, say, by a wound, they die for their whole length between the point of severance and the muscle or skin they go to. Then at once the cut ends of the nerve-fibres start re-growing from the point of severance, although for years they have given no sign of growth. The fibre, so to say, tries to grow out to reach to its old far-distant muscle. There are difficulties in its way. A multitude of non-nervous repair cells growing in the wound spin scar tissue across the new fibre's path. Between these alien cells the new nerve-fibre threads a tortuous way, avoiding and never joining any of them. This obstruction it may take many days to traverse. Then it reaches a region where the sheath-cells of the old dead nerve-fibres lie altered beyond ordinary recognition. But the growing fibre recognises them. It joins them and, tunnelling through endless chains of them, arrives finally, after weeks or months, at the wasted muscle-fibres which seem to have been its goal, for it connects with them at once. It pierces their covering membranes and reforms with their substance junctions of characteristic pattern resembling the original that had died weeks or months before. Then its growth ceases, abruptly, as it began, and the wasted muscle recovers and the lost function is restored.

Can we trace the causes of this beneficent yet so unaccountable reaction? How is it that severance can start the nerve re-growing. How does the nerve-fibre find its lost muscle microscopically miles away? What is the mechanism that drives and guides it? Is it a chemotaxis like that of the antherozooid in the botanical experiment drawn towards the focus of the dissolved malic acid? If so, there must be a marvellously arranged play of intricate sequences of chemically attractive and repellent substances dissolved suitably point to point along the tissue. It has recently been stated that the nerve-fibre growing from a nerve-cell in a nutrient field of graded electrical potential grows strictly by the axis of the gradient. Some argue for the existence of such potential gradients in the growing organism. Certainly nerve regeneration seems a return to the original phase of growth, and pieces of adult tissue removed from the body to artificial nutrient media in the laboratory take on vigorous growth. Prof. Champy describes how epithelium that in the body is not growing, when thus removed starts growing. If freed from all fibrous tissue, its cells not only germinate, but, as they do so, lose their adult specialisation. In nerve regeneration the nerve-sheath cells, and to some extent the muscle-cells which have lost their nerve-fibre, lose likewise their specialised form, and regain it only after touch with the nerve-cell has been re-established. So similarly epithelium and its connective tissue cultivated outside the body together both grow and both retain their specialisation. The evidence seems to show that the mutual touch between the several cells of the body is decisive of much in their individual shaping and destiny. The severance of a nerve-fibre is an instance of the dislocation of such a touch. It recalls well-known experiments on the segmenting egg. Destruction of one of the two halves produced by the first segmentation of the egg results in a whole embryo from the remaining half-egg; but if the two blastomeres, though ligated, be left side by side, each then produces a half-embryo. Each half-egg *can* yield a whole embryo, but is restrained by the presence of the twin cell to yielding but a half embryo. The nerve severance seems to break a mutual connexion which restrained cell growth and maintained cell differentiation.

It may be said that the nerve-sheath cells degrade because the absence of transmission of nerve impulses leaves their fibre functionless. But they do not degrade in the central nerve-piece, although impulses no longer pass along the afferent fibres. This mechanism of reconstruction seems strangely detached from any direct performance of function. The sprouting nerve-fibres of a motor nerve with impulses for muscular contraction can by misadventure take their way to denervated skin instead of muscle. They find the skin-cells the nerve-fibres of which have been lost, and on these they bud out twigs, as true sensory fibres would do. Then, seemingly satisfied by so doing, they desist from further growth. The sense-cells, too, after this misunion, regain their normal features. But this joining of motor nerve-fibre with sense-cell is functionless, and must be so because the directions of functional conduction of the two are incompatible. Similarly a regenerating skin-nerve led down to muscle makes its union with muscle instead of skin, though the union is a functional misfit, and cannot subserve function. Marvellous though nerve regeneration be its mechanism seems blind. Its vehemence is just as great after amputation, when the parts lost can of course never be re-reached. Its blindness is sadly evident in the suffering caused by the useless nerve-sprouts entangled in the scar of a healing or healed limb-stump.

There is a great difference, however, between the growth of such regeneration and the growth impulse in pieces of tissue isolated from the body and grown in media outside. With pure cultures, in the latter case, Prof. Champy says the growth recalls in several features that of malignant tumours, for example, multiplication of cells unaccompanied by formation of a specialised adult tissue. A piece of kidney cultivated outside the body de-differentiates, to use his term, into a growing mass unorganised for renal function. But with connective-tissue cells added even breast-cancer epithelium will in cultivation grow in glandular form. New ground is being broken in the experimental control of tissue growth. The report of the Imperial Cancer Research Fund mentions that in cultivation outside the body malignant cells present a difficulty that normal cells do not. To the malignant cells the nutrient soil has to be renewed more frequently, because they seem rapidly to make the soil in which they grow poisonous to themselves, though not to normal cells. The following of all clues of difference between the mechanism of malignant growth and of normal is fraught with importance which may be practical as well as theoretical.

The regenerating nerve rebuilds to a plan that spells for future function, but throughout all its steps prior to the time when it actually reaches the muscle or skin, no actual performance of nerve-function can take place. What is constructed is functionally useless until the whole is complete. So similarly with much of the construction of the embryo in the womb for purposes of a different life after emergence from the womb; of the lung for air-breathing after birth; of the reflex contraction in the fœtal child of the eyelids to protect the eye long before the two eyelids have been separated, let alone ere hurt or even light can reach it; of the butterfly's wing within the chrysalis for future flight. The nervous system in its repair, as in its original growth, shows us a mechanism working through phases of non-functioning preparation in order to forestall and meet a future function. It is a mechanism against the seeming prescience of which is to be set its fallibility and its limitations. The "how" of its working is at present chiefly traceable to us in the steps of its results rather than in comprehension of its intimate reactions; as to its mechanism, perhaps the point of chief import for us here is that those who are closest students of it still regard it as a mechanism. If "to know" be "to know the causes" we must confess to want of knowledge of how its mechanism is contrived.

If we knew the whole "how" of the production of the body from egg to adult, and if we admit that every item of its organic machinery runs on physical and chemical rules as completely as do inorganic systems, will the living animal present no other problematical aspect? The dog, our household friend—do we exhaust its aspects if in assessing its sum-total we omit its mind? A merely reflex pet would give little pleasure even to the fondest of us. True, our acquaintance with other mind than our own can only be by inference. We may even hold that mind as an object of study does not come under the rubric of Natural Science at all. But this Association has its Section of Psychology, and my theme of to-night was chosen partly at the suggestion of a late member of it, Dr. Rivers, the loss of whom we all deplore. As a biologist he viewed mind as a biological factor. Keeping mind and body apart for certain analytic purposes must not allow us to forget their being set together when we assess as a whole even a single animal life.

Taking as manifestations of mind those ordinarily received as such, mind does not seem to attach to life, however complex, where there is no nervous system, nor even where that system, though present, is little developed. Mind becomes more recognisable the more the nerve-system is developed; hence the difficulty of the twilit emergence of mind from no mind, which is repeated even in the individual life history. In the nervous system there is what is termed localisation of function—relegation of different works to the system's different parts. This localisation shows mentality, in the usual acceptation of that term, not distributed broadcast throughout the nervous system, but restricted to certain portions of it; for example, among vertebrates to what is called the forebrain, and in higher vertebrates to the relatively newer parts of that forebrain. Its chief, perhaps its sole, seat is a comparatively modern nervous structure superposed on the non-mental and more ancient other nervous parts. The so-to-say mental portion of the system is placed so that its commerce with the body and the external world occurs only through the archaic non-mental remainder of the system. Simple nerve impulses, their summations and interferences, seem the one uniform office of the nerve-system in its non-mental aspect. To pass from a nerve impulse to a psychical event, a sense-impression, percept, or emotion is, as it were, to step from one world to another and incommensurable one. We might expect, then, that at the places of transition from its non-mental to its mental regions the brain would exhibit some striking change of structure. But it is not so; in the mental parts of the brain there is nothing but the same old structural elements, set end to end, suggesting the one function of the transmission and collision of nerve impulses. The structural inter-connexions are richer, but that is merely a quantitative change.

I do not want, and do not need, to stress our inability at present to deal with mental actions in terms of nervous actions, or *vice versa*. Facing the relation borne in upon us as existent between them, however, may we not gain some further appreciation of it by reminding ourselves even briefly of certain points of contact between the two? Familiar as such points are, I will mention rather than dwell upon them.

One is the so-called expression of the emotions. The mental reaction of an emotion is accompanied by a nervous discharge which is more or less characteristic for each several type of emotion, so that the emotion can be read from its bodily expression. This nervous discharge is involuntary, and can affect organs, such as the heart, which the will cannot reach. Then there is the circumstance that the peculiar ways and tricks of the nervous machinery as revealed to us in the study of mere reflex reactions repeat themselves obviously in the working of the machinery to which mental actions are adjunct. The phenomenon of fatigue is common to both, and imposes similar disabilities on both. Nervous exhaustion and mental exhaustion mingle. Then, as offset against this disability, there exists in both the amenability to habit formation, mere repetition within limits rendering a reaction easier and readier. Then, and akin to this, is the oft-remarked trend in both for a reaction to leave behind itself a trace, an engram, a memory, the reflex engram, and the mental memory.

How should inertia and momentum affect non-material reactions? Quick though nervous reactions are, there is always easily observed delay between delivery of stimulus and appearance of the nervous end effect; and there is always the character that a reaction once set in motion does not cease very promptly. Just the same order of lag and overrun, of want of dead-beat character, is met in sense-reactions. The sensation outlives the light which evoked it, and the stronger the reaction the longer the sensation persists. Similarly the reflex after-discharge persists after the stimulus is withdrawn and subsides more slowly the stronger the reaction. The times in both are of the same order. Again, a reflex act which contracts one muscle commonly relaxes another. Even so, with rise of sensation in one part of the visual field commonly occurs lapse of sensation in another. The stoppage is in both by inhibition, that is to say, active. Then again, two lights of opposite colour falling simultaneously and correspondingly on the two retinæ will, according to their balance, fuse to an intermediate tint or see-saw back and forth between the one tint and the other. Similarly a muscle impelled by two reflexes, one tending to contract it, the other to relax it, will, according to the balance of the reflexes, respond steadily with an intensity which is a compromise between the two, or see-saw rhythmically from extreme to extreme of the two opposite influences.

Reflex acts commonly predispose to their opposites; thus the visual impression of one colour predisposes to that of its opposite. Again, the *position* of the stimulated sensual point acts on the mind—hence the light seen or the pain felt is referred to some locus in the mind's space-system. Similarly the reflex machinery directs, for example, the limb it moves towards the particular spot stimulated. Such spots in the two processes, mental and non-mental, correspond.

Characteristic of the nervous machinery is its arrangement in what Hughlings Jackson called "levels," the higher levels standing to the lower not only as drivers but also as restrainers. Hence in disease underaction of one sort is accompanied by overaction of another. Thus in the arm affected by a cerebral stroke, besides loss of willed—that is higher level—power in the finger muscles, there is in other muscles involuntary overaction owing to escape of lower centres from control by the higher which have been destroyed. Similarly with the sensory effects; of skin sensations some are painful and some not, for example, touch. The seat of the latter is of higher level, cortical; of the former lower, sub-cortical. When cerebral disease breaks the path between the higher and the underlying level a result is impairment of touch sensation but heightening of pain sensation in the affected part. The sensation of touch, as Dr. Head says, restrains that of pain.

Thus features of nervous working resemble over and over again mental activities. Is it mere metaphor, then, when we speak of mental attitudes as well as bodily? Is it mere analogy to liken the warped attitude of the mind in a psychoneurotic sufferer to the warped attitude of the body constrained by an internal potential pain? Again, some mental events seem spontaneous; in the nervous system some impulses seem generated automatically from within.

It may be said of all these similarities of time-relation and the rest between the ways of the nervous system and such simpler ways of mind as I here venture on, that they exist because the operations of the mental part of the nervous system communicate with the exterior only through the non-mental part as gateway, and that there the features of the nerve-machinery are impressed on the mind's working. But that suggestion does not take into account the fact that the higher and more complex the mental process, the longer the time-lag, the more incident the fatigue, the more striking the memory character, and so on.

All this similarity does but render more succinct the old enigma as to the nexus between nerve impulse and mental event. In the proof that the working of the animal mechanism conforms with the first law of thermodynamics is it possible to say that psychical events are evaluated in the balance sheet drawn up? On the other hand, Mr. Barcroft and his fellow-observers in their recent physiological exploration of life on the Andes at 14,200 ft. noted that their arithmetic as well as their muscles were at a disadvantage; the low oxygen pressure militated against both. Indeed, we all know that a few minutes without oxygen, or a few more with chloroform, and the psychical and the nervous events will lapse together. The nexus between the two sets of events is strict, but for comprehension of its nature we still require, it seems, comprehension of the unsolved mystery of the "how" of life itself. A shadowy bridge between them may lie perhaps in the reflection that for the observer himself the physical phenomena he observes are in the last resort psychical.

The practical man has to accept nervous function as a condition for mental function without concerning himself about ignorance of their connexion. We know that with structural derangement or destruction of certain parts of the brain goes mental derangement or defect, while derangement or destruction of other parts of the nervous system is not so accompanied. Decade by decade the connexion between certain mental performances and certain cerebral regions becomes more definite. Certain impairments of ideation as shown by forms of incomprehension of language or of familiar objects can help to diagnose for the surgeon that part of the brain which is being compressed by a tumour, and the tumour gone the mental disabilities pass. Similarly those who, like Prof. Elliot Smith and Sir Arthur Keith, recast the shape of the cerebrum from the cranial remains of prehistoric man, can outline for us something of his mentality from examination of the relative development of the several brain regions, using a true and scientific phrenology.

Could we look quite naïvely at the question of a seat for the mind within the body we might perhaps suppose it diffused there, not localised in any one particular part at all. That it is localised and that its localisation is in the nervous system—can we attach meaning to that fact? The nervous system is that bodily system the special office of which, from its earliest appearance onward throughout evolutionary history, has been more and more to weld together the body's component parts into one consolidated mechanism reacting as a unity to the changeful world about it. More than any other system it has constructed out of a collection of organs an individual of unified act and experience. It represents the acme of accomplishment of the integration of the animal organism. That it is in this system that mind, as we know it, has had its beginning, and with the progressive development of the system has developed step for step, is surely significant. So it is that the portion in this system to which mind transcendently attaches is exactly that where are carried to their highest pitch the nerve-actions which manage the individual as a whole, especially in his reactions to the external world. There, in the brain, the integrating nervous centres are themselves further compounded, inter-connected, and re-combined for unitary functions. The cortex of the forebrain is the main seat of mind. That cortex with its twin halves corresponding to the two side-halves of the body is really a single organ knitting those halves together by a still further knitting together of the nervous system itself. The animal's great integrating system is there still further integrated and this supreme integrator is the seat of all that is most clearly inferable as the animal's mind. As such it has spelt biological success to its possessors. From small beginnings it has become steadily a larger and larger feature of the nervous system, until in adult man the whole remaining portion of the system is relatively dwarfed by it. It is not without significance, perhaps, that in man this organ, the brain cortex, bifid as it is, shows unmistakable asymmetry. Man is a tool-using animal, and tools demand asymmetrical, though attentive and therefore unified, acts. A nervous focus unifying such motor function will, in regard to a laterally bipartite organ, tend more to one half or the other and in man's cerebrum the preponderance of one-half, namely, the left, over the other may be a sign of unifying function.

It is to the psychologist that we must turn to learn in full the contribution made to the integration of the animal individual by mind. But each of us can recognise, without being a professed psychologist, one achievement in that direction which mental endowment has produced. Made up of myriads of microscopic cell-lives, individually born, feeding and breathing individually within the body, each one of us nevertheless appears to himself a single entity, a unity experiencing and acting as one individual. In a way the more far-reaching and many-sided the reactions of which a mind is capable the more need, as well as the more scope, for their consolidation to one. True, each one of us is in some sense not one self, but a multiple system of selves. Yet how closely those selves are united and integrated to one personality. Even in those extremes of so-called double personality one of their mystifying features is that the individual seems to himself at any one time wholly either this personality or that, never the two commingled. The view that regards hysteria as a mental dissociation illustrates the integrative trend of the total healthy mind. Circumstances can stress in the individual some, perhaps lower, instinctive tendency that conflicts with what may be termed his normal personality. This latter, to master the conflicting trend, can judge it in relation to his main self's general ethical ideals and duties to self and the community. Thus intellectualising it, he can destroy it or consciously subordinate it to some aim in harmony with the rest of his personality. By so doing there is gain in power of will and in personal coherence of the individual. But if the morbid situation be too strong or the mental self too weak, instead of thus assimilating the contentious element the mind may shun and, so to say, endeavour to ignore it. That way lies danger. The discordant factor escaped from the sway of the conscious mind produces stress and strain of the conscious self; hence, to use customary terminology, dissociation of the self sets in, bringing in its train those disabilities, mental or nervous or both, which characterise the sufferer from hysteria. The normal action of the mind is to make up from its components one unified personality. When we remember the manifold complexity of composition of the human individual, can we observe a greater example of solidarity of working of an organism than that presented by the human individual, intent and concentrated, as the phrase goes, upon some higher act of strenuous will? Physiologically the supreme development of the brain, psychologically the mental powers attaching thereto, seem to represent from the biological standpoint the very culmination of the integration of the animal organism.

The mental attributes of the nervous system would be, then, the coping-stone of the construction of the individual. Surveyed in their broad biological aspect, we see them carrying integration even further still. They do not stop at the individual; they proceed beyond the individual; they integrate, from individuals, communities. When we review, so far as we can judge it, the distribution of mind within the range of animal forms, we meet two peaks of its development—one in insect life, the other in the vertebrate, with its acme finally in man. True, in the insect the type of mind is not rational but instinctive, whereas at the height of its vertebrate development reason is there as well as instinct. Yet in both one outcome seems to be the welding of individuals into societies on a scale of organisation otherwise unattained. The greatest social animal is man and the powers that make him so are mental; language, tradition, instinct for the preservation of the community, as well as for the preservation of the individual, reason actuated by emotion and sentiment, and controlling and welding egoistic and altruistic instincts into one broadly harmonious, instinctive-rational behaviour. Just as the organisation of the cell-colony into an animal individual receives its highest contribution from the nervous system, so the further combining of animal individuals into a multi-individual organism, a social community, merging the interests of the individual in the interests of the group, is due to the nervous system's crowning attributes, the mental. That this integration is still in process, still developing, is obvious from the whole course of human pre-history and history. The biological study of it is essentially psychological; it is the scope and ambit of social psychology. Not the least interesting and important form of social psychology is that relatively new one, dealing with the stresses and demands that organised industry makes upon the individual as a unit in the community of our day and with the readjustments it asks from that community.

To resume, then, we may, I think, conclude that in some of its aspects animal life presents to us mechanism the "how" of which, despite many gaps in our knowledge, is fairly explicable. Of not a few of the processes of the living body, such as muscular contraction, the circulation of the blood, the respiratory intake and output by the lungs, the nervous impulse and its journeyings, we may fairly feel, from what we know of them already, that further application of physics and chemistry will furnish a competent key. We may suppose that in the same sense as we can claim to-day that the principles of a gas-engine or an electro-motor are comprehensible, so will the bodily working in such mechanisms be understood by us, and indeed are largely so already. It may well be possible to understand the principle of a mechanism which we have not the means or skill ourselves to construct; for example, we cannot construct the atoms of a gas-engine.

Turning to other aspects of animal mechanism, such as the shaping of the animal body, the conspiring of its structural units to compass later functional ends, the predetermination of specific growth from egg to adult, the predetermined natural term of existence, these, and their intimate mechanism, we are, it seems to me, despite many brilliant inquiries and inquirers, still at a loss to understand. The steps of the results are known, but the springs of action still lie hidden. Then again, the "how" of the mind's connexion with its bodily place seems still utterly enigma. Similarity or identity in time-relations and in certain other ways between mental and nervous processes does not enlighten us as to the actual nature of the connexion existing between the two. Advance in biological science does but serve to stress further the strictness of the nexus between them.

Great differences of difficulty therefore confront our understanding of various aspects of animal life. Yet the living creature is fundamentally a unity. In trying to make the "how" of an animal existence intelligible to our imperfect knowledge we have, for purposes of study, to separate its whole into part-aspects and part-mechanisms, but that separation is artificial. It is as a whole, a single entity, that the animal, or for that matter the plant, has finally and essentially to be envisaged. We cannot really understand one part without the other. Can we suppose a unified entity which is part mechanism and part not? One privilege open to the human intellect is to attempt to comprehend, not leaving out of account any of its properties, the "how" of the living creature as a whole. The problem is ambitious, but its importance and its reward are all the greater if we seize and attempt the full width of its scope. In the biological synthesis of the individual it is concerned with mind. It includes examination of man himself as acting under a biological trend and process which is combining individuals into a multi-individual organisation, a social organism surely new in the history of the world. This biological trend and process is constructing a social organism the cohesion of which depends mainly on a property developed so specifically in man as to be, broadly speaking, his alone, namely, a mind actuated by instincts but instrumented with reason. Man, often Nature's rebel, as Sir Ray Lankester has luminously said, can, viewing this great supra-individual process, shape his course conformably with it even as an individual, feeling that in this case to rebel would be to sink lower rather than to continue his own evolution upward.

Scientific Problems and Progress.

ADDRESSES OF PRESIDENTS OF SECTIONS OF THE BRITISH ASSOCIATION.

THE THEORY OF NUMBERS.

IN his presidential address to Section A (Mathematics and Physics), Prof. G. H. Hardy propounded a series of five problems of general interest in the theory of numbers, which are still awaiting solution.

(*a*) *When is a number the sum of two cubes, and what is the number of its representations?* The density of the distribution of such numbers tends to zero as the number tends to infinity, but no simple criterion by which these numbers can be recognised is known. The least number expressible in more than one way as a sum of two cubes is 1729, which is 12^3+1^3 or 10^3+9^3. Four representations of 19×363510^3 are known, and this is apparently the largest number of such forms which has been obtained.

(*b*) *Is every large number the sum of five cubes?* Two numbers, 23 and 239, require nine cubes; there are fifteen numbers requiring eight, and 121 numbers requiring seven, the largest of the latter being 8042. Six-cube numbers probably disappear before reaching 1,000,000, and possibly five-cube numbers also disappear, but in huge numbers, for four-cube numbers persist for ever.

(*c*) *Is $2^{137}-1$ prime?* This problem belongs to the theory of the so-called "perfect" numbers, each of which is the sum of all its divisors including unity. The number 2^n-1 can be prime only when n is prime, and 137 is the least value of n for which the answer is still doubtful. Two other problems connected with the perfect numbers, for which solutions are still sought are: Can a perfect number be odd? and, are there an infinite number of perfect numbers?

(*d*) *Are there infinitely many primes of the form n^2+1?* The general distribution of primes is, in all essentials, solved, but much remains to be done among numbers of special form. The form n^2+1 is the simplest case of the general form $an^2+2bn+c$, and although an approximate formula, which has been well tested, has been obtained for determining the number of primes, there is no immediate prospect of an accurate proof.

(*e*) *Are there infinitely many prime pairs, p, $p+2$?* This is a particular case of the question whether any group of primes recur indefinitely. Apparently all possible groups recur for ever with definite frequency, and so far as the first million numbers are concerned, the proposition has been tested, but there is no rigid proof of its accuracy.

CHEMISTRY OF THE SUGARS.

PRINCIPAL IRVINE spent the first part of his address to Section B (Chemistry) in discussing the new responsibilities which devolve upon scientific chemists who take advantage of the facilities offered by the Department of Scientific and Industrial Research (see NATURE, July 22, p. 131).

The second section of the address was devoted to an account of how investigations on the sugars carried out in the St. Andrews' Laboratories for many years are being developed so as to include the structural problems of the polysaccharides. These compounds are shown to be composed of comparatively simple units, as indicated below.

Cellulose.—α-Cellulose gives a trimethyl derivative as the maximum substitution product, and this in turn yields on hydrolysis only 2-, 3-, 6-trimethyl glucose. The simplest formula for cellulose would thus be an anhydro-di-glucose, each hexose residue being substituted in positions 1 and 5, but, in order to accommodate the yield of cellobiose obtained from cellulose, the molecule for the latter is held to be that of a tri-(1-, 5-anhydroglucose).

Starch.—The methylation of starch gives a product which contains seven methyl groups for every unit of eighteen carbon atoms. These are distributed in such a manner that one glucose residue contains three methyl groups, while two such groups are present in each of the remaining glucose residues. Starch is thus based on an anhydro-trisaccharide to which a structure has been ascribed.

Inulin.—This polysaccharide is known to be composed entirely of γ-fructose residues, and each of these has now been shown to be identical in structure. It is in the meantime premature to say if inulin is derived from the simple unit $C_6H_{10}O_5$ or from the double or triple multiple of this, but in any event the γ-ketose residues are symmetrically disposed.

A close structural relationship has thus been established between (*a*) cellulose and starch, (*b*) starch and lactose, (*c*) inulin and sucrose.

PHYSIOGRAPHY OF THE COAL SWAMPS.

THE purport of the presidential address delivered by Prof. P. F. Kendall to Section C (Geology) was to show that coal seams are the result of growth and accumulations of peat, *in situ*, and that all the phenomena of the British coal-measures can be explained upon this hypothesis, with the necessary implication of great deltaic swamps.

The English coal-measures consist of fresh-water muds and sands with occasional intercalations of marine sediments of relatively small amount. This theory is in full accord with what is known of modern swamps and deltas. Two types of sandstones occur; one, having the form and arrangement of deltaic sand-banks, is often of wide extent, the other taking the form of meandering river-channels which may cut out an entire seam, producing a "wash out." One such example, in which 90 ft. of normal measures and large areas of coal are replaced, was mentioned.

The splitting of coal-seams is attributed in some cases to contemporary river-erosion, and in others to local sags, drowning the vegetation and interrupting coal growth. Effects of contemporary earthquakes are recognisable in many seams and districts. They take the form of "lurched" margins of wash-outs, casts of sand-fountains, sandstone dykes, "swillies," or trough-like inflexions of seams, and contemporary faults affecting lower and not upper seams. All these effects are of earlier date than the ordinary faulting of the strata.

In discussing the various types of material which constitute coal-seams, stress was laid on the distinction between coal and cannel. The explanation of "coal balls" proposed by Stopes and Watson is accepted with the corollary that the constituent plants must, in some cases, have grown in salt water.

In conclusion attention is directed to the phenomenon of cleat, that is, the system of jointing in coal, the one coal-measure phenomena for which there is no obvious modern parallel. Observation of its direction all over the world and in deposits of all ages, from Carboniferous to Pleistocene, shows an overwhelming preponderance of N.W.-S.E. in the northern hemisphere and N.E.-S.W. in the southern. This seems to be in some way related to the earth's planetary rôle, but data are not yet sufficiently complete to justify the formulation of a theory. Every morsel of coal, even a single leaf of cordaites $\frac{1}{100}$ of an inch in thickness, exhibits a regular cleat in the specified direction. The absence of cleat in anthracite is held to explain the low ash percentage. Jointing, comparable to cleat and agreeing in direction, occurs in some limestones.

THE PROGRESSION OF LIFE IN THE SEA.

IN his address to Section D (Zoology) the president, Dr. E. J. Allen, first discussed the theory that life in the world had its origin in the sea, referring to recent work by Baly on the formation of formaldehyde and sugars by the action of light of short wave-length on carbonic acid and water, and to the views expressed by Church on the building up of an autotrophic flagellate from the ions present in sea-water. An account was given of work on the culture of marine diatoms, showing the necessity for the presence of traces of organic matter before healthy growth of plant life took place. The passage from plant to animal nutrition was illustrated by the chrysomonad Pedinella. A similar change in nutrition was described amongst the Dinoflagellates. The line of progression from the flagellates to the metazoa probably proceeded through the cœlenterates, which represent the highest stage attained by the primary plankton or free-swimming animals. Further development took place when the latter established a connexion with the sea-bottom. Many of the bottom-living animals subsequently again adopted the free-swimming habit, and gave rise to the various groups of animals found in the plankton to-day. Fishes were probably evolved in rivers, and developed their swimming powers to resist the action of the current.

The conditions controlling the production of organic food material in the sea were discussed and some account given of the food-chain from the diatom and peridinian to the fish. Recent work by Hjort and Drummond was described, on the production of vitamin by marine plankton diatoms, and the passage of this growth stimulant through their food into the bodies of fishes, where it is found in the oil of the liver and subsequently in the ovary. In conclusion it was urged that for the solution of problems dealing with practical fisheries the life of the sea must be studied as a whole.

HUMAN GEOGRAPHY.

DR. MARION NEWBIGIN'S address to Section E (Geography) was on "Human Geography: First Principles and Some Applications." Geographers are agreed that there is a definite human geography, but little attention has been given to the problem as to the precise way in which man's response to environmental conditions differs from that of animals. Since man once ran into a number of species—or even of genera—it is obvious that there was once a time when there was no distinctively human response, when adaptation led to specific differentiation, just as it does among animals. But since all living men now belong to one species, it is clear that this time has passed. Its passing appears to be associated with the fact that growing intelligence meant that the barriers to distribution which limit the movements of animals ceased to function. This in its turn might have meant that human evolution stopped, that man ceased to be adapted to any particular habitat because fitted for all, were it not that the factors of fixation and isolation, so important in the case of the lower organisms, began to act in a new way. With the growth of cultivation, communities became fixed to particular areas, and if the isolation was sufficient to ensure the necessary continuity and protection during the early stages, a communal as distinct from an individual adaptation appeared. The second part of the address dealt with applications of these general principles to the chief foci of civilisation in Europe and the adjacent lands. Thus the causes which promoted the origin, growth, and decay or modification of the successive cultures of the great river valleys, of the Mediterranean seaboard, and of the forest belt of Western Europe were considered, and the peculiar difficulties encountered in establishing stable communities in the steppe lands of Eastern Europe discussed briefly.

RAILWAY PROBLEMS OF AUSTRALIA.

THE presidential address to Section G (Engineering), by Prof. T. Hudson Beare, was on "Railway Problems in Australia." Two great problems have to be faced by the Commonwealth—(1) the unification of the existing railway gauges, and (2) the joining up of the tropical areas of Northern Australia by a system of railways linking up with the railway systems of the southern and eastern areas of the continent.

(1) The first is a problem which has been prominent since 1888; up to the present no satisfactory solution has been found. Various Royal Commissions have inquired into the matter, and the only point which has been definitely settled is that the standard gauge shall be 4 ft. 8½ in. In 1921 a Royal Commission made two proposals—(1) to convert the main railway system connecting the various capitals from Fremantle to Brisbane to a uniform 4 ft. 8½ in. gauge, the length of track being somewhere about 3300 miles, the estimated cost of conversion and of the necessary new lines being 19,000,000*l.*, which would be increased to a total of 21,500,000*l.* if all the 5 ft. 3 in. lines in Victoria and South Australia were simultaneously converted to 4 ft. 8½ in.; (2) to convert the whole Australian railway system to 4 ft. 8½ in.—this the Commission estimated would cost about 57,000,000*l.*, but this estimate has not been accepted by the State railway authorities, and the Premier of South Australia at a recent conference stated that he was of opinion that the total cost would not be far short of 100,000,000*l.* sterling. If some mechanical device for overcoming the break-of-gauge difficulties could be evolved, the need for the expenditure of this enormous sum would be postponed to a period when it is to be hoped costs of constructional work would be greatly reduced.

(2) When the Commonwealth took over the Northern Territory from the State of South Australia on January 1, 1911, an agreement was entered into between the Commonwealth and the South Australian Government to the effect that the Commonwealth Government should construct a north-south railway connecting Port Darwin with Adelaide. It was agreed to construct a railway line from a point on the Port Darwin and Pine Creek railway southwards to a point on the northern boundary of South Australia proper, and a railway northward from a point on the Port Augusta and Oodnadatta railway to connect with the other portion of the line at a point on the northern boundary of South Australia proper. Up to the present no definite steps have been taken to carry out this agreement, but the Commonwealth Joint Standing Committee of Public Works last year appointed a sub-committee to investigate the country of this route and to take evidence. The Commonwealth Engineer for Ways and Works submitted two alternative transcontinental routes: (*a*) a direct north-south line with the necessary branches to connect it with the Queensland railways, estimated cost about 16,000,000*l.*, and (*b*) the eastern route, estimated cost about 14,300,000*l.*, to which must be added an additional sum of about 1,500,000*l.* if the existing 3 ft. 6 in. line from Port Augusta to Oodnadatta was extended to Alice Springs in order to open up the McDonnel Range country for closer settlement. The urgency for a prompt decision in regard to the route of the north-south line is brought out by the fact that at the present time the journey by sea from Brisbane, the nearest State capital, to Darwin takes longer than the sea voyage from Darwin to Singapore or Hong-Kong, a perilous state of things to the Commonwealth in certain contingencies which need not be more emphasised but are obvious to all who are fighting so strongly for the white Australia policy.

THE STUDY OF MAN.

IN his presidential address to Section H (Anthropology) Mr. Harold Peake said that during the last twelve years an anthropological school has arisen, which regards different groups of men as following, not one single path of evolution, but various routes according to their environment. This view has brought the anthropologist more closely into touch with the geographer, who has thereby become more human and less factual, has interested the sociologist and the economist, has infected many classical scholars, and may even wean the historian from a too exclusive study of kings and politicians. Anthropology may be defined as "the study of the origin and evolution of man and his works." As such it must be psychological as well as physical, dynamic rather than static. Nor must it be limited to the study of backward peoples, but extended to such civilised peoples as those of the Far East and Hindustan. We have much information concerning the arts, languages, and official religions of these regions; too little concerning the physical and mental traits of their "masses," their customs and actual beliefs. Such ignorance leads to constant misunderstanding and friction, as, for example, in India, and this can be removed only by giving our rulers there some training in anthropology. The British Schools at Rome and Athens have been of enormous value in establishing friendly relations. Let there be a British School in India, endowed by private benefactors of both races, to act as an anthropological centre from which would radiate a truer understanding of the ideals of both civilisations. The need for similar institutions in the European region is painfully manifest. It is, in fact, the spirit if not the detailed facts of anthropology which seem most likely to lead to that breadth of view and deeper sympathy which humanity requires. We need this not abroad alone; we have in these islands, as the result of successive invasions, various races, each with peculiarities of outlook which still lead to friction. These the anthropologist must study for the sake, not of knowledge only, but also for the sake of peace.

THE EFFICIENCY OF MAN AND THE FACTORS WHICH INFLUENCE IT.

IN his presidential address to Section I (Physiology) Prof. Cathcart, after a brief discussion of the meaning of the term efficiency, in which he differentiated mechanical and industrial efficiency, went on to emphasise the intimate relation which exists between the efficiency of man in the physiological and industrial sense. There was a tendency to lay too much stress on organisation and machinery; to forget the fact that no matter what mechanical improvements were evolved man was always behind the machine, and that, therefore, physiological laws must be reckoned with as an essential factor in industrialism. Attention was directed to the tremendous annual loss in time due to sickness and disability, and it was pointed out that primarily this wastage could not be charged to man being of unsuitable design for the work he was called upon to perform; on the contrary, the physiological balance of the organism was beautifully designed to meet most varying strains. After reference to the relation of the various systems, respiratory, circulatory, etc., to the maintenance of efficiency, Prof. Cathcart went on to discuss the factors which, in his opinion, play the predominant rôles in the maintenance of maximum efficiency. He believed that there were, at least, four intrinsic factors, *i.e.* factors directly related to muscle movement—(*a*) the rate of the performance of the work, (*b*) the amount of rest offered to or taken by the subject, (*c*) the rhythm with which the work was performed, and (*d*) the work habits developed by the worker. He reviewed each of these factors in turn; the influence of load and the type of work (positive and static) was dealt with under the rate of performance, and the formation of conditioned reflexes in connexion with rhythm and habit. The more extrinsic factors, *i.e.* those less directly related to muscle effort, were next discussed, including the influence of the state of nutrition and the nature of the food supplied, of the work environment, and the psychic factor generally, particular reference being made to monotony of occupation and the part played by the temperament of the worker. Other still more extrinsic factors like housing, personal habits, lighting, heating, ventilation, etc., were also mentioned. The general conclusion reached was that although the real over-all efficiency of the worker could not be causally related to any single factor, further scientific investigation along physiological lines, with the mutual co-operation of the employer, employee, and scientific worker, would throw much light on this most difficult and vitally important problem.

TRANSPORT OF ORGANIC SUBSTANCES IN PLANTS.

THE address to Section K (Botany), by Prof. H. H. Dixon, dealt with the transport of organic substances in plants. Organic substances are conveyed upwards in the rising transpiration and root-pressure currents. The transport is probably mainly effected in the tracheæ of the outer layers of the wood. Ringing may block these channels completely or partially by the introduction of air-bubbles and by exudations from injured cells into the lumina and walls of the tracheæ.

The downward transport of these substances from the leaves to the lower parts of the plant is usually assigned to the bast, although there is weighty experimental evidence that living conduits are not essential. Calculation shows that if the bast were used as the conduit a velocity of flow in it of about 50 cm. per hour would be required. In such narrow tubes as the bast is composed of, with frequent cross partitions and colloid contents, this velocity seems quite impossible. These considerations render it highly probable that the tracheæ of the wood are the path for downward transport also. There is ample experimental evidence for downward as well as upward movement of sap in the tracheæ. Tension in the sap determines a flow from any source above or below. Resistance to transverse flow in the wood practically subdivides that tissue into a number of longitudinal filaments of tracheæ connected anatomically at various levels in the plant. Transpiration from the upper end of one filament may thus lead to a downward motion in a neighbouring one.

There is also conclusive evidence for this reversed motion in intact normal plants.

Recent work has shown that the transfer of stimuli from the receptive to the motile regions of plants is effected by the passage of hormones. In several cases it is certain that the hormones are conveyed in the transpiration current. Moreover, the movement is often basipetal. Such a downward flow is clearly available for the conveyance of organic foodstuffs as well as hormones. Local increases in the permeability of leaf-cells will allow solutions of organic substances to pass into the tracheæ. The tension generated in the sap by the transpiration of other leaf-cells will draw this solution downwards in the tracheæ. Experimental evidence for this method of transport is available. The volume-changes of leaves and parts of leaves observed during transpiration are in all probability the result of these changes in permeability, and are directly connected with the supply of organic substance from the leaf-cells to the transpiration-current for downward transport.

EDUCATIONAL AND SCHOOL SCIENCE.

SIR RICHARD GREGORY'S address as president of Section L (Educational Science) was a statement of the biological basis of education and a plea for broader conceptions of the scope and substance of science teaching in schools. It is the business of education to promote the right adjustment between the developing human organism and its surroundings, and this implies that the nourishment provided at all stages of growth should be not only such as supplies the needs of the moment but also builds up strength to live a full life under the conditions of the times. School instruction in science is not, therefore, intended to prepare for vocations, but to equip pupils for life as it is and as it soon may be. It is as essential for intelligent general reading as it is for everyday practical needs; no education can be complete or liberal without some knowledge of its aims, methods, and results, and no pupil in primary or secondary schools should be deprived of the stimulating lessons it affords. In such schools, however, the science to be taught should be science for all, and not for embryonic engineers, chemists, or even biologists; it should be science as part of a general education—unspecialised, therefore, and without reference to prospective occupation or profession, or direct connexion with possible university courses to follow. There is very present need for the reminder that science is not all measurement, nor is all measurement science. In the great majority of secondary schools science signifies chiefly quantitative work in physics and chemistry—laboratory exercises and lessons based upon them—and rarely is any attempt made to show the pupils what a wonderful world we live in, or what science has done, and is doing, for them in everyday life. By the prevailing obsession in regard to quantitative work the pupil is made the slave of the machine, and appliances have become encumbrances to the development of the human spirit. In addition to subjects studied experimentally, there should be general science courses covering a wide field. Geography can be made the unifying principle of such instruction. Practically all the subjects of a broad course of general science are of geographical significance, inasmuch as they are concerned with the earth as man's dwelling-place, and are the scene of his activities.

The Royal Observatory, Greenwich.

THE Royal Observatory is situated in Greenwich Park on the edge of a scarp overlooking the Thames. The ground descends sharply to the north and west. On the east (running diagonally across the photograph) is a level avenue leading southwards to Blackheath. This is joined at an acute angle a little south of the observatory by the avenue from Greenwich, which rises at moderate gradient to the level of the plateau.

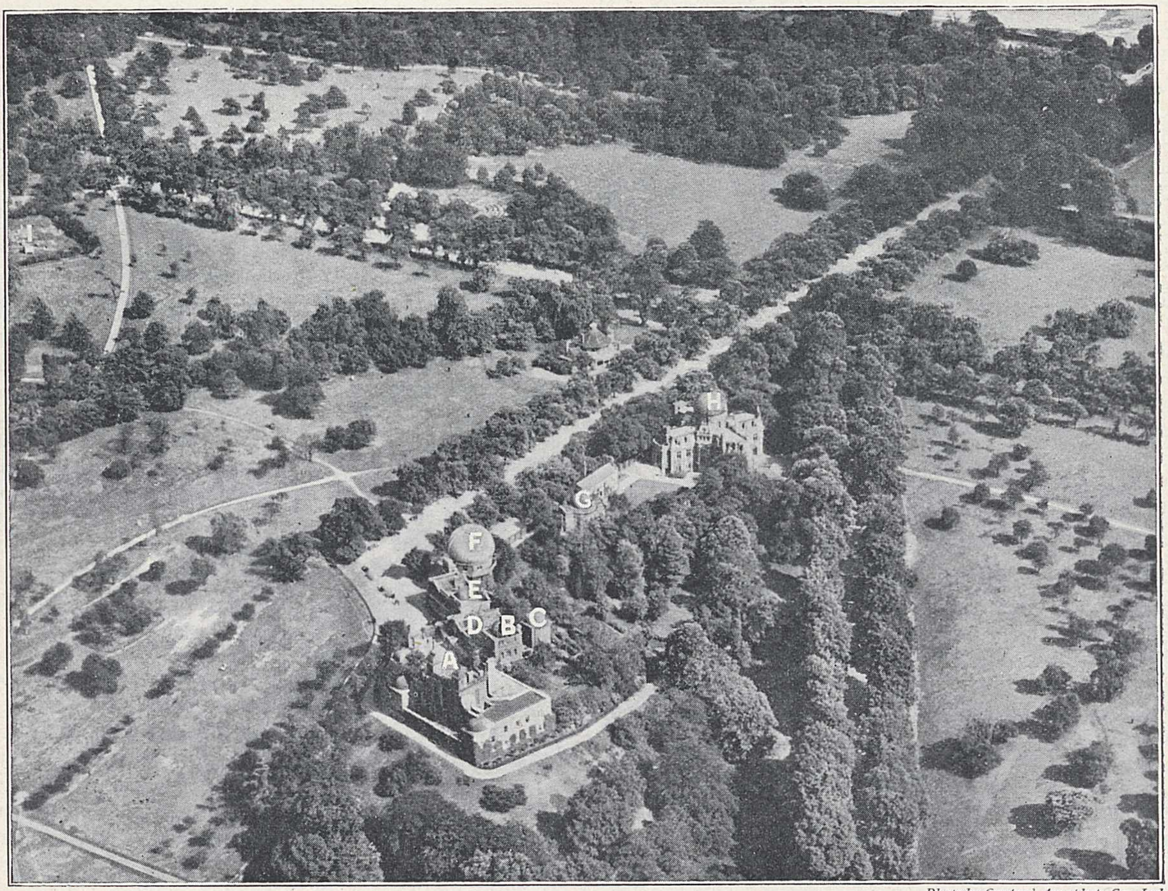

Photo by Central Aerophoto Co., Ltd.

THE ROYAL OBSERVATORY, GREENWICH.

A=ORIGINAL BUILDING. B=ASTROGRAPHIC EQUATORIAL. C=PHOTO HELIOGRAPH. D=TRANSIT CIRCLE. E=SHEEPSHANKS TELESCOPE. F=28-INCH EQUATORIAL. G=ALTAZIMUTH. H=THOMPSON EQUATORIAL. I=MAGNETIC AND METEOROLOGICAL INSTRUMENTS.

The observatory was founded by Charles II. and designed by Wren. The original building, A, is shown surmounted by the time-ball at the north-east corner and anemometers on the north-west and south. The octagon room, so called from its shape, contained in this building was the observatory of Flamsteed, who was commissioned to make observations of the sun, moon, and planets for the assistance of navigators, especially with the view of their utilising predicted positions of the moon among the stars for the determination of longitude at sea. Some of the instruments employed by Flamsteed were in this room, but others were in the open. Under the octagon room are four small rooms where Flamsteed lived. In Maskelyne's and Airy's time additions were made to the house by buildings to the south and west; the part of the Astronomer Royal's official residence looking over the western edge of the scarp is shown prominently in the picture.

To the south of the octagon room are shown two small domes. The first of them, B, covers the astrographic equatorial, a photographic telescope which was erected by Sir William Christie, and has done good service in the photographic mapping of the heavens, the determination of the solar parallax from observations of the planet Eros, and the determination of photographic magnitudes of stars.

Behind B, at C, is a drum-shaped dome beneath which Airy's altazimuth for observations of the moon was situated. This instrument was taken down in 1911 and a photoheliograph installed, with which the daily photographs of the sun are taken. These with photographs taken at the Cape and supplemented by others from India give a complete daily record of sunspots. They are measured and the results utilised to determine the peculiarities of the sun's rotation and the remarkable 11-year period in sunspots and their connexion with terrestrial magnetism.

To the east of the astrographic equatorial is the transit circle in a building, D, with a gable roof running north and south. This instrument, erected in 1851 by Airy, is on the Greenwich meridian. It has been in constant use for seventy years to determine Greenwich time, and with it regular observations are made for the positions of sun, moon, planets and stars. These observations have contributed very materially to the foundation of the tables and catalogues from which the "Nautical Almanac" is computed. In addition, many other stars have been observed for comparison with earlier observations made by Bradley and others at Greenwich and elsewhere. The small changes in position of the stars among themselves as seen in the sky determined in this way and combined with other data give the sun's motion in space, the average distances of stars, and prove the existence of two streams of stars.

To the left is a building, E, surmounted by a small dome containing the Sheepshanks telescope, used for observations of comets. These buildings also contain office rooms, record rooms, a small laboratory for receiving the wireless time signals from Paris, Bordeaux, Lyons, Nauen, Annapolis, and other stations, and rooms in which chronometers and watches are stored.

The large dome, F, contains the 28-inch equatorial. This large telescope was erected in 1893 on a mounting which had carried the 13-inch Merz telescope, which at the time of its erection in 1860 was the largest telescope in the observatory. The 28-inch refractor is used mainly for the measurement of close double stars.

The care of the chronometers and watches belonging to the Royal Navy is part of the work of the observatory, and the room beneath the large telescope is the main chronometer room; it contains ovens in which chronometers and watches are tested to see that they are correctly compensated. In this room is preserved the beautiful chronometer, made by Harrison, which obtained the Government prize of 20,000*l.*, and a copy of it made by Larcum Kendal which was carried by Capt. Cook on his voyage round the world. On the ground floor is another room for chronometers and refrigerating plant for testing them at low temperatures.

A little to the south is the altazimuth, G. This was erected by Sir William Christie in 1896, and is used to supplement the observations of the moon made with the transit circle. A little south-east is a building used as a store-room, in which the publications of the Greenwich and Cape observatories are housed.

At the extreme south is the new building erected in 1896–1898. It is cruciform, and has on the main floor office rooms, where photographs are measured, calculations made, and observations discussed. The basement consists of libraries and a workshop. Three of the rooms of the upper floor are used for storing records and photographs, the fourth is used for photographic work, such as reproduction of the Franklin Adams Charts. The central part of the building is surmounted by the Thompson equatorial under a 36-ft. dome, H. This instrument, given by Sir Henry Thompson, consists of two telescopes on the same equatorial mounting. One of these is a 26-inch photographic telescope with a guiding telescope of 13 inches, and the other a 30-inch reflector made by Dr. Common. The photographic refractor has been put to many uses, including the observation of satellites and minor planets. It is at present used regularly for the determination of the distances of stars, delicate work which is carried on very successfully in spite of difficulties arising from weather and short summer nights. The reflecting telescope has been used for photographing nebulæ, comets, and faint objects where great light-grasping power is required. With it a very faint and distant satellite of Jupiter was discovered. It is at present employed with a coarse grating to determine the colours of stars, or with a spectroscope to study the distribution of light in stellar spectra.

Only one important instrument is not shown in the photograph. The Cookson telescope, lent by the University of Cambridge and used for observation of small movements of the earth's pole, is in a small wooden hut to the east of the octagon room, and is hidden by that building.

Near the top left-hand corner, I, of the photograph is an enclosure in which are two buildings devoted to magnetic observations. Magnetic instruments had to be moved some distance from the main observatory, owing to the effect of iron in the domes on the magnets. Continuous photographic traces are taken showing the changes of the magnetic elements, controlled by regular observations made by eye. This enclosure also contains a radium collector for the study of atmospheric electricity, and various meteorological instruments.

Colour Vision and Syntony.

By Prof. E. H. BARTON, F.R.S.

THE classic theory of colour vision due to Young and developed by Helmholtz and Maxwell attributes the observed phenomena to three sensations (red, green, and violet), but does not enter into detail as to the type of mechanism involved in their stimulus and response. In the days before the discovery of the electron, it was unlikely that any hypothesis of syntony (or sympathetic vibratory response) should be developed for the eye, because nothing was then known of vibrators capable of such high frequencies as those involved in the visible spectrum. But it is now open to us to attempt a syntonic hypothesis of colour vision, since so much more is known as to the constitution of the atom and the behaviour of the electrons. The fundamental facts which recommend the resonance theory of hearing are the smallness and rapidity of those motions which constitute the external stimulus of audition. But how much stronger is the argument based on the corresponding facts for vision! For in vision we are concerned with the frequencies of light, many millions of millions per second, and with displacements correspondingly minute. Further, we now know that in all receptions for wireless telegraphy there must be the tuning of a sympathetic vibrator before the detection of the excessively minute and rapidly alternating disturbances which constitute the signal.

Thus the question naturally arises, Can a syntonic theory of colour vision prove tenable? To answer this we must review the main facts of the case, put forward a specific hypothesis based upon them, and test it against the facts.

CHIEF FACTS OF COLOUR VISION.—These may be classed under five heads: the spectrum, spurious colour mixtures, true colour mixtures, time phenomena, and colour blindness.

(i.) *The Spectrum* of white light extends over nearly an octave (to borrow the musical term) from red with a wave-length of nearly four-fifths μ to violet of wave-length two-fifths μ. The spectrum has no gaps in it, thus showing that we have continuous vision over the range in question. The colours change gradually all the way along the spectrum, and we have six or seven common names for the chief colours occurring. But Dr. Edridge Green finds that the spectrum can be divided into bands, each seeming monochromatic and each different from its neighbours. The number of these bands varies with the observer, but he finds it may reach from 18 to 27 for those with very sensitive colour vision.

(ii.) *Spurious Colour Mixtures.*—By mixing pigments (in water colour or oils) and by superposing coloured glasses or films we really execute a double subtraction of colour and not a true addition at all. Thus blue and green pigments mixed or blue and green glasses superposed almost always give green. This is because each pigment or glass subtracted (or absorbed) certain colours from the whole spectrum and left certain colours, and that of the colours thus left, green was the only one common to both residues. By the same methods red and green will give a low colour approaching grey, or it may give an absolute black. This last effect is easily obtained by superposing two good films, each of which transmits only a limited portion of the spectrum, with no colour common to both films.

(iii.) *True Colour Mixtures.*—These true additions of colour may be obtained by converging two or more coloured beams of light, by the colour top, or by stippling, weaving, or the various colour processes now used in book illustrations. These true mixtures give results quite different from those of the spurious mixtures and thus throw valuable light on colour vision. Thus blue and yellow do not make green but white or a light pinkish tinge; red and green make yellow; red, green, and violet make white, while red and violet give a colour not found in the spectrum.

(iv.) *Time Phenomena.*—It is known that the full acquisition of a visual sensation is not attained under something of the order of a tenth of a second, and that the vision also persists for a like period after the stimulus is withdrawn, before dying out completely. Again, there are effects of fatigue, so that after gazing for twenty seconds at a red object and then at a white surface, a green image appears of the size and shape of the previous red object which had fatigued the eye for red and thus caused the white to appear deficient in red and so look green.

All the facts of colour vision hitherto enumerated apply to those with normal sight.

(v.) *Colour Blindness.*—Finally there are the facts of colour blindness. Some patients are blind to red, others are blind to green or to two of the three colour sensations, some are blind to all three.

SYNTONIC HYPOTHESIS.—In forming a syntonic hypothesis of vision, in which the initial response of the eye to the stimulus of light is supposed due to the sympathetic vibration of something, we must indicate the number of different vibrators imagined to be present at each element of the retina, also the frequencies and dampings natural to them. Since the tri-colour theory of vision has been so successful in many ways it is natural to try first if three vibrational responders could form the basis of a syntonic theory. Obviously if three responders are to suffice their "resonance" or response curves must replace the sensation curves usually drawn to indicate the degrees to which the three colour sensations are excited by the various spectral colours. These curves are much spread and overlap, so that no portion of the spectrum is left without power to excite one or more of the colour sensations. The response curves of the vibrators now postulated can be equally spread by rightly choosing the damping (or dying away of their free vibrations) natural to the vibrator. For, the greater the damping the flatter is the response curve, the less the damping the more sharply tuned is the response. Thus, by the hypothesis of three strongly damped responding vibrators we can account for the visibility of the continuous spectrum just as easily as by the vaguer hypothesis of three colour sensations. What natural frequencies must be assigned to these vibrators? Probably such as to respond to light of wave-lengths rather less than $0{\cdot}76\mu$, about $0{\cdot}55\mu$, and rather more than $0{\cdot}4\mu$. Or we can think of the matter in musical terms as follows, rather sharper than C♯, about F♯, rather flatter than B, all three to be in the same octave.

The Hypothesis Tested.—We have now to test this postulated set of vibrators against the facts of true addition of colours. This test may be carried out mathematically or by experiments with a simple arrangement or model in which the vibrational responders are crudely imitated by pendulums RGV with paper cones as bobs (Fig. 1). (Any form or type of vibrators will serve equally well, as is shown by mathematical theory.) They hang from a stretched horizontal cord AB which is set in motion by the swings of a heavy pendulum CD, as shown in the accompanying figure. To represent a second light stimulus, simultaneously imparted, a second cord, AE, and pendulum FH are provided; the two cords are connected by a bridge of wood near *v* when both drivers are in action.

By the use of this model it is easy to make the desired tests of the hypothesis. In speaking of it we may conveniently refer to the heavy pendulums by the names of colours, thus "red," if of the same frequency as the "red" responder *r*R, etc.

Tried in this way we find the simultaneous use of blue and yellow drivers does not give the response appropriate to green but gives white, *i.e.* all the three responders are set in motion. On reference to the diagram it is possible to see why this follows. The blue driver (representing blue light) is intermediate in frequency between the responders G*g* and V*v*, and so excites both. The yellow driver has a frequency between those of R*r* and G*g* and excites both. But the simultaneous drives on the green responder will interfere by being often much out of phase, so the response of the green responder is no more than those of the violet and red, indeed the last-named often preponderates. It should be noted that in the above test the colours used as stimuli were both such as had no appropriate responder postulated.

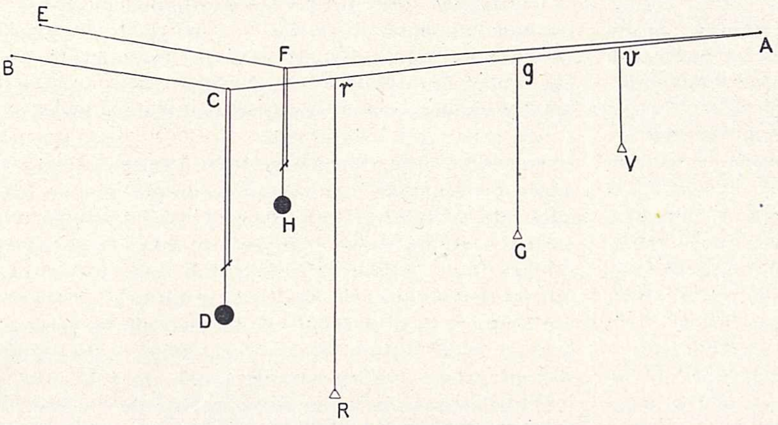

FIG. 1.

For red and green the case is different; each has an appropriate responder provided in the hypothesis, and each is affected by the corresponding stimulus when red and green pendulums are used as drivers. But when a yellow driver is used, *i.e.* a pendulum intermediate in frequency between the red and green responders, they are both affected as when the separate red and green drivers were in use. Thus, on the hypothesis under examination, the naked eye would mistake a true addition of red and green for a yellow. And this is just what happens when the experiment is tried.

This is quite different from what occurs in hearing, where two notes like C♯ and F♯ when sounded simultaneously are not mistaken for any single intermediate note. This distinction is, however, adequately explained in the two hypotheses dealt with in this article on vision and the previous one on audition (see NATURE, September 2, p. 316). In the case of vision only three heavily damped responders are postulated in the single octave, whereas for hearing twelve lightly damped responders were postulated for each octave. The latter secures the finer analysis of which the ear is known to be capable, whereas the former agrees with the known lack of spectrum analysis in the eye. It still leaves power to discriminate twenty or thirty distinct colours in the whole spectrum, however, for if one pendulum CD be used as stimulus it may be changed gradually in length by twenty or thirty steps from the frequency corresponding to the violet responder to that of the red one, and at each adjustment the relative amplitudes of the three responders are appreciably different.

Subsidiary Hypothesis.—To meet the cases of colour blindness, one or more of the three responders is supposed to be absent or *abnormal* in frequency or damping. This opens out a wide field of possibilities.

To explain the time effects (the tenth of a second needed to acquire or lose the full visual sensation) a subsidiary hypothesis is put forward. The vibratory response is supposed only to initiate the process of vision by starting some changes of a physiological or chemical nature which in turn affect the nerves, these changes being, however, quantitatively dependent upon their vibratory initiation. When the light stimulus ceases the vital activities are assumed to restore the changed materials of the retina to their normal states. Both changes are supposed to occupy something of the order of a tenth of a second.

The object of the present article was simply to show whether a syntonic hypothesis is adequate to explain the chief facts of vision. The conclusion is in the affirmative. But the hypothesis is not thereby established. We can only say that, if the hypothesis be true, colour vision would be, in the main, as we now experience it.

To suggest the exact nature of a probable or possible mechanism to carry out this syntonic hypothesis is another matter and beyond the scope of the present article. It was, however, discussed by Sir Oliver Lodge at the Bournemouth meeting of the British Association in 1919.

Obituary.

PROF. J. A. POLLOCK, F.R.S.

PROF. JAMES ARTHUR POLLOCK, professor of physics in the University of Sydney since 1899, who died after a short illness on May 24, at the age of fifty-seven years, was a fine physicist and a man of exceptionally high, loyal, and unselfish character. He was born in or near Cork, and was educated at the Manchester Grammar School and the Royal University of Ireland, taking an engineering degree. He and his brother, Hugh Pollock (they were inseparable), were intended to enter some linen-manufacturing business in which his family were interested; but this proving a disappointment in some way, the young men with their father and some other members of their family went to Sydney about 1884. Arthur Pollock obtained an appointment at the

Sydney Observatory, but soon gave it up to enter as a student at the University, to the great regret of the Government Astronomer, H. C. Russell. He took the B.Sc. with the university medal for physics in 1889, and in 1890 was appointed demonstrator in physics under Sir Richard Threlfall, who at that time occupied the chair of experimental physics. On Threlfall's return to England in 1899 Pollock succeeded to the professorship, which he held up to the time of his death. He was president of Section A of the Australian Association for the Advancement of Science in 1909, was secretary of the Royal Society of New South Wales for the last eleven years of his life, and was elected F.R.S. in 1916.

When the Australian Mining Battalion was formed for work in France about 1915, Pollock at once joined with the rank of captain—the fact that he was fifty years old at the time naturally made no difference to a man of his character. Soon after he got to France he was put in charge of the school for training officers in "listening" underground by means of geophones and related devices. The school was near Poperinghe, within easy reach of Messines and other points of the line where tunnelling was in progress, and he took his full share in the nervous work of estimating how near our tunnels were to the German works. It was characteristic of him that having noticed that in binaural listening with geophones some observers were much more effective than others, he used his opportunities to estimate the minimum retardation of phase which would cause the sound to go "round the head." He finally discovered a young Russian who was so sensitive that he could point the geophone indicator in the direction of the sound with an accuracy of the same order as is attainable by visual means!

After the mining period was over Pollock was moved to Farnborough, where he worked at the problems of aeroplane navigation with the rank of major until the end of the war; but his real contribution to the final victory lay in the way he conducted the school at Poperinghe, where all instruction in "listening" was practically in his hands.

Pollock's experimental work in physics, contained in some twenty papers, is characterised throughout by his striving for accuracy and the avoidance of ambiguity. His early training at an observatory coloured all his work. Whatever the apparatus was, the best result must be got out of it, and when the work was published nothing must appear that was not really essential. His skill in adjusting instruments has probably scarcely ever been equalled, as may be seen by reference to a joint paper on a gravity balance (Phil. Trans., 1899, Vol. A, 193). In this work, whatever degree of success was attained may be attributed mainly to Pollock's skill and devotion: the late Mr. Duddell—no mean judge in such matters—once told the writer that had the thing not been done he should have regarded it as impossible.

During the years 1890 to 1895 Pollock was greatly interested in optical experiments. He had acquired great skill in making the adjustments required when using the Michelson-Morley classical apparatus, and with it made some observations of the effect of the velocity of a stream of water on light passing through it. Like many other of his experiments no publication was made, because he considered that the conclusions he came to did not constitute an advance on existing knowledge.

After 1900, for some years Pollock's work was mainly directed to establishing the relations between the geometrical constants of a conductor and the wavelength of the electromagnetic radiation obtained from it. The accurate figures obtained were very welcome at the time, and he returned to the subject at a later date. The apparatus was then used for the determination of the specific inductive capacity of a sheet of glass at high frequency 24,000,000 (Pollock and Vonwiller). Measurement was repeated at a frequency of 50, and no appreciable difference in specific inductive capacity was found. This work was then extended to Selenion by Vonwiller and Mason as a supply of well-purified material was available. The value obtained, again practically the same whether the frequency was high or low, namely, 6·13 at 16° C. by low frequency and 6·14 by high frequency at 23·6° C., is probably the most trustworthy figure extant for the material in the physical state described in the paper. As the measurement was not made in Germany, it is doubtful whether it will ever reach a text-book.

The above investigations were followed by an experimental and theoretical investigation of the application of the ionic theory of conduction to the carbon arc—especially in regard to the phenomena of "relighting" (Pollock, Wellisch, and Ranclaud), 1909, but for several years Pollock's experimental work was much interrupted by the illness of his brother, to whom he was devoted and to whom much of his scanty leisure was given—he died some years ago.

Probably the most important work done by Pollock was his investigation of the ions of the atmosphere (*Phil. Mag.*, 29, 1915, pp. 514 and 636, and Proc. Roy. Soc. N.S.W., Oct. 1909). Starting with the "large ions" discovered by Langevin, Pollock showed that their mobility was definitely related to the relative humidity of the air; applying a thermo-dynamic argument to his observations he concluded that the large ions condensed water in the liquid phase. He then discovered a new class of ions intermediate in mobility between Langevin's ions and free ions, and by the same thermodynamic argument indicated that in this case the ion was weighted with water in the vapour phase.

The two papers quoted give a very good idea of Pollock's powers as a physicist, since he allowed his scientific imagination more scope than usual. Among minor contributions his description of an automatic Sprengel pump and an investigation of the mode of formation of very small bubbles in frothing solutions may be mentioned. In fact, his exposition of froth formation (*Phil. Mag.*, 1912) is exceptionally clear and judicious.

In 1914 Pollock returned to his observations on the relation of the length of electromagnetic waves to the length of a "straight terminated" rod in which they are generated, and more recently was applying his experience in acoustics, obtained during the war, to the investigation of the action of the stethoscope and to the study of the velocity of sound through earth.

As a colleague Pollock was ever cheery and obliging, but his courteous manner covered a character of great firmness, and if he had once made up his mind as to the propriety of any line of conduct he could not be turned from it. On the whole, both Pollock's life and work were determined by an almost Roman sense of duty, and his output of scientific investigation (considerable though it was) was limited by the severe view he took of his obligations as a teacher.

PROF. TADEUSZ GODLEWSKI.

TADEUSZ GODLEWSKI was born on January 4, 1878, the youngest son of the distinguished plant physiologist, Dr. Emil Godlewski, Sr., who was for many years a professor in the Jagellonian University of Cracow. After receiving his early education at the St. Anna School in Cracow, Godlewski entered the philosophical faculty of the Jagellonian University in 1897, and graduated in 1903, the subject of his dissertation being the osmotic pressure of solutions. Between 1901 and 1903 he worked under Prof. A. W. Witkowski as demonstrator in the University Physical Laboratories, and then proceeded to Stockholm for a year's post-graduate study with Prof. Svante Arrhenius, from whose laboratory he published a paper on electrolytic dissociation.

In October 1904 Godlewski travelled to Montreal and entered the laboratory of Sir Ernest Rutherford, by whom he was initiated into radioactive research, and under whose guidance he published three papers on radioactivity during the following year. On his return to Poland in 1905 he was appointed demonstrator, in 1906 assistant professor, and in 1910 full professor of physics at the Technical High School, Lwów (Leopol or Lemberg, Poland), and for the academic year 1918–1919 he was elected Rector of that institution. In 1921 he was elected a Corresponding Member of the Polish Academy of Science and Letters in Cracow. He died on July 28, 1921, from the effects of a slow poisoning, resulting from a coal-gas leak in his laboratory.

Godlewski's later work was devoted mainly to radioactive and electro-chemical problems, and he published numerous original papers. His nature was kindly and lovable, and those who knew him could not but feel the charm of his personality. During the period of my association with him in Vienna in 1915, he looked forward to the dawn of better days for a united Poland, and I well remember his unutterable grief at the death of his friend Smoluchowski in 1917, when he wrote me: "This is truly the greatest calamity that could have befallen us." During the last few years Poland has suffered the loss of several eminent men of science, whom she could ill spare, whose foresight and influence would have been invaluable in her policy of scientific and educational reconstruction. International science, too, mourns the loss of such men as Olszewski, Rudzki, Danysz, Smoluchowski and Godlewski.

R. W. L.

M. L. FAVÉ.

THE death of M. Louis Favé after an illness of several weeks occurred on July 31. Before his retirement M. Favé was the chief hydrographic engineer to the French Navy, and the greater part of his forty years' administrative service was devoted to the study of tides, to coastal surveys, and to the configuration of oceanic basins. He was interested chiefly in the observational side of such work, and especially so in connexion with the invention and construction of new scientific instruments for those purposes. Among these may be mentioned a very efficient device for the damping of small periodic movements in such instruments as mariners' compasses; he also devised instruments for the navigation of balloons.

His most outstanding achievement, however, for which M. Favé deservedly received great credit, was the invention of the Favé tide-gauge. This ingenious instrument, designed for the continuous registration of tidal heights in the open sea, was invented in 1887 and has received continuous development. It is essentially a pressure gauge and registers the variations in pressure by means of two Bourdon gauges on a rotating piece of smoked glass, from which measurements are made with the aid of a microscope. One of the advantages of the instrument is that it can be left without attention at the bottom of the sea for a fortnight. By various devices M. Favé was enabled to obtain records in fairly deep water, and recently he claimed successful operation at a depth of 400 metres. The applications of such an instrument as this are very interesting and important; for instance, Whewell suggested the existence of a point about half-way between England and Holland, where the vertical movement of the sea is zero, and the Favé gauge has been used to supplement other observations, so proving the existence of such a point.

The news of M. Favé's death will be received with much regret by all who are interested in hydrography.

THE death is announced from New York of Dr. Jokichi Takamine, at the age of sixty-eight years. Born in Japan, Dr. Takamine was educated at the Imperial University and afterwards in Glasgow at Anderson College. While in Glasgow he worked at the enzymes of fungi and introduced the useful preparation known as "taka-diastase." He returned to Japan in 1881 and, after marrying an American lady, went to the United States in 1890, became attached to Messrs. Parke, Davis and Co. as consulting chemist, and set up a laboratory of his own. His chief scientific achievement was the separation of adrenaline from the supra-renal bodies. Much of his time was spent in travelling between the United States and Japan. He thus played an important part in facilitating the relations between these countries.

WE notice with regret that Dr. Sophie Bryant has met her death by accident near Chamonix. She left her hotel at Montanvert on August 15 to walk to Chamonix, and her body, bearing marks of several injuries, was found on August 28. She appears to have wandered from the usual path and to have fallen on to a rock. Dr. Bryant was the first woman in the British Isles to receive the degree of doctor of science, and she was headmistress of the North London Collegiate School for Girls from 1895 to 1918.

WE regret to see the announcement of the death, on August 27, of Dr. David Sharp, F.R.S., at the age of eighty-one years.

Current Topics and Events.

H.R.H. THE PRINCE OF WALES, who is patron of the Ramsay Memorial Fund, has consented to unveil on Friday, November 3, at 12 noon, the memorial tablet of the late Sir William Ramsay which is being placed in Westminster Abbey. The tablet has been executed by Mr. Charles L. Hartwell and was exhibited at the Royal Academy this summer. Invitations will be sent out in October. Any communications with respect to the unveiling should be addressed to the organising secretary of the Ramsay Memorial Fund, Dr. Walter W. Seton, at University College, Gower Street, London, W.C.1.

"INTELLECTUAL CO-OPERATION" is the phrase, sufficiently comprehensive, employed by the Council of the League of Nations to designate the field of investigation of a commission set up by it in May last. This body, consisting of twelve members, among whom are Profs. Henri Bergson (president), Gilbert Murray (vice-president), Madame Curie-Sklodowska, and Prof. A. Einstein, held its first session at Geneva on August 1-5. The commission had been given a free hand to define its own programme with due regard to existing national activities and existing organs of international intellectual life. The following were among the topics selected for consideration: the desperate economic condition of the *intelligenzia* in some European countries—notably Austria and Poland; the protection of proprietary rights in scientific discoveries and ideas; the establishment of an international *entente* for the examination and publication of archæological monuments; inter-university relations; and an international organisation of bibliography. All these questions have been referred to individual members of the commission or to sub-commissions for the preparation of reports with the view of taking further action. As for co-operation in scientific research, the commission, anxious not to interfere in the organisation or work of the scientific societies, decided that this should be left to the initiative of the societies themselves. Another question on which the commission found itself unable to take any useful action was the publication by common consent of workers in all parts of the world of discoveries relative to toxic gases and the development of chemical warfare. It decided to reply to the Reduction-of-Armaments Commission, which had referred the question, that it was unable to suggest methods whereby this result might be brought about.

A REPORT of the European Health Conference (League of Nations), held at Warsaw in March last, has been issued. It contains a general report of the work of the Health Organisation since its initiation in 1920, a summary of information received from delegates, minutes of plenary meetings, and reports of various sub-committees on the cost of measures required and the needs of various states, with four useful charts showing the epidemic situation in Eastern Europe. Dr. Rajchman, the secretary, summarised the results achieved by the conference, and explained the plan of campaign devised to fight epidemic disease. That there is need for this will be realised when it is stated that during 1922 there were many districts in Eastern Europe with thousands of cases of typhus and relapsing fevers, and cholera.

FROM the Otago University Museum we receive the Annual Report for the year 1921, drawn up by the curator, Prof. W. B. Benham, professor of biology in the University, who says that "in the not distant future it will be necessary to build a new Biological Department altogether distinct and separate from the Museum, and to divorce the functions of professor and curator, now nominally carried on by one individual." Fortunately, Prof. Benham has a most capable assistant in Mr. H. D. Skinner, who is well known as an ethnologist, but that branch of science and his duties as Hocken Librarian absorb all his time. To judge from the work recorded in the present report, there is more than enough to occupy all the energies of a full-time curator, as well as the additional technical assistants for whom Prof. Benham calls. We note that the Chinese colony in Dunedin has subscribed the sum of 35*l.* to provide cases for a recent donation of Chinese objects. When the rest of the population takes equal interest in the Museum, the just demands of Prof. Benham may perhaps be fulfilled.

THE Trieste Academy of Science and Art announces a competition for the best contribution upon the subject of "Partial Differential Equations of Maxwell-Lorentz." Three prizes will be given. The competition is open to all nationalities. Contributions must bear a pseudonym and be accompanied by a sealed envelope with the name and address of the competitor. The latest date for the receipt of contributions is December 31, 1922. The papers will be published in the Annals of the Academy. Further information may be obtained from the secretary of the Academy of Science and Art, Trieste, Hugh Foscolo Street, 2.

A CENTENARY celebration of the birth of Gregor Mendel is to take place at Brünn, Czecho-Slovakia, on September 22-24. A monument to Mendel's memory was erected at Brünn in 1910, and in the succeeding twelve years the fundamental significance of the principle which he discovered has been still more widely recognised and applied in biology. The programme of the celebration will include addresses on the personality and work of Mendel, as well as papers by prominent Mendelians from various countries, and an excursion to neighbouring caves and to Mazocha. The programme is in the hands of a local committee, and inquiries or contributions should be sent to Dr. Hugo Iltis, Bäckergasse 10, Brünn, Czecho-Slovakia.

A SUMMARY of the weather for the past summer, comprised by the thirteen weeks ended August 26, is given in the *Weekly Weather Report* published by the Meteorological Office for the week ended August 26. The highest temperature in any district of Great Britain was 86° F., which occurred in the north-west of England. The north of Scotland was the only district where the thermometer failed to touch 80° F. Mean temperature was everywhere below the normal.

the deficiency ranging from 2°·6 in the east of Scotland and 2°·5 in the west of Scotland to 1°·3 in the north-east of England. Rainy days were slightly above the normal except in the north-east of England and in the Channel Islands. The total rainfall was in excess of the normal in all the eastern English districts and in the south-west of England; the excess was greatest in the Midland Counties, amounting to 2·44 in., the next largest excess being 0·83 in., in the north-east of England. The duration of bright sunshine was generally deficient and ranged from 7 hours per day in the Channel Islands to 4·6 hours in the north of Scotland. At Greenwich the mean temperature for the three summer months, June to August, was 60° F., which is 4° cooler than for the corresponding period last year; June was slightly the warmest month, and after June 19 the thermometer failed to touch 80° during the remainder of the summer, a feature similarly outstanding in 1920 and 1910. The total rainfall for the three summer months in London was 6·7 in., and July was the only month with an excess of rain; the total for the three months was a quarter of an inch above the normal and more than five times greater than in the corresponding three months last year. Bright sunshine in London was 150 hours less than in the corresponding quarter in 1921; August was the least sunny month.

The Report of the National Physical Laboratory for the year 1921 covers more than 200 pages and gives outlines of many of the researches which have been in progress during the year, with sufficient diagrams to enable the reader to understand the methods and apparatus in use. The outstanding events in the history of the Laboratory for the year are :—the presentation of a bas-relief of Sir Richard Glazebrook executed by M. Cluysenaar of Brussels, which has been erected in the hall entrance of the administrative building with the back of Sir Richard's head towards the entrance; the unfortunate disaster to airship A.38 at Hull, which involved the loss of two of the most valued members of the aeronautics' staff; and the completion of the new buildings for the Admiralty Research Laboratory, and some of those sanctioned by the Treasury in 1920. Funds for the Physics building and for the extension of the Metallurgy building are not yet available. Research for the fighting services has grown considerably during the year, and the Research Associations established by the Department of Scientific and Industrial Research have been responsible for an extensive programme of work, though with one or two exceptions all departments record a decrease in the number of tests made. Dr. J. A. Harker, one of the original members of the staff, has resigned to take up a consulting practice, and Dr. G. W. O. Howe is going to Glasgow University as professor of electrical engineering.

We learn that Messrs. Taylor, Taylor, and Hobson, Ltd., of Leicester, the makers of the well-known Cooke lenses, have now become associated in business with Messrs. Bellingham and Stanley, Ltd., of 71 Hornsey Rise, London, N.19. It is hoped that by pooling the knowledge and resources of the two firms the interests of the British optical industry will be promoted, and that additional economy of manufacture will be secured.

We have received a copy of the first number of the *Record of Photography*, a journal to be issued monthly by the Professional Photographers' Association. It is devoted to the interests of professional and trade photographers and is not to compete with any existing publications. It has the feature, probably unique, that the pages of text are each backed with advertisements, so that any part may be cut out for filing without the loss of other matter (except advertisements) on the back. Accompanying it are two good reproductions of portraits by Mr. Pirie MacDonald of New York.

The last number received of the *Revista de Sciencias* (Rio de Janeiro) contains articles on the new survey of Brazil, Poincaré's mathematical philosophy, clinical forms of *Granuloma ulceroso*, and the dynamic theory of the seismograph. There are notes on the mathematical theory of muscular work, on the occurrence of rare earths in Brazil, the determination of the constants of a thermionic valve, geological notes on the Ceara region, notes on some plants which furnish material for the study of protoplasmic currents, and a general summary on the mineral resources of Brazil as well as shorter notes and articles on other subjects.

We have received a catalogue of microscopes and microtomes from the Bausch and Lomb Optical Co. (37 and 38 Hatton Garden, E.C.). A great many different types of microscope stands are listed, ranging from the simplest to complex models for advanced research and of the binocular pattern. Achromatic, fluorite, and apochromatic objectives and eye-pieces of all types are supplied, as well as all the usual accessories. The microtomes include the well-known small and large Minot forms. Many of us had an opportunity during the war of using the Bausch and Lomb instruments, and found them eminently satisfactory, both mechanically and optically. The prices compare favourably with those of other makers.

Messrs. George Bell and Sons, Ltd., will publish this month, under the title of "Bell's Mathematical Tables," a new book by Dr. L. Silberstein, suited to the requirements of the mathematician and the theoretical physicist. The work will be in two parts, the first containing the usual logarithms of numbers and of the fundamental trigonometric functions. The second and larger part will contain a collection of mathematical formulæ, definitions, and theorems, together with tables of the more important special functions, such as elliptic integrals, Bessel functions and spherical harmonics, Fresnel integrals, etc. Another book in Messrs. Bell's list of announcements is "A Text Book of Machine Construction and Drawing," by H. E. Merritt and M. Platt, the object of which is to provide a thorough and comprehensive exposition of the subject for engineering students. It will cover intermediate requirements, and be of service to more advanced students as a book of reference. A further book by the same authors on the subject of machine design for the use of degree students and designers is in active preparation.

Our Astronomical Column.

AUGUST METEORS.—The great shower of August Perseids was not well observed this year in consequence of cloudy weather and moonlight. A rich display of Cygnids was, however, witnessed during the last half of the month from the point 291° +50° near θ Cygni. The individual members of this stream were brilliant with swift motion and short paths. At the end of their flights many of them burst with a sudden acquisition of brightness. The shower is fairly well known and gave an abundant display in 1893. In that year, between August 4 and 16, 28 of its meteors were seen at Bristol, while 40 were recorded by Mr. Corder at Bridgwater, and 30 by Mr. Blakeley at Dewsbury. A full description of the shower appeared in the *Observatory* for September 1893, and the explosive character of the meteors was specially pointed out. The visible strength of the shower varies from year to year, but its period has not yet been ascertained; further observations are required of this particular stream, for it is certainly one of the most important of the many systems which are in contemporary activity with the well-known Perseids.

MARS.—The first drawings of Mars at the present apparition are published in *L'Astronomie* for July. They were made by M. Mentore Maggini at Catania. One, made on May 23, accords with the description of M. Jarry-Desloges of the paleness of the dark markings at this period, presumably due to their being covered by a veil of mist or dust. This seems to have dissipated by June 1, a sketch on that date showing these regions dark, especially Syrtis Major; the southern end of it is flanked by two brilliant white patches. Nepenthes is very prominent, and widely double. The drawing indicates 15 other canals. Both polar caps are shown, the southern being the larger. Dr. Fountain in the B.A.A. Journal for June 28 ascribes the red colour of the Martian deserts to ferric oxide, and suggests that owing to the escape of the lighter gases the Martian atmosphere may be relatively rich in oxygen, so that meteoric dust would tend to become oxidised.

THE FRYE REFLECTING TELESCOPE.—The 100-inch Hooker Telescope is not long to remain the largest in the world. Mr. T. S. H. Shearman, Government Meteorologist at Vancouver, has successfully cast a speculum of 10 feet diameter and 50 feet focal length which is to be erected in the new observatory planned by Mr. Chas. H. Frye at Seattle. This observatory is to be open to the public at certain times; the telescope will then be used in a horizontal position, being fed with light by a plane mirror; but when it is employed for the photography of nebulæ or other faint objects it will be pointed directly at the sky. The cost of the instrument is in the neighbourhood of 300,000 dollars, and is apparently being borne wholly by Mr. Frye. The above particulars are taken from Circular No. 1 of the Frye Observatory, which also states that Mr. Shearman expected to make the first astronomical observation with the new speculum before the end of July.

VARIABLE STARS NEAR M. 53.—Dr. Baade gives in *Mitteilungen der Hamburger Sternwarte*, Bd. 5, No. 16, an account of a photographic search for variables near the globular cluster M. 53. It resulted in the discovery of 7 variables within a region extending from R.A. $13^h\ 1^m$ to $13^h\ 13^m$, and from Decl. +17° 39′ to +19° 41′. Five of them are of the cluster type, with periods between $\frac{1}{3}$ and $\frac{2}{3}$ of a day. Applying Shapley's rule for the absolute magnitudes of these stars, their distances, in units of 1000 light-years, are 16, 20, 23, 41, 62 respectively. The last named, the mean magnitude of which is 16·25, appears to be a member of the globular cluster, though distant 34′ from its centre. The others are probably unconnected with the cluster. Since the latter is in galactic latitude 79°, the results suggest a much greater extension of the sidereal system in this direction than that indicated by Prof. Kapteyn, who concluded that the star-density became sensibly zero at a distance of some 10,000 light-years towards the galactic poles.

ABBREVIATIONS OF CONSTELLATIONS' NAMES.—In the printing of Star Catalogues in which reference is made to the names of the constellations, a large amount of valuable space is wasted in consequence of the lack of a standard system of an abbreviated nomenclature. At the meeting of the International Astronomical Union held at Rome in May last, the Commission on notation, units, and economy of publication decided on a system of abbreviations which involve only three letters for each constellation. Thus, to give a few examples, And is Andromeda; CMa, Canis Major; CVn, Canes Venatici; Gem, Gemini; etc. In the Harvard College Observatory Bulletin, No. 771, it is stated that this system will be adopted forthwith. It is expected that it will now be used universally, since it is a great economy and convenience in printing, especially when large catalogues of stars with their magnitudes, positions, proper motions, spectrum types, parallaxes, etc., are in hand.

NEW NEBULÆ.—In the Harvard College Observatory Bulletin, No. 773, it is announced that Mr. Donald H. Menzel has found recently approximately two thousand new nebulæ on ninety photographs made with the 24-inch Bruce telescope at Arequipa, the southern hemisphere station of the Harvard College Observatory. Most of the new objects are south of declination −45°: their positions and descriptions will be published later. Of the eight hundred brightest nebulæ found by Mr. Menzel, about thirty-five per cent. appear to be spirals, *i.e.* they show spiral arms or the characteristic spindle form. The majority of the other bright objects are stated to belong probably to the type designated by Hubble as globular nebulæ. It is interesting to note that the total number of nebulæ now recorded is nearly 20,000.

A VERY MASSIVE STAR.—Much attention is now being given to the determination of the masses of stars, so that any star of excessive mass becomes at once an interesting object. Dr. J. S. Plaskett, Director of the Dominion Astrophysical Observatory at Ottawa, describes (Mon. Not. R.A.S., vol. 82, p. 447) the star B.D. 6° 1309, No. 2422 of the Harvard Revised Photometry, which consists of two very bright Oe stars, *i.e.* stars at nearly the highest temperature, 10,000 light years away from us; they revolve around one another in an elliptic orbit in a period of 14·414 days, but are separated by a distance of 90,000,000 kilometres. The brighter of the two stars has a probable mass of at least 86 times that of the sun, a density of 0·01, and an absolute magnitude of −5·65. The fainter star has a mass of 72 and is of the same density, its absolute magnitude being −5·4. The absolute magnitude of the system as a whole is −6·3, which is the greatest so far determined.

Research Items.

Neolithic Script in India.—The recent discovery of two neoliths, one from Chota Nagpur, the other from Assam, said to be marked with decipherable scripts, has attracted some attention. On one of these Prof. Bhandarkar read the word "Maata," assumed to mean "a headman or chieftain." The script is believed to be that known as the Brahmi, which, according to Bühler, was introduced in India from Semitic sources about 800 B.C. Unfortunately, however, there is no evidence that this character was ever written from right to left. The question of these neoliths has been examined by Mr. Hem Chandra Das Gupta in the Journal of the Asiatic Society of Bengal (vol. xvii. No. 2), who points out that the evidence of provenance and of the fact that the inscriptions date from the Neolithic Age is far from satisfactory. Symbols like letters of the alphabet have been found in European soil painted upon pebbles belonging to a stratum between the Palæolithic and Neolithic Ages at Mas d'Azil in France, but scholars are still doubtful whether these so-called inscriptions form a scientific basis for investigation of the origin of the alphabet. The same may be said of these recent Indian discoveries.

The Swastika, Gammadion, Fylfot.—The familiar symbol known in India as the Swastika, or omen of good luck, and in the West as the Gammadion or Fylfot, has generally been interpreted to represent the sun in its apparent course. Its origin has been investigated by Mr. Harit Krishna Deb in the Journal of the Asiatic Society of Bengal (vol. xvii. No. 3). He suggests that it is based on the method of writing the sacred syllable Om, afterwards typical of the Brahmanical triad of deities. This, when written in the Brahmi character, takes the form of two crossed pothooks, which he regards as the earliest form of the Swastika. This theory meets with the serious objection that while this symbol comes down from the Bronze Age at least, and is found on pottery from the Third City at Hissarlik, the Brahmi alphabet, according to Bühler, was derived from a Semitic source about 800 B.C. Mr. H. K. Deb suggests that some of the Brahmi characters may be of indigenous origin in India, while others were adopted from Semitic scripts, but there is no evidence of this. Nor is there any reason to believe that the Swastika was adopted for the first time in India. The interpretation now suggested may be regarded as not proven, unless we are prepared to believe that in this specialised form it is peculiar to India, and the solar explanation may for the present be regarded as holding the ground.

Insectivora from the Congo.—The collections made by the American Museum Congo expedition are gradually being worked out and the results published. The latest section dealt with concerns the Insectivora and was the work of the well-known American zoologist J. A. Allen, who, alas, died without seeing the final proofs (Bull. Amer. Mus. Nat. Hist., vol. xlvii.). The Soricidæ were described in the same Bulletin in 1916 by N. Hollister, but the gist of his work is here repeated to make the whole subject complete. Fifty-two species and subspecies are chronicled, of which only two are, however, new.

Foraminifera of the Atlantic Ocean.—The third part of an important monograph on the Foraminifera of the Atlantic Ocean by J. A. Cushman has just made its appearance (Bull. U.S. Nat. Mus., 104). The first part, dealing with the Astrorhizidæ, was published in 1918 (see Nature, vol. cii. p. 51), and the second on the Lituolidæ in 1920. The present part includes the family Texulariidæ, which is apparently more primitive than most of the other families of the Foraminifera, and follows the Lituolidæ in its general characters, a number of the simpler genera being wholly or in part composed of species with arenaceous tests. In the most primitive subfamily, the Spiroplectinæ, a coiled development makes up a considerable portion of the test. A number of new species are described, and there are twenty-six excellent plates.

Hawaiian Natural History.—The Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History continues its useful career, and its "Occasional Papers" have reached the eighth volume. Three of the latest numbers bearing on natural history are now before us. C. Montague Cooke, jr. (vol. vii. No. 12), supplies "Notes on Hawaiian Zonitidæ and Succineidæ." Among the former the author includes Vitrina, which has long been placed in a family of its own; he elevates Godwinia into a subfamily on anatomical grounds; and founds a new genus Nesovitrea for the *Vitrea pauxillus* of Gould. To the Succineidæ he adds two new species of Catinella, and creates a new genus, Laxisuccinea, for two new fossil species. Adequate illustrations of anatomical details are given in the text, and there are two plates of the shells from the pencil of Miss Winchester, which is a guarantee of their worth. The Stomatopoda in the Museum are the subject of a paper by C. H. Edmondson (vii. No. 13). The collection comprises 53 specimens, of which one is new. The same writer also treats of the Hawaiian Dromiidæ (viii. No. 2), amounting to four species, of which one, *Dromidia hirsutissima* (Lamk), recorded by Dana, has not been seen by him, and he considers its occurrence doubtful.

Ecology of South Australia.—An interesting contribution to the study of arid regions, with special reference to the vegetation, has been prepared by Mr. W. A. Cannon ("Plant Habits and Habitats in the Arid Portions of South Australia." Washington: Carnegie Institution, 1921). The importance of bringing under cultivation those portions of the earth's surface which, at present, are of more or less desert nature, is becoming increasingly important in face of the growing demands for food of the world's population. The studies of the physical, geobotanical and ecological characteristics of such areas are being carried out by our American friends with their typical vigour and freshness of outlook and are already proving of practical value. In the work under notice the varying vegetational features are correlated with the rainfall in the districts which they inhabit, an arbitrary classification of regions being based on the annual amount of rain. It is shown that in South Australia as a whole the flora is distinctly of a xerophytic type, and that of the dry northern portion differs from the rest only in degree and not in kind. The total absence of deciduous species is noteworthy. The morphological and ecological peculiarities of the species of Acacia and Eremophila are especially considered. The halophytes, mainly species of Chenopodiaceæ and Amarantaceæ, constitute the most prominent element of the flora of the very dry districts. *Triodia irritans* and *Spinifex paradoxus* are among the most frequent grasses. The work is illustrated by 32 pages of photographs, some showing characteristic landscapes and vegetational features, and others peculiarities of root, shoot or leaf morphology. There is a bibliography and a summary of contents but no index.

EXPERIMENTAL SILICOSIS OF THE LUNGS.—It is well known that the inhalation of dust particles in various industries may be provocative of serious fibrotic and other changes in the lungs. This obtains particularly among grinders, file-makers, and clay workers, while other dusts, notably coal dust, are much less harmful. The miners on the Rand suffer much from silicosis, due to the inhalation of silica particles derived from the quartz, and A. Mavrogordato has investigated the question experimentally by causing guinea-pigs to breathe dust-laden air of various kinds over varying periods (Publications of the S. African Institute for Medical Research, No. xv. 192). He finds that the solubility and chemical activity of dust, *e.g.* silica, are the important factors inducing fibrotic changes in the lungs, hardness and sharpness of the particles being of little importance. The majority of the particles entering the lungs are less than 1μ in diameter. The particles do not penetrate the tissues, but the tissues take up the particles by means of phagocytic cells. The silica-laden cells block lymphatics and thus prejudice the lungs' ability to deal with infections, and hence secondary tuberculous infection is common.

THE BACTERIAL FLORA OF GREENLAND.—Samples of the soil and of the fæcal matter of polar animals collected by Dr. T. Wulff in North Greenland in 1916 and 1917 were examined bacteriologically by Dr. C. Barthel in Copenhagen. Nineteen species of bacteria were isolated from the soil and identified. They included such well-known forms as *B. subtilis*, *S. flava*, *B. mesentericus*, and *B. zopfii*. Almost all the soils contained nitrates, and in some, nitrifying micro-organisms were detected. In addition, denitrifying, ammonising, urea-fermenting, and butyric forms were found. In the fæcal matter of such animals as the blue fox, arctic hare, crow, seal, polar bear, lemming, and white partridge a variety of aerobic and anaerobic organisms was isolated, including *M. candicans*, *Strep. fæcalis*, *B. putrificus*, and others. The results obtained indicate the ubiquity of many species of bacteria, both simple saphrophytes of the soil and of the animal intestine, and special putrefactive and nitrifying forms. (Recherches bactériologiques sur le sol et sur les matières fécales des animaux polaires du Groënland Septentional. Den II. Thule Ekspedition til Grønlands Nordkyst 1916–18. Nr. 1. Copenhagen, 1922.)

PRECIPITATION IN THE UNITED STATES.—A notice of the new precipitation section of the Atlas of American Agriculture is given by Prof. Robert De C. Ward in the U.S. *Monthly Weather Review* for March. Notice has previously been given of the monthly, seasonal, and annual rainfall charts, but the fresh material to complete the precipitation section has recently been sent in the form of loose sheets to some to whom the material is of immediate practical use, prior to the final issue. The records are for a uniform period of 20 years, 1895–1914, from about 1600 stations, and in addition shorter records are used from about 2000 other stations. The object of the publication is to benefit agriculture, and it lays marked emphasis upon the departures which may be expected from the average, so that the farmer may decide for himself what crops he may plant with the greatest probability of success. Numerous charts and graphs are given. The percentage of the annual precipitation occurring between April 1 and September 30 is highest, more than 70 per cent., over most of the great agricultural region of the eastern United States, embracing the eastern Plains and Prairie States. Frequency and intensity of precipitation are shown in great detail for the whole country. Day and night rain percentages are separately given, and it is shown that over the great agricultural states east of the Rocky Mountains large sections receive more than half, and considerable areas receive about two-thirds of their warm season rains at night, and there is therefore much less rapid evaporation. Snowfall is considered, and the annual number of days with thunderstorms, and the distribution of fog and cloudiness are given.

THE STANDARD ATMOSPHERE.—In aeronautical and artillery calculations it is now necessary to know the condition of the atmosphere at heights up to 20 kilometres with a degree of accuracy not previously required, and each nation is at present concerned to define a mean condition from which the actual condition within its borders at any time will deviate only by relatively small amounts. It has been found that Toussaints's formula $t-15° = 0{\cdot}0065z$, where z is the altitude in metres, gives the mean temperature throughout the year up to 10 kilometres, above which the temperature is constant at $-55°$ C. The observations in the United States set on foot by the American National Advisory Committee for Aeronautics have, according to Report No. 147, prepared by Mr. W. R. Gregg, established the applicability of the formula to that country. The report also shows that the hypsometric equation based on Toussaints's formula leads to values of the pressure in agreement with observations, and that the density at any level may be calculated from the pressure and temperature by the "perfect gas" equation.

SENSITISERS FOR THE EXTREME RED.—In the *British Journal of Photography* for August 11, Drs. C. E. K. Mees and G. Gutekunst describe three new sensitisers for the extreme red, giving their properties and methods of preparation. They are suitable either for adding to the emulsion or for bathing ready prepared plates, with the exception noted below. Beta-naphtha-cyanole gives a strong maximum at 690 $\mu\mu$, and sensitises the green markedly less than pinacyanol. Acetamino-cyanole added to an emulsion gives a strong maximum at 730 $\mu\mu$; but in dilute aqueous solution as prepared for bathing plates it appears that the acetyl is hydrolysed off, and its effect is much restricted. Kryptocyanine gives a very strong maximum at 760 $\mu\mu$, and even at 850 $\mu\mu$ its sensitising power is greater than that of dicyanine, but beyond this point dicyanine is the more advantageous, and at 900 $\mu\mu$ kryptocyanine is almost useless. It does not sensitise in the green, and therefore may prove to be of special value in astronomical photography. On account of their peculiarly advantageous properties, naphthacyanole and kryptocyanine will be added to the list of sensitisers prepared and supplied by the Research Laboratory of the Eastman Kodak Company.

CANNED FOODS.—The Food Investigation Board has issued a special report (No. 10, 1*s.* 6*d.* net) on methods used for the inspection of canned foods (Part II., Canned Marine Products), compiled by Dr. William G. Savage. Attention is directed to the want of uniformity in procedure adopted by food inspectors. Much experimental work was carried out, but no tests were evolved more trustworthy than those in vogue for distinguishing swiftly and accurately between the safe, the dubious and the unfit tins. A "blown" tin is clearly a bad tin, but a tin with an abnormal shake sound or a springy top or bottom is merely a suspect sample. An organisation is suggested whereby better results and greater uniformity of inspection of canned foods might be obtained.

The First Messel Memorial Lecture.

DR. RUDOLPH MESSEL came to England in 1870 and died here in 1920. During the fifty years of his residence in this country he was engaged in the manufacture of sulphuric acid; he was a chemist of considerable repute, a fellow of the Royal Society, an accomplished and kindly man; by his will he left the whole of his fortune to the Royal Society and the Society of Chemical Industry. The council of the latter Society decided to set aside a small part of the legacy to found a series of Messel Memorial Lectures to be delivered by eminent chemists, each of whom is to receive a Messel medal. The first of such lectures was delivered in Glasgow last July by Prof. H. E. Armstrong, who was for very many years an intimate friend of Dr. Messel. The lecture is now published in the issue of the Journal of the Society of Chemical Industry for August 15.

The subject of the lecture is "Chemical Change and Catalysis," but Prof. Armstrong contrives to make sundry alarums and excursions into adjacent territories. There is a good and sympathetic account of the life and work of Messel, some amusing chaff of Ostwald and his school of ionic chemists, of Bancroft and his satellites, of colloid chemists and most other varieties of chemists, and an important contribution to our conceptions of the processes involved in chemical change. The lecture is important not so much because of the new matter in it, but because it puts the problem in an arresting manner and compels those readers who have any power of thought to cry a halt for a moment and consider first what the lecturer means, and then what the reader really thinks on this subject, and whether a good deal of what he has been in the habit of thinking is sound or not. Prof. Armstrong has long scoffed at text-books and has very successfully practised a method of teaching, the vital principle of which is to tell very little and make the pupil do a good deal of thinking and investigating. He continues to practise his method, if this lecture is any criterion of his present habits. The view he outlines is that no chemical change takes place except in the presence of an electrolyte, which he calls the "determinant"; unless the substances concerned are in an electric circuit chemical activity is suspended. The work of Prof. H. B. Baker on the inactivity of perfectly dry substances is referred to several times. Electrolytic conductivity is discussed and the electrolysis of water; according to the lecturer this takes place in stages, the first stage being the formation of hydrogen peroxide; this unstable compound plays an important part in the association views of Prof. Armstrong: it is the first stage in the oxidation of hydrogen. The combustion of carbon monoxide, the oxidation of xanthin and hypoxanthin are discussed, and there is some account of catalysis, the action of enzymes, and the nature of acids.

The determination of Prof. Armstrong or perhaps his catalytic nature compels the mind of the reader to execute a sort of Brownian movement. He is driven from Gowland Hopkins to Meredith, from hydroxylation to Hudibras, from colloids to Lewis Carroll. And when he thinks, good, easy man, full surely the argument is ripening, he is switched off to a quotation from Erasmus Darwin or some new paradox about the basic properties of sulphuric acid, in a manner which those who are familiar with Prof. Armstrong's style will easily imagine, although they cannot—one scarcely knows whether to say fortunately or unfortunately—imitate it.

No one will begin this lecture without finishing it. No one will fail to be interested and amused; no one will come to the end without a stimulus to thought, a renewed curiosity as to chemical change, a new scepticism, and fresh ideas.

Stellar Radiation in the Infra-red.

DR. W. W. COBLENTZ[1] is developing the application of the thermocouple to the study of stellar radiation, and is deriving results of considerable interest and value, especially so far as red stars and red variables are concerned. The instrument he uses is not so sensitive as the photo-electric cell which is doing such delicate work in the hands of Guthnick, Stebbins, and others, but it lends itself more readily to the investigation of radiation in the longer wavelengths.

Most workers engaged on spectrophotometric measures of the stars have concentrated on the visible spectrum. Dr. Coblentz uses various transmission screens which allow only radiation over fairly narrow regions of the spectrum to pass through to the thermocouple. He thus obtains the spectral energy distribution of the stars, and derives stellar temperatures agreeing fairly closely with the values obtained at Potsdam by Wilsing, Scheiner, and Münch. The chief interest lies in the extension to their work that he makes by using a water absorption cell, which is transparent for radiation between $0{\cdot}3\ \mu$ and $1{\cdot}4\ \mu$ in the infra-red, and does not absorb much radiation less than $0{\cdot}5\ \mu$ in wave-length. When the transmission through a layer of 1 cm. of water is only a small fraction of the incident radiation as in the case of α-Orionis and α-Scorpii, then Dr. Coblentz rightly concludes that the total radiation from these stars is far higher than is suggested by their visual magnitudes. It appears that we are faced with the fact that photo-visual methods can give us trustworthy magnitudes of stars only for a limited range, and that certain stars, especially novæ, radiate with much greater intensity in the extreme ultra-violet than we are allowed by our atmosphere to measure, while others—the red stars and invisible dark stars—radiate with great intensity in the infra-red.

Even within the range where visual methods have prevailed, Dr. Coblentz shows that the failure to take into account the infra-red radiation has given much too small a value for the luminosity, or intensity of radiation, of the giant red stars. This may account for the puzzling fact which Prof. Russell recently proclaimed, that giant stars of all spectral classes were of about the same absolute magnitude. Dr. Coblentz's evidence is that this is not the case, but that the giant red stars are radiating far more energy than are the giant blue stars of the same visual absolute magnitude.

A further point of interest arises from the close relation between a star's spectrum and the transmission of its radiation through a water-screen. When more radiation is lost in passing through the screen than is normal with the spectral class to which a star belongs, this has been traced to the presence of a dark companion to the star which makes its presence known in yet a new way by the action of its hitherto unnoticed infra-red radiation. It is to be hoped that the method may be made more sensitive, or that some more sensitive measure of infra-red radiation may be developed which will enable the astronomer of the next century to measure the radiation from the dark nebulæ and—it is not an impossible thought—to plot the dark stars on the next *Carte du Ciel*.

[1] Scientific Papers of the Bureau of Standards, No. 438. "Tests of Stellar Radiometers and Measurements of the Energy Distribution in the Spectra of 16 Stars." Washington, 10 cents.

University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made: Assistant Professor K. N. Moss to be professor of coal and metal mining; Prof. G. Haswell Wilson to be professor of pathology in succession to Prof. Shaw Dunn; and Mr. T. H. P. Veal to be assistant lecturer in civil engineering.

CAMBRIDGE.—The Chancellor of the University has appointed Prof. H. R. Dean, professor of pathology in the University of Manchester, to be professor of pathology in succession to the late Sir German Sims Woodhead.

THE Salters' Institute of Industrial Chemistry has awarded fellowships for post-graduate study to Messrs. C. G. Harris, W. S. Martin, J. H. Oliver, and W. Randerson, and has renewed the fellowship of Mr. F. R. Jones.

A PROSPECTUS has been issued from the chemistry department of the Borough Polytechnic Institute, Borough Road, S.E.1, for the coming session. In addition to the customary course in general and organic chemistry, electro-chemistry, and the chemical technology of the essential oils, a grouped series of courses have been arranged, for this session, to meet the needs of students taking the National Certificate in Chemistry. There will also be a series of lectures on the chemistry of foodstuffs and a course on chemistry as applied to the laundry industry. In assessing the fees payable by students, special consideration is given to apprentices, while there is a special scale for students residing outside the county of London.

THE convenient practice of issuing abridged and sectional calendars adopted by the authorities of Battersea Polytechnic, Battersea Park Road, S.W.11, has been continued for the coming session. The abridged calendar of afternoon and evening classes gives some idea of the scope of the institution's activities; courses are provided in mechanical, civil, and electrical engineering, pure and applied mathematics, physics, chemistry and technological chemistry, hygiene, photography, and domestic science. The fees are fixed for students residing in the London area while at the Polytechnic, but for those residing outside the county an additional fee, generally equivalent to the difference between the ordinary school fee and the cost to the London County Council of the student's education, is charged.

IT is announced in *Science* that Prof. A. Sommerfeld, of the chair of mathematical physics at the University of Munich, will be in residence at the University of Wisconsin for the first part of the academic year 1922–23, holding the Karl Schurz memorial professorship in the university for that period. The Karl Schurz memorial professorship was founded in 1910 in memory of Karl Schurz, of Watertown, Wisconsin, sometime member of the board of regents of the State University, as an exchange professorship with the German universities, and the appointment of Prof. Sommerfeld marks the resumption of the professorship after the interruption caused by the war. Prof. Sommerfeld is expected to lecture on atomic structure, and on either the analysis of wave propagation or the general theory of relativity.

Calendar of Industrial Pioneers.

September 10, 1827. George Medhurst was buried.—The projector of the atmospheric railway, of which he published descriptions in 1812 and 1827, Medhurst was born in 1759, began life as a clockmaker, and was afterwards a machinist in Soho. Various atmospheric railways were constructed, but not till some years after Medhurst's death.

September 12, 1870. Karl August Steinheil died.—Born in Alsace in 1801, Steinheil in 1835 became a professor in Munich, where he invented a form of electric telegraph. During 1849–1852 he was director of the Department of Telegraphs at Vienna, while three years later he founded an optical institute at Munich.

September 12, 1914. Edward Riley died.—Riley's name is associated with two great advances in the manufacture of steel. As a young chemist at the Dowlais Iron Works in 1857 he made experiments on the Bessemer process, while some twenty years later as a consulting chemist he was associated with Thomas and Gilchrist in the introduction of basic linings in converters. He was also a pioneer in the accurate analysis of iron and steel.

September 13, 1906. Hubert Henry Grenfell died.—A pioneer in the development in modern gunnery, Grenfell, when first lieutenant of H.M.S. *Excellent* in 1869, with Chief Engineer Edward Newman, worked out the first design of hydraulic mounting for naval ordnance. Retiring in 1886 he joined Armstrong's of Elswick, and in 1891 invented self-illuminated sights for night firing.

September 14, 1882. Georges Leclanché died.—An inventor who by a single invention won a world-wide reputation, Leclanché was for some years chemical engineer in the laboratory of the Chemin de Fer de l'Est. His well-known battery was patented in 1867.

September 14, 1892. Rudolph Proell died.—Trained at the Technical Academy in Berlin, Proell became a professor in the Technical High School at Aix-la-Chapelle, but afterwards as a consulting engineer devoted himself to the development of automatic valve gears.

September 14, 1907. Leveson Francis Vernon-Harcourt died.—Educated at Harrow and Balliol College, Oxford, Vernon-Harcourt, after graduating in 1862, became a pupil of Sir John Hawshaw. From 1882 to 1905 he was professor of civil engineering in University College, London, and was widely known as an authority on all that concerns tidal harbours, rivers and estuaries. In 1895 he served as president of the Mechanical Science Section of the British Association.

September 15, 1859. Isambard Kingdom Brunel died.—Among the engineers of the first half of the nineteenth century Brunel holds a high place. He assisted his father on the construction of the Thames Tunnel, became engineer to the Great Western Railway, introduced the broad gauge, and was the designer of the Clifton Suspension Bridge and the Albert Bridge at Saltash. With his three ships, the *Great Western*, 1838, *Great Britain*, 1843, and *Great Eastern*, 1857, he made notable contributions to the advancement of naval architecture. He is commemorated by a window in Westminster Abbey.

September 16, 1871. Dennis Hart Mahan died.—For forty years Mahan was professor of civil and military engineering at the Military Academy, West Point, and published works on these subjects, his course of civil engineering being translated into various foreign languages. He was one of the incorporators of the American National Academy of Science.

E. C. S.