NATURE

THURSDAY, OCTOBER 7, 1920.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.

Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

The Metric System and International Trade.

IN the year 1917, when the nation was in the throes of war, a committee of the Conjoint Board of Scientific Societies arrived at certain conclusions on the question of the compulsory adoption of the metric system in Great Britain, but, unfortunately for the committee, the publication of its findings has been delayed until the present time.[1] During the intervening three years our attention has been transferred from warlike to peaceful occupations, and the nation at large is now much more alive to the necessity of improving our commercial equipment for the impending vital struggle to recover and expand our overseas trade in order that we may "pay for the war." The committee apparently appreciates this change in the general atmosphere, and has accordingly published an apologetic prefatory note, from which it incidentally appears that the chief source of its evidence was the "Report on Commercial and Industrial Policy after the War." It may be recalled that Lord Balfour of Burleigh, the chairman of that committee, naïvely admitted afterwards, during a House of Lords debate on decimal coinage, that his committee had been so overloaded with other problems that the subject of decimalisation had possibly not received the attention it really deserved.

Unfortunately, this preface will probably escape general attention, because so many readers will skip it, glance through the report, and really note only the final "Recommendations," which are published on p. 35 of the committee's report, and are about as unsatisfactory as they could well be. Hence we have the lay Press to-day stating that British men of science have denounced the metric system, whereas actually the report has not been adopted by the Conjoint Board, and is issued solely on the authority of the committee. Moreover, in par. 88 of the report the committee recognises "the intrinsic superiority of the metric system in scientific and technical work."

One looks in vain for a note in these recommendations to the effect that the metric system is (*a*) already universally employed in science; (*b*) the practical basis of industry in many countries the trade of which we seek; (*c*) already legally recognised throughout the civilised world; and that accordingly, in the interests of the scientific permeation of industry, as well as of the expansion of our overseas trade, everything possible should be done to encourage its use. Instead of this, we find the committee recommending "that the British system of units of weights and measures be retained in general use in the United Kingdom," which is tantamount to suggesting that British manufacturers engaged in world-wide trade must continue indefinitely to employ two systems—the British for home trade and the metric for overseas trade—involving an increasing volume of misunderstandings and unnecessarily wasted time spent in conversions from one system to the other. If the British manufacturer can, as he already does, sell a portion of his output under metric description, he can obviously sell the whole of it on that basis, and he should clearly be encouraged to conduct all his business in one language of quantity instead of two.

In par. 82 of the report the following constructive sentence occurs: "In the opinion of the committee it would be to the advantage of British industry if the manufacture of all machinery and apparatus of new types were to be established as a matter of course in the metric system; and that this practice should be directed and encouraged by specification in this system for Government and official work"; and yet no reference is made to this in their final "recommendations," which, instead, include a plea for the continued use of British units by Departments of State.

[1] "Report on Compulsory Adoption of the Metric System in the United Kingdom." Submitted by the Metric Committee appointed by the Conjoint Board of Scientific Societies, and published on the authority of the Committee. Pp. 70. (London: Board of Scientific Societies, Royal Society, n.d.) Price 1*s*.

According to the second recommendation, the committee apparently views with equanimity the perpetuation of our use of two systems where one would suffice for all purposes. In the third recommendation the committee suggests the decimalisation of the British units of weight and measure, thus supporting a proposal roundly condemned by a select committee of the House of Commons which, in 1862, reported that "It would involve almost as much difficulty to create a special decimal system of our own as simply to adopt the metric system in common with other nations. And if we did so create a national system we would, in all likelihood, have to change it again in a few years, as the commerce and intercourse between nations increased, into an international one."

Our choice to-day rests between (1) the continued use of a dual system (because we must employ the metric system in an increasing proportion of our business, whether we like it or not), and (2) the establishment of the metric system as the universal language of quantity (involving the gradual abandonment of the Imperial system which, by reason of its manifest defects, is so obviously unsuitable for universal adoption).

It is sheer insularity which makes us cling to the first course and, regarding the alternative, the committee of the Conjoint Board states in par. 50 of its report (but omits from the "recommendations") that "It will be sufficient for the purpose of this inquiry to admit unreservedly that the metric system of weights and measures is the only system which has considerable claims to be truly international, and that it is the only system to which a change could reasonably be made should any country propose to abolish its existing national system."

Some further Government action is clearly required beyond the Act of 1897, but it does not necessarily follow that the next step need be the adoption of legislation of a compulsory character. The Government could do very much to *encourage* the more widespread use of the system by its employment in Government specifications and by a declaration that ultimately at some future date (not necessarily fixed at present) the metric system would become the sole legal system in this country. Many manufacturers would be thereby stimulated to establish all their new standards and their revisions of old standards in terms of the metric system, and there would be nothing to prevent them from continuing to manufacture their existing standards in the British system and describing them for sale in terms of the metric system, as they already have done for so many years. We should thus progress beyond the present passive permission, through a period of intensive encouragement, to the final stage in which the metric system would become the sole legal system of weights and measures, when "compulsion" need be applied only to the stragglers who had failed to adopt it voluntarily.

It is satisfactory to note that with regard to decimal coinage the committee "sees no serious objection in principle" to the proposals for decimalising the £ sterling, and it may be interested to know that the revision of Lord Southwark's Bill is now under consideration with a view to the removal of some of the practical difficulties to which the committee refers. In the meantime we may perhaps be permitted to remark that it is futile to talk about "preserving the credit of the penny" at a time like the present, when the failure of the penny to meet modern conditions is so very obvious.

HARRY ALLCOCK.

The Study of Live Embryos.

Contributions to Embryology. Vol. ix., Nos. 27 to 46. A Memorial to Franklin Paine Mall. (Publication No. 272.) Pp. v+554+plates. (Washington: The Carnegie Institution of Washington, 1920.)

LONG before the war it was being realised in England that the centre of embryological research, at least so far as concerns inquiries into the developmental stages of the human body, was shifting from the laboratories of Germany to those of the United States. The transference was the work of one man—the late Prof. F. P. Mall, who died in 1917 at the age of fifty-five. Prof. Mall stocked the new and highly equipped anatomical laboratories of the United States with young men and women who had served their apprenticeship with him in the anatomical department of Johns Hopkins Hospital, Baltimore. In 1918 he would have reached the twenty-fifth anniversary of his appointment at Baltimore, and his pupils, "in recognition of his inspiring leadership, and in response to the strong feeling of affection with which they had come to regard him," intended to mark the occasion by dedicating to him a volume of their most recent investigations. These essays, owing to his untimely death, have now to appear as a memorial volume, and the sense of regret that Prof. Mall did not live to study it will be felt as acutely on this side of the Atlantic as on the other, for many of its contributors have made highly important additions to our knowledge of the growing embryo. The volume is issued by the Carnegie Institution of Washington, under the ægis of which Prof. Mall had established a department of embryology two years before his death.

In these essays we see employed the exact technique which Prof. Mall learned when working under the late Prof. His, of Leipzig, but in addition there is evidence of a clear realisation that embryology is a series of vital processes, and that to understand them the living as well as the dead embryo must be studied. The developing chick lends itself particularly well for vitalistic observation, but we have every reason to suppose that the earlier stages of mammalian development —including the early stages in the growth of the human ovum—can be investigated in a similar manner. In this respect a return has been made to the earlier methods of Harvey and of Hunter.

As examples of the vitalistic method of observation, we may cite papers by Prof. Florence Sabin on "The Origin of Blood-vessels and of Red Blood Corpuscles," by Dr. Eliot R. Clark and Eleanor L. Clark on "The Origin and Early Development of the Lymphatic System," and by Dr. Margaret R. Lewis on "Muscular Contraction in Tissue Cultures." Prof. Sabin shows that blood-vessels arise from islets, or groups, of angioblastic cells, which by canaliculisation and inosculation unite to form a capillary network. The angioblastic cells give rise to the endothelial lining of blood-vessels, and both the angioblasts and endothelial cells can, and do, produce nucleated red blood corpuscles. The lymphatic system of vessels, however, as one is led to infer from the experiments of the two Clarks, arises from the endothelium of the veins in certain embryonic regions, and from these regions, or centres, the endothelial outgrowths invade certain neighbouring areas of the body and thus provide it with a lymphatic system. If one centre of outgrowth is destroyed, neighbouring centres will supply the deficiency.

Another series of papers records observations on the vital reactions of certain cells in the body of adult animals. Capt. Charles Essick found that when a solution containing fine particles was placed in the sub-arachnoid spaces of the brain of a living animal the endothelial cells of these spaces were transformed into phagocytes, which consumed the foreign matter thus introduced. Capt. Essick's investigation was occasioned, apparently, by observations made by Capt. Lewis H. Weed during a research on "The Experimental Production of Hydrocephalus"—an important inquiry which also appears in this memorial volume. To this series also belongs the paper contributed by Dr. Charles C. Macklin on "The Development and Function of Macrophages in the Repair of Experimental Bone-wounds Vitally Stained with Typan-blue." We infer from Dr. Macklin's experiments that the phagocytes which appear at the sites of repair and of rapid growth have, as their chief business, the consumption of tissue-débris and the rendering of that débris fit for return to the general circulation of the body. Dr. George Corner's observations on "The Widespread Occurrence of Reticular Fibrils produced by Capillary Endothelium" serve to enhance the functional importance of the cells which line blood and lymphatic vessels.

Besides these papers on the living behaviour of the tissues of the body, this volume contains important contributions to orthodox or morphological embryology—particularly a most valuable summary of the present state of our knowledge of the youngest known human embryos, given by Prof. George L. Streeter, who succeeded Prof. Mall as director of the department of embryology in the Carnegie Institution of Washington. Dr. Warren H. Lewis's description of the skull of a human fœtus towards the end of the second month of development is also a very welcome addition to our knowledge of the human body. Other papers, like those of Prof. C. R. Bardeen on "The Post-natal Development of the Human Body," Prof. Robert Bean's on "The Post-natal Growth of the Heart, Kidneys, Liver, and Spleen of Man," and Dr. Schultz's "Development of the External Nose of Whites and Negroes," represent contributions to anthropology as well as to embryology. Altogether, this volume represents a worthy memorial to a really great man.

Two Books for the Country.

(1) *Springtime and Other Essays.* By Sir Francis Darwin. Pp. vii + 242 + viii plates. (London: John Murray, 1920.) Price 7s. 6d. net.

(2) *Memories of the Months.* Sixth series. By the Right Hon. Sir Herbert Maxwell, Bart. Pp. xi + 314. (London: Edward Arnold, 1919.) Price 7s. 6d. net.

(1) SIR FRANCIS DARWIN'S essays have a peculiar charm; the reader is caught in the current of the author's enjoyment. Uninfluenced by artifice, we find ourselves sharing in his pleasures, and, to begin with, in the delight of the spring renascence. "The spring is the happiest season for those who love plants, who delight to watch and record the advent of old friends as

the great procession of green leaves and beautiful flowers unwinds itself with a glory which no familiarity can tarnish." To a representative list in the order of their flowering, Sir Francis adds the remark: "To a lover of plants, this commonplace list will, I hope, be what a score is to a musician, and will recall to him some of the charm of the orchestra of living beauty that springtime awakens."

The book begins with "Springtime" and ends with "A Procession of Flowers," behind both essays lying the problem of "the elements in the struggle for life which fix the dates on which plants habitually flower." "It looks, to put the thing fancifully, as if a parliament of plants had met and decided that some arrangement must be made, since the world would be inconveniently full if they all flowered at once; or they may have believed that there were not enough insects to fertilise the whole flora, if all their services were needed in one glorious month of crowded life. Therefore it was ruled that the months should be portioned among the aspirants, some choosing May, others June or July. But it must have been difficult to manage, and must have needed an accurate knowledge of their own natural history." Similar touches of wise humour are not rare. "It has been said that Thoreau, the American recluse and naturalist, knew the look of the countryside so intimately that had he been miraculously transferred to an unknown time of year he would have recognised the season 'within a day or two, from the flowers at his feet.' If this is true, either American plants are much more business-like than ours (which is as it should be), or else Thoreau did not test his opinions too severely, and this seems even more probable." For, as a matter of fact, the dates of flowering vary considerably with the temperature and some other environmental variables—a fact which gives subtle value to old-fashioned phenological maxims: "When the sloe tree is as white as a sheet, You must sow your barley be it dry or wet"; "When we hears the wryneck, we very soon thinks about rining (barking) the oaks." "There is," Sir Francis says, "something delightfully picturesque in the thought of man thus helped and guided on some of his most vital operations by the proceedings of the world of plants and animals, to whom that hard taskmaster, Natural Selection, has taught so much."

Another delightful essay discusses the traditional names of English plants. "The fact that language is handed on from one generation to the next may remind us of heredity, and the way in which words change is a case of variation. But we cannot understand what determines the extinction of old words or the birth of new ones. We cannot, in fact, understand how the principle of natural selection is applicable to language: yet there must be a survival of the fittest in words, as in living creatures." The author proceeds to show how "the wonderful romance inherent in the great subject of evolution also illumines that cycle of birth and death to which existing plant-names are due."

This is scarcely the place for an appreciation of the essays on "Some Names of Characters in Fiction" or "Old Instruments of Music," or for those on Sydney Smith and Charles Dickens, but they are not less interesting than those on Sir Joseph Dalton Hooker and Sir George Biddell Airy. In connection with the last, we looked for some remark on the astronomer's paper on phyllotaxis, which seemed to us particularly luminous many years ago, but we were disappointed. Very delightful are the author's personal recollections, especially of his early years. We have not the courage to write in NATURE of the way in which Francis Darwin expressed in the church at Down his innate fondness for musical instruments; but we are within safe natural history lines in quoting the next two sentences: "The only other diverting circumstance was the occurrence of book-fish [Lepisma?] in the prayer-books or among the baize cushions. I have not seen one for fifty years, and I may be wrong in believing that they were like minute sardines running on invisible wheels." One more quotation from a fascinating book, and we have done: "I continued to work with my father at Down, and in spite of the advantages I gained by seeing and sharing in the work of German laboratories, I now regret that so many months were spent away from him."

(2) Sir Herbert Maxwell has given us a sixth volume of his "Memories of the Months," and it will be as much appreciated as its predecessors. It consists, for the most part, of evening recollections of the natural history experiences of the day. The breezes play with the pages. For while the author is often erudite he never wears his learning but lightly. The year begins with winter flowers and winter visitors, with the humble leek which Nero is said to have loved, and with good-going problems like the significance of the white disc on the roe-deer's rump or the rabbit's cotton-tail. The temperature rises, and we have daffodils and birds' nests and the puzzles of the cuckoo and the corncrake. In speaking of the frog-hopper, the author slips in calling it a diminutive member of the grasshopper family, and his story of the

foam-making is not quite accurate. But this is merely a crumpled rose-leaf. Summer's memories deal with butterflies, British orchids, the behaviour of a hunter-wasp, the ways of char, and the insurgence of climbing plants. Here also is included an unashamed confession of faith in the powers of the divining rod. In the fall of the year Sir Herbert discourses on gossamer and migration; in midwinter he brings us up against such problems as the otter's survival in the hard months and the general question of animal intelligence. In connection with animal behaviour, the author inclines, if we understand him rightly, to a somewhat remarkable transcendental conclusion, that conscious intelligence is "the consequence of an external and superior mandate or suggestion, acting upon a suitable physical receptacle." "Assuming a First Cause, instinctive activities in the lower animals may be regarded as the comparatively simple and intelligible results of forces initiated by him, acting unerringly in prescribed directions by means of co-ordinate organs modified by evolution." In short, this lifelong student of the ways of living creatures is frankly dualistic. But he does not seek to ram his philosophy down the reader's throat.

We notice a few slips in the pages; thus Fabre's volumes are referred to as "Etudes Entomologiques," and again as "Mémoires Entomologiques," whereas the title was surely neither. But such slips are trivial in a book of great attractiveness. It is full of interesting observations; it expresses and arouses the inquiring spirit. Its happy style suggests that the writing of it must have been a pleasure, and that is certainly true of the reading. We wish there had been an index, for the topics touched on are numerous.

Principles of Aeronautics.

Aeronautics: A Class Text. By Prof. E. B. Wilson. Pp. vii+265. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 22*s.* net.

THE work under notice differs considerably in conception and treatment from that usually associated with the title "aeronautics." It is very clearly written, and will be particularly valuable to advanced students of the subject for many reasons. On the other hand, it will not appeal strongly to the less advanced worker who delights to regard himself as "practical," for he will find only a "skeleton airplane" of the simplest type as a basis for all the calculations made. The more usual curves by which laboratory results are expressed are subordinated to analytical expressions. The peculiar advantages of this point of view are obvious in many places, notably in the treatment of the fall of bodies through air. Without containing such original matter as that of Bryan in "Stability in Aviation," the new volume expresses ideas more nearly those of Bryan than of any other writer on the subject.

The introduction to the book includes the ideas underlying simple flight and the aerodynamics of aerofoils, and the chapters of this section are probably of little importance. It is with the chapter on "Motion in Two Dimensions" that the serious student of aeroplane motion will begin to appreciate the book, for here are collected with concise proofs the fundamental theorems in dynamics which are otherwise only to be found by perseverance in the reading of such volumes as Routh's "Rigid Dynamics." The principles are carried step by step to the consideration of stability, and are then illustrated by example. The study of motion in three dimensions is committed to a following chapter, and starts from the apparently simpler problems relative to fixed axes and uses these as a basis for developing the theorems for moving axes. The reasons for the ultimate simplicity of the latter in relation to complex motions are given, and the treatment is direct and helpful. The last chapter in the section devoted to rigid dynamics applies the equations developed to the stability of the aeroplane. The stage reached is not further than that of English workers, and is obviously dependent on the latter for much of its inspiration; but the chapters are more complete and self-contained than any others available at the moment.

The rest of the book is devoted to "Fluid Mechanics," and here are interposed chapters on the simpler theories generally known as "hydraulics" and the more complex and unfortunately less applicable theorems of velocity potential, etc., of hydrodynamics. The ninth chapter introduces the fundamental laws of laminar motion, and develops the formula for an adiabatic atmosphere. Then follow the important Bernoulli's theorem and the Rayleigh expansion, which indicates the velocity at which air must be considered as a compressible fluid so far as the effect on the resistance of bodies moving through it is concerned. From Bernoulli's equation the laws for Pitot and Venturi tubes are developed on standard lines. Viscous fluids are dealt with in steady motion up to the calculations relating to Poisseuille's famous experiments, and a table of coefficients of viscosity is given.

The fundamental principles of dynamical similarity, which have been applied so fruitfully in aeronautics, receive attention in chap. xi., and cover the ground rendered familiar to us by the reports of the Advisory Committee for Aeronautics.

The remainder of the book is conventional hydrodynamics, and is a further reminder of the lack of success which has attended the efforts of mathematicians and others to solve the problems of the motion of fluids under conditions resembling those of normal occurrence. As a summary of formulæ the chapters have a value to advanced students.

Taken as a whole, the book is one to be recommended to those students on whom the future developments of aviation will depend, for it contains the fundamental theorems on which the science of the subject rests and must continue to rest for such period as we can now visualise.

Text-books on Chemistry.

(1) *Treatise on General and Industrial Inorganic Chemistry.* By Prof. Ettore Molinari. Second edition. Translated from the fourth revised and amplified Italian edition by Thomas H. Pope. Pp. xix+876+2 plates. (London: J. and A. Churchill, 1920.) Price 42*s.* net.

(2) *Trattato di Chimica Generale ed Applicata all' Industria.* Vol. ii. *Chimica Organica.* By Prof. Ettore Molinari. Parte Prima. Terza edizione riveduta ed ampliata. Pp. xix+624. (Milano: Ulrico Hoepli, 1920.) Price 28 lire.

(3) *A Text-book of Inorganic Chemistry.* Edited by Dr. J. Newton Friend. Vol. ix. Part 1. *Cobalt, Nickel, and the Elements of the Platinum Group.* By Dr. J. Newton Friend. (Griffin's Scientific Text-books.) Pp. xvii+367. (London: Charles Griffin and Co., Ltd., 1920.) Price 18s.

(1 and 2) DR. ETTORE MOLINARI is professor of industrial chemistry at the Royal Milan Polytechnic and at the Luigi Bocconi Commercial University in the same city, and his treatises on inorganic and organic chemistry are, apparently, mainly directed to the special character of his teaching in those institutions. Here chemical theory, in effect, is wholly subordinated to practical application, and the books are simply descriptive manuals of chemical technology, adapted to the needs of polytechnic students and suitable for general reading. They may be said to occupy a position intermediate between the general treatise on chemical theory and the specialised handbooks on chemical technology. Prof. Molinari goes so far as to say that his books reflect the change which has come over the teaching of modern chemistry. In his opinion the methods and spirit of the teaching of Liebig, Hofmann, and Kekulé no longer correspond with present-day requirements. The "beneficent impulse" which these great teachers gave to chemical studies was, we gather, too exclusively "scientific" and "theoretical." The author, however, is a little unfortunate in his argument. He could scarcely have selected three names more alive to the utilitarian aspects of chemical science, however mindful they might be of the primary purpose of their calling and profession. The whole development of certain great branches of applied organic chemistry may be said to have sprung directly from the teaching and example of Liebig, Hofmann, and Kekulé. Liebig's genius ranged over practically the whole field of the industrial chemistry of his day; Hofmann early threw himself, with characteristic zeal and energy, into the newly created synthetic colour industry, the enormous extension of which is fundamentally based upon Kekulé's fruitful conception.

Prof. Molinari insists that "general chemistry can no longer be a simple and arid exposition of fundamental laws and of the properties of the innumerable known substances, but should possess a soul which brings it into contact with the vital activities around which it clings." "The chemical text-books which have been used up to the present time do not correspond sufficiently with these requirements." "The present treatise took its rise from these considerations, and has no other pretensions than to be an attempt to initiate a work of reform in the teaching of chemistry."

These excerpts are taken from the preface to the first edition of the former of Prof. Molinari's two works cited above, in which the author sketches the general plan of his work and makes his *apologia* for its special character. In the preface to the fourth Italian edition, on which the present English edition is based, he enforces his point of view. The Great War, he contends, "has emphasised the necessity of developing chemical teaching more and more along the lines of its practical applications." Hence he has been led "to treat the material still more from the industrial standpoint." Various chapters have been considerably enlarged, "certain improvements—presumed or real—being indicated only by the numbers of the patents in question, so that the further details may be ascertained from the journals of applied chemistry." Considering the class of person to whom the work is ostensibly addressed, a list of patents restricted to their numbers, with a general reference to technical journals in which further particulars may possibly be discovered, is of no great educational value. The extension of his principles has, in fact, led the author into an *impasse,* and by carrying it still further on similar lines his volumes threaten to become unwieldy and their material ill-digested.

Although we have no great sympathy with the spirit which has actuated the author in the compilation of these treatises, and, indeed, may be said to pervade them, in bare justice it must be admitted that they contain a great mass of useful facts, and the reader who will steadily work through their 1500 pages will acquire a considerable stock of information on general industrial chemistry. But we question whether this is quite the *pabulum* on which to feed the young chemist, even if intended for technology. Prof. Molinari thinks that the slow progress, and even the ruin, of many Italian chemical industries are to be attributed to the erroneous direction of chemical training in the universities. Nevertheless, this training was presumably modelled on that of French and German schools of chemistry, and similar evil results have not followed in France or Germany. There must be other causes—social, economic, temperamental—to account for the general lack of success of which the author complains. We seriously doubt if it will be remedied in the manner he indicates. The experience of every other country in Europe which has acquired a commanding position in chemical industry is against him. It is only in America that a similar sentiment has been seen, and, until comparatively recently, America has shown no great aptitude in creating chemical industry. Now, thanks to the enormous development of chemical teaching of a university type in the United States, a great impetus has been given to the higher branches of chemical technology, especially since the war, and largely owing to the collapse of Germany. But the system of chemical training in the best American institutions is not markedly different from that which prevails in the leading European schools. Japan affords a like example. Practically all her leading teachers and technologists have been trained in Continental laboratories, and have introduced their systems into the Japanese universities and technical institutes. It would be interesting to know the views of such eminent Italian chemists as Paternò, Ciamician, and Nasini concerning Prof. Molinari's surmise as to the cause of Italy's backward condition in chemical industry. We should be surprised to learn that they would attribute it to faulty methods of teaching the science and theory of chemistry. It may turn out to be due to a superficial system of instruction in chemical technology, in which chemical theory is insufficiently considered and the methods and practice of chemical manufacture are imperfectly expounded.

(3) Vol. ix. of the "Text-book of Inorganic Chemistry" edited by Dr. Newton Friend is concerned with the elements of Group viii. of the Periodic Table, on which system of classification the entire work is based. The volume is divided into two parts, of which this instalment is the first. It deals with cobalt, nickel, and the metals of the platinum group, six in number. Strictly speaking, this is a departure from the plan uniformly followed in the preceding volumes, in which the element of lowest atomic weight in the several groups is treated of first; in this case it should be iron. It is proposed, however, to deal with iron and its compounds in a separate section forming part ii. of this particular volume. There are, no doubt, good reasons for this course. Iron occupies an exceptional position, and the space needed for its consideration may well necessitate a special section. But this fact does not necessarily require any alteration in the established plan of sequence—viz. that the element of lowest atomic weight should take precedence of its fellow-members in the group. We surmise that the only reason for the change in treatment was that on account of "the enormous amount of research" that has been carried out in connection with the properties of iron and of its compounds, delay has occurred in putting together the material. It is, of course, a small matter, and leads to no practical inconvenience. But in the interests of uniformity it is worth rectifying, which can easily be done in a later edition of the entire work.

The present volume well maintains the reputation which its predecessors have conferred upon the work as a whole. In general plan and arrangement and method of treatment it is similar to these. It opens with a chapter on the general characteristics of the elements of the group with which it is concerned. The anomaly in the position of cobalt in the Periodic Table is duly pointed out. In the table cobalt is placed between iron and nickel, although the bulk of experimental evidence goes to show that the atomic weight of cobalt is distinctly greater than that of nickel. No sufficient explanation of this anomaly has been given. It is one of those apparent exceptions to the universality and comprehensiveness of the doctrine which await solution. Similar difficulties have occurred before, and subsequent research has removed them. A case in point was met with in other members of the same group. When Mendeléeff enunciated his generalisation the accepted atomic weights of osmium, iridium, and platinum were found to be not in accordance with the previsions of the law, and Seubert showed that Mendeléeff's surmise that the numbers were inaccurate was correct. The proper sequence of the elements has now been established, although we concur with Dr. Friend that, with the exception of that of platinum, which, thanks to the careful experiments of Archibald, published in the Proceedings of the Royal Society of Edinburgh, is now well determined, the values of the other members, especially of osmium and iridium, fall very far short of the standard demanded by modern atomic weight work.

It may be hoped that we shall not have long to wait for new and more accurate determinations. These elements, it is true, present special difficulties, accentuated, no doubt, by the present scarcity of material. Indeed, the term "rare elements," originally applied to some of those of Group iii., is in these strenuous and evil days more appropriate to the members of the platinum group.

We presume that part ii., devoted to iron and its compounds, will complete the entire work of ten volumes, when we hope to be able to congratulate Dr. Friend and his coadjutors on the termination of their task. The complete treatise will form an admirable contribution to the chemical literature of this country, philosophical in plan, comprehensive in treatment, and accurate in detail, not the least of its merits being its excellent bibliography.

Our Bookshelf.

Practical Plant Biochemistry. By Muriel Wheldale Onslow. Pp. vii+178. (Cambridge: At the University Press, 1920.) Price 15*s*. net.

THE author indicates that her book is primarily intended for students of botany, and that it should be a guide to practical work. It is stated that the volume is planned to supplement the knowledge of plant products which students obtain in their study of organic chemistry and of plant physiology. The introduction is followed by eight chapters, each giving a brief survey of some portion of the chemistry of plant life—*e.g.* the colloidal state (chap. ii.), carbon assimilation (chap. iv.), glucosides and glucoside-splitting enzymes (chap. ix.). The general matter of the chapters is followed by, or interspersed with, data upon which experimental work can be carried out to illustrate the points dealt with in the respective chapters. A list of references to original literature is given at the end of each chapter, and cross-references are frequently employed. As to errors, it is rather surprising that those in the structural formulæ for α- and β-glucose on p. 48 (where the formulæ are used to illustrate a statement concerning the two forms) should have been overlooked.

The chapter on plant bases (chap. x.) consists rather too largely of a list of names, to which are attached complex structural formulæ that are more likely to confuse the students who have "an elementary knowledge of organic chemistry" than to be of assistance to them. But for the somewhat disjointed effect resulting from the method of introducing the experimental instructions, the matter is presented in an interesting form, and on the whole there is a pleasing freedom from dogmatic assertions concerning unknown or uninvestigated chemical changes, which so frequently detract from the value of works of this type. The general survey of the problems involved in the chemistry of plant life, and the instructions for experimental work which this volume contains, should prove both useful and interesting to the class of student for whom it was written, and to many others who are interested in the chemistry of the plant world.

A. E. E.

Vergleichende Anatomie des Nervensystems. Erster Teil., Die Leitungsbahnen im Nervensystem der Wirbellosen Tiere. Von Æ. B. Droogleever Fortuyn. Pp. viii+370. (Haarlem: De Erven F. Bohn, 1920.) 12.50 guilders.

THE author is to be congratulated on this excellent digest of the known facts regarding the paths of conduction in the nervous system of invertebrates—a work which has entailed careful reading of the extensive and complicated literature of the subject and skilful collation of the results. He gives an account of the principal issues of the researches—treated for the most part in historical sequence—on the arrangement of the sensory cells and ganglion cells and the course of their processes, so far as this has been ascertained, in each phylum of invertebrates. The internal structure of the cell and the intracellular neurofibrillæ are not discussed. After dealing with the Porifera in less than a page, there being no evidence of the presence of nervous elements in sponges, the author examines in turn the Cœlentera, Vermes, Mollusca, Echinoderma, Arthropoda, Bryozoa, Tunicata, and Amphioxus, the last-named being included because its nervous system presents a number of features in common with that of invertebrates. In some cases—*e.g.* Echinoderma, Bryozoa, Tunicata—our knowledge of the paths of conduction is extremely slight, but in others —*e.g.* Annelida and Decapod Crustacea—there is an extensive literature which has received full consideration. The digest, illustrated by 116 diagrams, shows clearly what has been done, and renders obvious how much still remains to be done to elucidate the detailed structure of the nervous system of invertebrates, for, as the author remarks, we have as yet only an imperfect conception of the various conduction paths in the ganglia of the earthworm's nerve-cord, although these ganglia have been investigated more than any other part of the nervous system of any invertebrate. J. H. A.

A Guide to the Old Observatories at Delhi; Jaipur; Ujjain; Benares. By G. R. Kaye. Pp. vii + 108 + xv plates. (Calcutta: Superintendent Government Printing, India, 1920.) Price 3s. 6d.

This little book is an abstract of the larger publication on the same subject which was reviewed in Nature, vol. ciii., p. 166. It is evidently intended for travellers who have seen one or more of these curious and gigantic instruments and wish to know something about their origin. All the tabular matter and similar details have been omitted, while the clear descriptions and some of the excellent pictures have been retained. We could have wished that the author had omitted from this guide-book his remarks about the supposed scientific knowledge of Jai Singh. It cannot be denied that this man, living in the eighteenth century, not only was quite unaware of what had been done in Europe during the previous two hundred years to improve the construction of instruments, but also did not even make the slightest advance on the work of the Greek and Arabian astronomers. All he did was to copy some instrumental monstrosities erected at Samarkand three hundred years before his time, and it is no wonder that little or no use was ever made of them.

(1) *Reports on Hides and Skins.* Pp. ix + 123. (2) *Reports on Oil-seeds.* Pp. ix + 149. (Imperial Institute. Indian Trade Inquiry.) (London: John Murray, 1920.) Price 6s. net each vol.

In 1916 the Imperial Institute Committee for India was invited to inquire into the possibility of the increased use of Indian raw materials within the Empire. Various committees were set up to deal with the principal groups of materials selected for the inquiry, and the present volumes are the reports of those dealing with hides and skins and with oil-seeds. In the report on the former materials (1) it is shown that the pre-war trade in "kips" was almost entirely with Germany and Austria. During the war the Government was able to utilise most of the material produced, and proposals are made for preventing the return of the trade to the countries of Central Europe. For this purpose a preferential export duty is proposed; also the leading tanners of the Empire have been approached, and they have agreed that they can utilise all the hides produced by India. Suggestions are also made for improving the quality of the hides. Statistics showing the export trade between 1910 and 1918 in raw cow-hides, buffalo hides, and goat and sheep skins have been inserted. The report of the committee dealing with oil-seeds (2) discusses the position of the trade in that commodity with England, Germany, and France at some length. It is pointed out that there is likely to be a serious shortage of fats in the world, and a system of rationing is recommended in order to secure adequate supplies to Great Britain and her Allies. It is further suggested that a preferential import tax on vegetable oils should be levied at our ports, and that there should be co-operation between the seed-crushers, the banks, the Government, and the transport companies with the view of facilitating the transit or re-export trade and of reducing the cost of production. Statistics for 1895 onwards of the trade in ten different kinds of oil-seeds produced in India are given.

Immunity in Health: The Function of the Tonsils and other Subepithelial Lymphatic Glands in the Bodily Economy. By Prof. K. H. Digby. Pp. viii + 130. (London: Henry Frowde, and Hodder and Stoughton, 1919.) Price 8s. 6d. net.

In this book Prof. Kenelm Digby discusses the functions which may be performed by such structures as the tonsils, the intestinal lymphoid follicles, and the vermiform appendix, all of which are essentially lymphoid organs grouped by the author under the term "subepithelial lymphatic glands." The disadvantage of these structures in the body is their proneness to bacterial invasion and infection. The tonsils and appendix are, moreover, frequently removed by operation without any apparent effect due to their loss. The utility of these glands has, therefore, been doubted, and the appendix is commonly regarded as a vestigial organ in process of reduction. It is noteworthy that all these structures are located in situations—mouth, throat, and intestine—where large masses of bacteria are present, that they freely ingest bacteria, and that they occur only in birds and mammals, the highest and most differentiated of animals.

The hypothesis put forward by the author of the use of the subepithelial collections of lymphoid tissue is that they play an important function in immunising the body against pathogenic bacteria in proximity to the tissues—they are immunising stations, so to speak. The several tonsils form a protective circum-pharyngeal ring, and the Peyer's patches, appendix, and solitary follicles are distributed over the intestine—localities which are most in need of protection from bacterial invasion. In the stomach, on the other hand, lymphoid structures are almost absent, but here the acid nature of the secretion is sufficiently protective without their aid. The argument is sustained by a number of anatomical, microscopical, and clinical observations and data, and we think the author has made out a good case. The book is illustrated with several original drawings and diagrams. R. T. H.

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 discussion about the future of the British Association has turned mainly upon what may be called the "scale effect" consequent upon the vast increase in the activities connoted by the advancement of science. The effect is real enough; the decimal point has been moved on by one or more places in the course of the three-quarters of a century of the life of the Association.

And it is not only science of which this is true. We see the same kind of problem in such common affairs as university education, Parliamentary government, and Treasury control of expenditure Formulæ which were worked out fifty years ago or more for a certain scale are still being used, but they are not applicable now that the scale is increased tenfold or a hundredfold. Each case has, no doubt, an appropriate solution if we have the courage to face the facts and deal with them instead of ignoring them.

But as regards the British Association there is a social side of the question which has not received much attention. The Association does not select a town out of all England, Wales, Scotland, and Ireland at which to hold a summer meeting. It is invited to honour a town with its assemblies. The first magistrate and other leading citizens attend a meeting of the Association and offer the hospitality of their city.

If we go back some years beyond the beginning of the present century, the invitation meant an offer of the personal hospitality of the citizens to the active members of the Association. In those days the prosperous householders of the larger towns and their neighbourhood had spare rooms which were intended to be used, and were used, for the purpose of entertaining friends. The devotees of science were interesting people with whom to spend a week was a pleasure worth seeking. To offer hospitality for an astronomer from Ireland, a mathematician from Cambridge, an economist from Oxford, a geographer from London, a geologist from Wales, or a chemist from Scotland was not altogether a one-sided bargain. What these guests did with the time devoted to the discussion of recondite matters of their own science in the Sections was not the *quid pro quo*. Their hosts would become members or associates as part of the invitation, and possibly attend the Sections in order to be able to show their guests the way; but their insight into science and its methods was obtained by having one or more successful exponents of science staying in the house. They would probably learn more of what went on in the Sections from their guests' account of it over breakfast than by hours of personal attendance in a room where the difference between drivel and discovery is not always signalled. A party of half a dozen guests at one of the larger houses was brilliant company well worth entertaining.

The president's address dealt with the moving scientific topics of the day, the evening lectures were the last word in scientific exposition. The evening parties gave guests and hosts an opportunity of widening the circle of acquaintance, and the excursions often developed acquaintance into friendship. The guests left with a feeling of personal obligation which was not without opportunity of requital. If that feature of the British Association is lost in the effort to make the world better for somebody else, the loss of the grace of domestic hospitality is profound.

At the time it was not only a simple and natural grace, but also an essential preliminary to an invitation. To house a thousand visitors in the early days of the Association otherwise than by private hospitality would have puzzled the most energetic of local secretaries.

Very little money beyond the cost of the ticket came into the question. On the joint invitation of the authorities of a town, halls were available for meetings and other facilities provided. There remained to be paid for an abundant supply of stationery —which members appreciated, but not always with due respect—the printing of the journal and other incidental expenses, and one or more evening parties.

As time went on personal service became merged in or supplemented by a guarantee fund. The actual expenses of a meeting of the British Association do not appear in its accounts. In later years it was a shock to learn that people who had spare rooms actually absented themselves from home at the time when the Association was known to be coming; when it was our turn to act as hosts we thought the plea of an inexorable summer holiday rather a shabby excuse. But from the occasion of the meeting of a certain jubilee year hotel accommodation became the rule for the most active members of all the Sections, and members may now go through a meeting of the Association without making a single acquaintance in the town. There is no small danger of the meetings being changed from occasions for the exercise of graceful hospitality into the periodical lumbering of a rather ineffective machine.

I have no particular wish to be simply *laudator temporis acti*. If we have definitely turned our backs on the past and the pleasure of company has vanished, with all that that must have meant for a town in the dissemination over the table or round the hearth of information about science and education, where to go, and what to see or to read and all the rest, are we now instead to deliver within a week, in return for a guarantee fund, something which will be recognised as its equivalent in scientific exposition? If so, we shall want a strength of organisation that is at least quite uncommon in the scientific world, and I do not envy the organising secretary who has the duty in hand. The existing machinery is certainly not sufficient. The equivalent of twelve men enlightening a great town on the mysteries of all the sciences by talking for twelve hours each in a single week gives me the same impression as "seven maids with seven mops sweeping for half a year."

> "Do you suppose," the Walrus said,
> "That they would make it clear?"
> "I doubt it," said the Carpenter.

What I am quite clear about is that if you would allow a company of meteorologists, magneticians, seismologists, and other students of the earth and the sky to meet together for a week and discuss matters of common interest, the community that entertained us should not complain for lack of interest; but if you tell me that I have to expound modern meteorology to the man in the street in a paper or discussion of an hour and a half, and that ninety-five other people will do the like for their respective subjects within the week, I give it up. I know it cannot be done, even if I am allowed unlimited use of technical language, which appears, somewhat irrationally, to annoy some of your correspondents. I wonder why? Would they wish us always to paraphrase electricity as that which is produced when amber is rubbed with cat-skin? Science without technical language is very much like "French without accents."

We might do better if we concentrated our attention on the successful execution of what ostensibly we attempt. Let us give up arranging meetings at a time when we know, from the circumstances of the case, people cannot and will not attend, and give up also the formality of voting on questions which have been neither read nor circulated. If the popular evening lecture has ceased to be attractive, let us devise some other form of after-dinner appeal with scientific accessories; the Red Lions ought not to lag behind the kinema. If we wish to address an audience, let us address the audience; if we have something to say, let us say it; if we wish to make ourselves heard, let us make ourselves heard or know the reason why; and, finally, if the proceedings are reported, let the Sections make skilled reporting a part of their business. The word recorder seems to have got adrift from its moorings lately. Machinery in motion always has an irresistible attraction; if the meetings of the British Association presented examples of scientific purpose, perfectly managed and scientifically executed, they would be acceptable in many large towns, although the subject-matter might not all of it appeal to the man in the street. It ought not to be forgotten at this particular time that in 1903 Sir Norman Lockyer endeavoured to strengthen the hold of the British Association by keeping its organisation in operation throughout the year, and when the Association declined the suggestion, sought other means of giving expression to his views.

October 3. NAPIER SHAW.

IF you do not consider the subject of the British Association, which has been so fully discussed in recent issues of NATURE, to be now exhausted, I should like to state briefly how it appears to me.

The Association had at first six "Committees of Sciences." They were in 1835 converted into Sections. The following year another Section was added for Mechanical Science. The Sections continued to be seven only for the next fifty years, when H (or Anthropology) became a separate Section. Botany, Physiology, Educational Science, and Agriculture have since been added, making up the twelve existing Sections.

The Association was not in a hurry, for it was well aware of the practical difficulties arising from a multiplicity of Sections, but these added Sections have certainly not detracted from its popularity. The Conference of Delegates is another modern development of the work, and keeps interest in that work alive in many parts of the country.

A still more recent extension of the activities of the Association is the Citizens' Lectures, which were very successful at Cardiff. The meeting there was a good one, and would have been much larger but for the exorbitant railway fares. The address of the president, Prof. Herdman, was both brilliant and practical, and will, I hope, be fruitful in the near future. EDWARD BRABROOK.

October 1.

The Examination System.

PROF. H. E. ARMSTRONG's address on the university problem in London, published in NATURE of September 23, induces me to make the following remarks with special reference to the examination system in England.

The chief defects are:

(1) Expecting a candidate to remember details necessary for giving a complete answer to an essay question.

(2) Expecting him to answer a lot of questions in three hours.

This has been improved on recently by giving highest honours for five questions out of ten. But, in my opinion, at most four essay questions in three hours are all that should be expected; and in the case of difficult mathematical or similar questions not more than three.

It is notorious that the best men do not always come out at the top, partly because some hate to be hustled, others think slowly, and others still are not walking encyclopædias even in their own subject.

I know of an institution where the examinations are quite as well managed as in other educational institutions, though I admit the syllabus is so large for the time allowed that there is a good deal of "cram" necessary. As a rule, a student who is good at any subject seldom comes out very high up, whereas others who often have no taste or gift for a subject are placed at the top Also, there is a student who can come out top of nearly every examination because he is good at examinations.

I suggest the following improvements:

(1) That students be continuously examined throughout the period of their instruction by weekly or monthly papers and practical work.

(2) That there be fewer questions set in essay or problem papers. Details I have already suggested.

(3) That manuscript note-books of any kind be used by students in all theoretical as well as practical examinations, particularly in scientific subjects.

OXFORD M.A.

An Awkward Unit.

THERE has lately been introduced on the Daily Weather Report a small map showing barometric tendency. The barometric change from 4h. to 7h. is given as "a multiple of the half-millibar, that unit having been found convenient for reading the barograms and adopted for telegraphic reporting" (*Meteor. Mag.*, August, 1920, p. 150).

It is to be regretted that European meteorologists appear to be unaware of the fact that the megadyne or megabar atmosphere was correctly defined by Prof. Theodore Richards in his classic paper on "New Methods of Compressibility," published by the Carnegie Institution in 1903, and in later papers. The bar is a pressure unit expressed in terms of force, and is equal to one dyne per square centimetre. This is the bar of American chemists and physicists, and has been in use at Blue Hill Observatory since 1914. The term "millibar" which meteorologists hastily adopted in 1913 appears to us to be a misnomer for "kilobar."

There are many solid arguments in favour of the use of a megabar atmosphere. These will not be repeated here, but it may be pointed out that the expression "*multiple of a half-millibar*" is awkward. It is so much easier to use the proper definition "500 bar."

Isallobars can then be drawn for any desired value, while it would be rather troublesome to express the same values in fractional parts, such as "*one-fifth millibar*," meaning a 200-bar change.

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory,
Readville, Mass., September 23.

Absorption Spectrum of Hydrogen Chloride.

THE unexpected satellites which Imes (*Astrophysical Journal*, November, 1919) found beside each line in the HCl absorption band at $1{\cdot}76\mu$, and which measurements of his curves show to have an average wave-length 16±4 Å. longer than the lines which they accompany, are readily accounted for as due to the heavier of the two isotopes, atomic weights 35 and 37, of which Aston (*Phil. Mag.*, vol. xxxix., p. 611, 1920) has shown ordinary chlorine to consist. An approximate theory shows the wave-length of the band centre to vary as the square root of the effective mass, $m=\frac{m_1 m_2}{m_1+m_2}$, where m_1 is the mass of the hydrogen nucleus and m_2 that of the chlorine atom. Taking $m=35/36$ for the lighter and $37/38$ for the heavier isotope, the calculated difference between the wave-lengths of corresponding lines for the two isotopes comes out 13 Å. This is much larger than the differences of about 0·004 Å. which have been found between lines of the isotopes of lead (Aronberg, *Astrophysical Journal*, vol. xlvii., p. 96, 1918, and Merton, Roy. Soc. Proc., A, vol. xcvi., p. 388, 1920).

I hope soon to publish a more detailed account of the theory and measurements of these lines, probably in the *Astrophysical Journal*. F. W. LOOMIS.

New York University, University Heights,
New York City, U.S.A.

A New Visual Illusion.

A VISUAL illusion which I have never seen referred to may be of interest. If the gaze is steadily fixed for a few minutes on a spot in the descent of a waterfall which has a fairly long unbroken fall, and afterwards quickly transferred to the adjacent hillside, the hill itself appears to rise slowly as a whole, somewhat as though it were an elevator. The same result may be obtained by looking fixedly at the broken surface of a rapid and fairly wide stream; on directing the eyes suddenly to the opposite bank this appears to move slowly up-stream.

The illusion seems to me to be due to the rapidly moving water tending to carry the vision along in its own direction, as occurs when any moving object is unreflectively observed. But while the eyes are kept fixed on the selected point, this tendency becomes counteracted by a series of slight and rapid but unconscious muscular efforts which prevent the eyes from following the motion. After the gaze is removed to the adjacent stationary ground, these muscular efforts automatically persist for a short time, thus causing the ground to appear to move in the opposite direction to that of the water. But possibly a more accurate explanation can be advanced.

J. E. TURNER.

55 Allerton Road, Mossley Hill, Liverpool.

Plant-life in the Cheddar Caves.

SINCE reading the letter relating to plant-growths in the Cheddar caves by Mr. L. Pendred which appeared in NATURE of August 5, I have been able, by the courtesy of Messrs. Gough, to examine the plants *in situ*, and to secure a quantity of material for fuller investigation.

The green patches on the cave-walls were found to consist of a small green unicellular alga. The loose cave-earth on the sides of the cave-paths yielded a few specimens of fern prothallia. The plant patches in the neighbourhood of the electric lights were found to consist of the following species of mosses: *Plagiothecium denticulatum*, *Amblystegium serpens*, and *Fissidens bryoides*, all of which are fairly common. My determinations of these species have been confirmed by Mr. A. Gepp, of the botanical department of the British Museum (Natural History).

I think Mr. Pendred's suggestion that the spores were carried into the caves by the spades or on the clothes of the workmen is highly probable, or that the excellent ventilation maintained in the caves may have resulted in the spores being carried in by air-currents. In any event, the dampness and the air-currents would be factors assisting in the subsequent germination of the spores.

EDITH BOLTON.

Armstrong College, Newcastle-upon-Tyne.

Old Maps.

REFERRING to the kind notice of my presidential address to the Conference of Delegates at the Cardiff meeting of the British Association in NATURE of September 16, p. 90, time did not permit details to be given of the evolution of Scottish maps, or those of Faden, etc., would certainly have been referred to. The large map of Cary's which I mentioned was not the one you surmise, "with the coach roads coloured in blue, which is on the scale of five miles to an inch," but the map on the scale of *two* miles to an inch. The typist or printer, quite pardonably, has apparently mistaken my "two" for "ten." With regard to Griffith's map of Ireland, I still contend that the date of the map "to be included as a classic" is that of 1853. I know there was a slightly improved edition in 1855; there is one in the library of the Geological Society of London, but that was the *third* edition, and not the second, as stated in your columns. T. SHEPPARD.

The Museum, Hull.

I CONFESS that I was not aware of a large map by J. Cary on the scale of one inch to two miles. The one that I mentioned, with mail-coach routes in blue, is of constant service to me. Great confusion has been caused in regard to Griffith's geological maps of Ireland by references to them as successive editions, as if all were published and on the same plan and scale. Maxwell H. Close (Journ. R. Geol. Soc. Ireland, vol. v., p. 136, 1879) is, I think, responsible for calling a geological map exhibited in 1815 "the first edition," but he carefully added that it was never printed, and he evidently meant only "the first form." He emphasised the fact, by underlining the word, that W. Smith's map of England was *published* in the same year. Griffith's map of 1835 was, according to John Phillips (*op. cit.* above, p. 138), large, but also unpublished. Phillips utilised its details in 1838. In 1838 a coloured geological map by Griffith was issued in connection with the Report of the Railway Commissioners, scale one inch to ten miles. A few months later in the same year his large map (one inch to four miles) appeared under the same auspices, and was, as Close tells us, sold to the public from March 28, 1839. These two maps of 1838 can scarcely be called two editions of the same groundwork, since they were both simultaneously in preparation. The large map of 1838 (published, with date, in 1839) was completely revised and re-engraved, with the addition of mineral localities, and issued in six sheets in April, 1855, the date being engraved on it against Griffith's signature. The map of 1853 was a small one (one inch to sixteen miles), and was issued in a guide to land-valuers.

The plates of the "classic" map of 1855 are preserved in the Ordnance Survey Office, Dublin. From inquiries that I have recently made of this office and of the original publishers, no coloured copies seem now to be available.

It is rarely that one has a chance of correcting Mr. Sheppard. THE WRITER OF THE NOTE.

The Iridescent Colours of Insects.[1]

By H. ONSLOW.

II.—DIFFRACTION COLOURS.

THE structure of the scales of a number of iridescent butterflies was described and illustrated in the first article. The colours of many of these insects are undoubtedly produced by thin plates, either of chitin or of chitin and air. In a few instances, however, the structure gave no indication whatever as to how the colours were evoked.

Some definite modification of the structure gives rise to the principal colour, but all the minor details, such as the exact shade and the quality of the surface, which are so characteristic of any particular species or variety, are determined by the shape and position of the scales, the amount and form of the surface modelling, and the colour and localisation of any accompanying pigment. Consider, for instance, the shimmering appearance of the familiar Green Hairstreak (*Thecla rubi*), Fig. 1, which makes this insect so difficult to find, when it sits with its wings folded high overhead, looking like a green leaf dancing in the breeze. The appearance of the green scales is well known, *1* (Fig. 2), and a discussion on their colour, and on the cause of their characteristic reticulation, was carried on in the *Entomologist's Record,* vol. vi., p. 35, 1895.

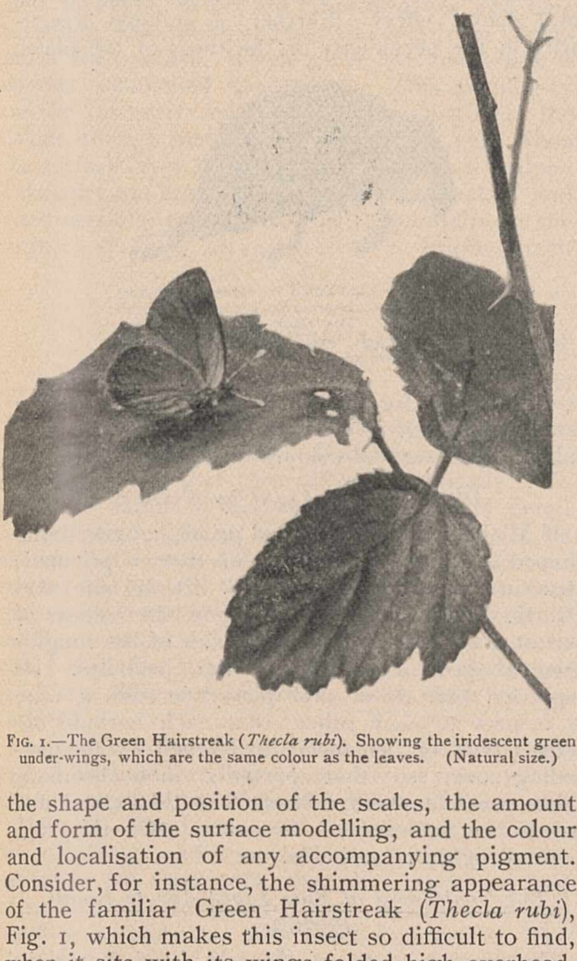

FIG. 1.—The Green Hairstreak (*Thecla rubi*). Showing the iridescent green under-wings, which are the same colour as the leaves. (Natural size.)

When observed by reflected light under the microscope, this shimmer is seen to be due to the spangled appearance of the scale, which is divided into many small, irregular areas, *o*, which reflect a green glitter of varying intensity, like so many sequins. These areas are divided from one another by pale lines, which form a reticulation. By transmitted light the reticulation shows as a transparent line, and, moreover, the brown colour of the polygonal areas is seen to vary considerably, some being dark brown and very opaque, and others pale yellow and transparent. Now the intensity of the green light varies in exactly the same way as this brown colour, the darkest and most opaque areas reflecting the brightest green. The iridescent colour is probably caused by a periodic structure not unlike that described in *Papilio ulysses,* the normal brown colour of the scale concealing any trace of this structure that might otherwise have been visible. The explanation of the reticulation and the spangled appearance it produces becomes at once evident on cutting a transverse section, 5 (Fig. 2), through the scale. It can be seen that the network corresponds to the thin places on the scale, *b*,

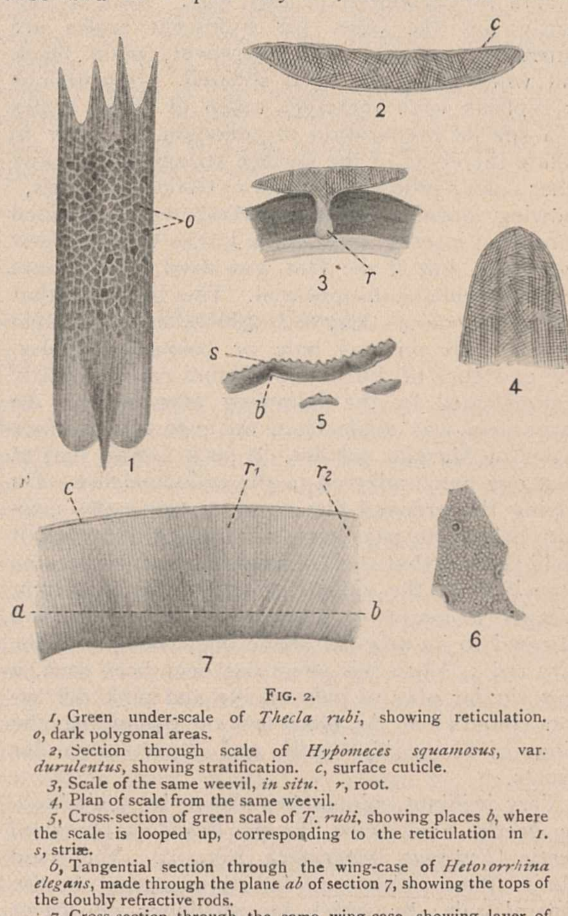

FIG. 2.

1, Green under-scale of *Thecla rubi*, showing reticulation. *o*, dark polygonal areas.
2, Section through scale of *Hypomeces squamosus*, var. *durulentus*, showing stratification. *c*, surface cuticle.
3, Scale of the same weevil, *in situ*. *r*, root.
4, Plan of scale from the same weevil.
5, Cross-section of green scale of *T. rubi*, showing places *b*, where the scale is looped up, corresponding to the reticulation in *1*. *s*, striæ.
6, Tangential section through the wing-case of *Heterorrhina elegans*, made through the plane *ab* of section 7, showing the tops of the doubly refractive rods.
7, Cross-section through the same wing-case, showing layer of rods r_1 and a deep layer r_2. *c*, the surface cuticle.
All these sections, with the exception of *5*, were drawn to the scale μ=1 mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc. The scale *1* has a magnification of about 100 diams.

[1] Continued from p. 152.

where it appears, as it were, to have been looped up. The bright green areas then correspond to the thickest portions of the scale. This is evidently only another example of the intensification of the colour produced by an underlying screen of dark pigment, which absorbs the excess of white light that would otherwise be reflected to the eye, causing the colour to become much desaturated.

Diffraction of Light by "Gratings."

Colours due to barred structures, or "gratings," which diffract light in the usual way, cannot be said, in Lepidoptera at least, to be of very great importance. They do, however, often produce effects which, though of secondary value, contribute a good deal to the final result. The fact that most scales appear to be marked with striæ, which form gratings of suitable dimensions, has sometimes given rise to the idea that most insect colours are produced in this way. This is evidently not the case, for iridescent scales are sometimes smooth, and, moreover, plain black and white ones are often striated. Impressions or replicas were therefore taken of many scales in a special preparation of collodion, in order to isolate the effect of the surface structure from any other colour-producing factors. Good "gratings," showing normal lateral spectra, were obtained from most insects, such as the Large White (*Pieris brassicae*), but if the film was dyed, the colours became feeble or disappeared. This indicates that diffraction colours are, as might be expected, discernible only on very pale or colourless scales. The existence of diffraction colours can be clearly demonstrated by the following experiment. An impression was made from the pale blue surface scales of *Morpho achilles,* in such a way that at least one patch adhered to the collodion film. On tipping the grooved film so as to cause the spectrum colours to pass across the patch of scales, it could be seen that their normal blue colour became intensified in the violet region of the spectrum, changed to mauve or pink in the red region, and returned to its original shade on passing into the infra-red. When this effect has once been seen, a very similar play of pale mauve and pink diffraction colours can be discerned on examining the wings of *M. achilles* itself, and of certain similar insects.

Very brilliant colours are shown by scale-bearing beetles or weevils, like the Brazilian Diamond Beetle (*Entimus imperialis*) (Fig. 3). Michelson admits these colours to be an exception to the general rule, by which he attributes all insect colours to selective metallic reflection, or surface colour. He believes the colours of these beetles to be due to gratings within the scale itself, since as soon as a fluid can enter the scales through a rent or tear the colour vanishes. Moreover, since the light is concentrated in a single spectrum, he is obliged to assume that the grating has bars, which are asymmetric or prism-shaped, so that they refract the incident rays in the same direction as the diffracted rays of the lateral spectra. For several reasons it is difficult to believe that such saw-tooth-shaped gratings are responsible for the total colour effect. For instance, the very saturated complementary colours seen by transmitted light, and the monochromatic character of the reflected colours at different angles, demand a form of grating structure even more complicated than that described by Michelson, such, for instance, as that named by Prof. R. W. Wood the "échelette grating." Moreover, though as a rule no structures are seen, a very well-defined stratification, 2 (Fig. 2), sometimes appears in cutting sections of certain scales, as in the pink weevil, *Hypomeces squamosus,* var. *durulentus.* This stratification can be seen in plan, 4 (Fig. 2), and appears to exist throughout the scale, giving it in section the crossed appearance of the strings of a tennis racquet. It seems probable that such a structure would contribute a large share to the total colour effect. Further, a suitable irregularity in the periodicity or thickness of the plates

FIG. 3.—The Brazilian Diamond Beetle (*Entimus imperialis*), a large, iridescent weevil. The black pits on the wing-cases are lined with gem-like scales. (Natural size.)

would account for the existence of the very saturated colours of some weevils, and of the very pale and desaturated colours of others.

Dispersion of Light by Prisms.

If Michelson's hypothetical prism- or saw-tooth-shaped gratings are omitted, no case of prismatic structure has been met with. It is true that Dr. H. Gadow has explained how the colours of certain feathers might be the result of the roughly prism-shaped structure of the barbules. He supposed that these were placed in such a way, in respect to each other, that each barbule obscured part of the spectrum formed by the preceding one, so that partially monochromatic colours would result. Numerous theoretical and practical considerations, however, make this suggestion highly improbable.

The Scattering of Blue Light due to Small Particles.

The investigations of the late Lord Rayleigh, and others, have shown that the blue of the sea, sky, snow and even tobacco smoke is caused by particles which, being very small compared with the wave-length of light, scatter the blue waves to a much greater extent than the longer red waves. Several colours can be produced in this way, as, for instance, the blue, green, and purple of certain feathers, which are matt, and do not change colour with the angle of incidence.

Such feathers show a faint yellow colour by transmitted light, and any pressure which destroys the structure also destroys all colour. The small bodies which scatter the light are in this case said to be exceedingly minute air-canals, which, on being filled with fluid, lose this property. In the case of feathers, as well as of certain animals, such as green frogs and many reptiles, the green is said to be due to the additional effect of a yellow pigment which is superimposed on the blue colour, as in the case of *Ornithoptera poseidon*, already described. There are also some exceedingly brilliant marine copepods which owe their colours to a prismatic layer of minute rods, said to be small enough to scatter coloured light.

In most beetles the metallic colours are seen to come from the surface, and the slightest scratch on the elytron removes all the colour. In the case, however, of certain emerald-green and blue Cetoniids, the colour appears to come from underneath the surface, which gives the wing-case a curious enamelled appearance. This peculiarity can be instantly recognised, and, moreover, the colour, though matt, is seen to persist, even when the surface layer has been removed with a scalpel. This layer has been called the "*Emailschicht*," and when sections are cut from it tangentially to the surface, 6 (Fig. 2), they give a bright green colour by reflected light, even when mounted in fluid media. A transverse section, 7 (Fig. 2), was cut from this layer of a beetle called *Heterorrhina elegans*; it is seen to be made up of very fine rods of chitin, r_1, about 1μ apart, and arranged at right angles to the surface; r_2 represents a second layer of rods at a lower depth. The section, 6 (Fig. 2), made through the line *ab* of section 7, reveals the cut ends of the rods. Thus the light, on striking the wing-case, is reflected from the tips or ends of a large number of these rods or pillars, and it seems possible that they may scatter the light in the same way as the air-canals do in the case of birds' feathers. It must, however, be pointed out that the above theory demands that the rods, or other bodies which scatter the light, should be appreciably smaller than the wave-length of light; that is to say, not much larger than a complex molecule. It is, however, uncertain whether bodies of the same order of magnitude as light waves (*i.e.* $0{\cdot}5$–$1{\cdot}0\mu$) can produce analogous colours. A very remarkable point about these rods of chitin is that under crossed Nicols they appear to be doubly refractive. This suggests that there may be some analogy with doubly refractive striated crystals like the tourmaline.

(To be continued.)

Physical Anthropology of Ancient and Modern Greeks.

By L. H. DUDLEY BUXTON.

IN classical times a clear distinction was drawn between Greek and Barbarian; Aristotle, indeed, claimed that they differed physically. To a certain extent it may be shown that in detail Aristotle had right on his side, but it can also be shown that Greek differs physically from Greek, so that his general thesis is untenable. It is true that most of our evidence rests on measurements made on modern Greeks, but there are data to prove that the latter possess physical characteristics not differing essentially from those of the former.

Among recent writers it has been generally admitted that at least two races are represented in Greek lands—the "Mediterranean" and the "Alpine." The former are short in stature, dark in colouring, and long-headed, typically represented by the Spaniards; the latter are fairer, and often, but not invariably, have auburn hair and hazel eyes, and vary very much in stature. The Eastern branch of the Alpines are usually known as "Armenoids." They are distinguished by their short, high heads, which are extremely flattened in the occipital region. It has also been suggested that long-headed, blond giants—Nordic—have contributed to the population of Greek lands.

Of the aboriginal population there is little evidence at present. Von Luschan believes that, at any rate in Anatolia, the earliest people were Armenoids, and in the Morea Prof. Myres considers that the Alpine strain is certainly ancient and may even be primitive. Early material is, however, so rare that it is easier, in stating the problem before us, to reverse the time process and to study the ancient people after the modern, about whom we are better informed.

The mean cephalic index in Greek lands to-day varies from 79 in Crete to 84 in the island of Leukas. None of the Greeks are as long-headed as the pure Mediterranean type, such as we find in a comparatively pure form in Corsica or Spain and in a less pure form in Egypt; nor, again, are they as broad-headed as the Lycian gipsies, who certainly represent pure Armenoids. If we group such cephalic indices on the living as are available, we obtain three classes: (1) Under 81, Cretans, Peloponnesians, Lycians (Greeks and Turks); (2) intermediate, Messenians and Cypriots; (3) more than 84, Leukadians, Albanians, Lycian gipsies. It would appear unlikely that this grouping is of any significance, if we turn from these figures to the variation, conveniently measured by taking the square root of the average square deviation from the mean (standard deviation). The Lycian Greeks and Turks have a very high standard deviation, suggesting considerable mixture, and the standard deviation of the cephalic indices of all the Greeks is sufficient to suggest a greater or less degree of intermixture. The condition of intermixture in Cyprus can be seen in Fig. 1—a photograph of a Cypriot woman and her three children. The elder boy might easily have been taken for an almost pure Armenoid; the younger had many characters usually associated with the Mediterranean people. The inadequacy of grouping by cephalic index alone is confirmed by the very great local differences to be found between groups of villages in Cyprus, to take one example only. The villages on the north coast have a cephalic index of 81·9, those round the Bay of Salamis, just the other side of the hills, an index of 83·4. There are similar local differences in Crete.

FIG. 1.—A Greek family, showing the two extreme types. The father (not shown in the photograph) had fair hair and blue eyes. The contrasted contours of the backs of the head should be noticed.

If we compare ancient crania with modern heads it would appear that the modern Greeks are slightly more round-headed than the ancient inhabitants of the same places. But this difference is not of any great significance, and there is a greater resemblance between the modern inhabitants of any one place and their predecessors than between the modern inhabitants of two neighbouring areas; in other words, the variation of types at any stage is horizontal, and not vertical, in the strata. First, the cranial indices, then, of the Greeks exhibit great variety, sufficient to suggest ethnic admixture. Secondly, this admixture has not been evenly distributed, and local and distinct sub-races have been formed, the mean of which forms a series of types, one of which is illustrated in Fig. 2—a type which has neither the breadth of head of the Armenoid, nor the length of head of the Mediterranean. So distinct are these sub-races that where crania over a long period have been obtained the cephalic index of one modern village more closely resembles that of their Bronze-age predecessors than that of a neighbouring area. Thirdly, there is archæological material which suggests that the mixture of race is early, possibly Neolithic in Leukas, certainly Bronze-age (or before) in Cyprus and Crete.

So few complete ancient skeletons have been collected that we cannot estimate the stature of the ancient Greeks. Among the modern, we find that

FIG. 2.—An intermediate type, with hazel eyes and brown hair.

the Cypriots and Cretans are the tallest, averaging about 5 ft. 6½ in., and the Leukadians and Peloponnesians the shortest, being about an inch shorter. So few measurements are, however, at present available that the stature must remain uncertain.

Data for hair and eye colour are rather scanty. The number of blue-eyed individuals is not, however, so few as might be expected. In Cyprus they form about 10 per cent. of the population, and most authorities are in agreement that blue eyes are not rare in Greek lands. It is this occurrence of light eyes that has made some writers postulate the presence of Nordics among the Greeks. Speaking from personal experience, the author was struck by the continual association of blue eyes with a very Armenoid type of skull in Cyprus and elsewhere—the taller boy in Fig. 1 is a good instance of this type—and though, historically, no doubt Nordics have filtered into the

Eastern Mediterranean at various times, the evidence of blue eyes is certainly insufficient to establish their presence as a recognisable element in the population.

The distribution of other characters, such as the form of the nose and of the orbits, cannot at present be plotted, as the evidence is scanty. Such measurements as have been made on the face suggest that, among the Greeks at any rate, broad faces accompany broad heads, and *vice versa*.

If we sum up the evidence afforded by all the physical characters which have been measured, we find that the Greeks probably represent a very old hybrid, older than the beginnings of the Bronze age. In Cyprus the earliest skulls examined were found associated with red polished and white painted ware, and were clear examples of this hybrid. We cannot at present say whether these early Greeks formed this physical type in the island or before they reached it. Elsewhere, so far as our scanty data go, the same tale seems probable. In each little district there is a mixture; sometimes the population of widely distant spots is similar; sometimes villages close to one another differ. It must be remembered that the geography of Greek lands favours the development of local strains, communication being often very difficult. There does seem to be a physical background to the differences between village and village in classical times, and to the struggles between Athens and Sparta. Most of the inhabitants of the Eastern Mediterranean, however, are also of this hybrid stock, and so Aristotle's dictum seems unjustified. There is no physical background for Hellas as a whole. Our present evidence suggests that the degree of mixture is fairly uniform throughout, though the results of the mixing may be different. Lycia, however, presents a far greater degree of heterogeneity; this heterogeneity did not escape the notice of Herodotus, who says that the Lycians were Cretan immigrants into a country with a previous Minyan population, with a third element from Attica.

There is little reason to doubt the generally accepted statement that the two stocks which have formed this hybrid are Mediterranean and Armenoid. The former is found in a comparatively pure state to the west and south of the Greek world, the latter sporadically in a pure state among the Greeks of Anatolia, and may even occur, though we have no evidence at present, in the Balkan Peninsula itself.

Obituary.

ALFRED E. FLETCHER.

BY the death of Alfred E. Fletcher, at the great age of ninety-four, the country has lost a scientific worker who, in his particular sphere, exercised on chemical manufacture a powerful and healthful influence. Born in 1826, Fletcher completed his school education in Berlin, and was employed for a time on railway surveying. He relinquished his career as an engineer in order to attend the science classes at University College, London (being debarred as a Nonconformist from attending the older universities), where he studied mathematics and chemistry, for which he received the gold medal in 1851. In the following year he was elected a fellow of the Chemical Society, and afterwards began a series of researches on artificial colouring matters, a field of inquiry which had been developed by Perkin's discovery of mauve in 1856, and greatly stimulated by the work of Hofmann and his pupils at the Royal College of Chemistry. Discouraged by prolonged litigation on the subject of a patent for a new colour process in which he was interested, Fletcher accepted in 1863 the post of assistant to Dr. Angus Smith, the first Chief Alkali Inspector. The origin of this department, which played so large a part in Fletcher's subsequent career, was the numerous complaints from farmers owing to the fumes from alkali and other chemical works. These fumes arose mainly from the discharge of hydrochloric acid in the manufacture of salt-cake. These and other acid vapours destroyed vegetation over large areas.

Under the Alkali Act of 1863 trained chemists were appointed to control this industry. The result of such inspection was soon apparent. The acid, which has since become a staple and profitable product of the process, was absorbed in towers by passing the gases through a descending stream of water. This is not by any means the only example whereby the alkali inspectors have helped the chemical manufacturer to utilise his noxious by-products to his own advantage and to that of the public.

As assistant, Fletcher devised an ingenious aspirator for extracting flue gases for analysis, and also invented an anemometer for determining their rate of flow. In 1884, on the death of Dr. Smith, he succeeded him as Chief Inspector, and continued in that office until his retirement in 1895.

Fletcher's activities were not confined to clearing the atmosphere from noxious fumes. He entered upon a campaign against the smoke nuisance, which he continued for thirty years, embodying his views in a series of articles, addresses, and pamphlets. He was, so far as the writer remembers, a strong advocate of a centralised inspectorate of all factory chimneys on the lines of the Alkali Act, and set an example of domestic heating without smoke by installing a central warm air system in his own house, details of which he published in the Press and technical journals. He also assisted the Scottish Office in the administration of the Rivers Pollution Act.

Fletcher married in 1858 Sarah Elizabeth, eldest daughter of Richard Morley, of Leeds, and is survived by his wife, six sons, and three daughters.

J. B. C.

D. H. NAGEL.

By the death of D. H. Nagel, of Trinity College, Oxford, science has lost an advocate who did much to remove the prejudice keenly felt in Oxford thirty years ago, and the University has lost a teacher remarkable for the thoroughness, the understanding, and the sympathy which endeared him to many generations of undergraduates.

In the examination for the open Millard Scholarship in Natural Science in 1882 Nagel was the only candidate who gained distinction both in the science subjects and in the optional classical paper. Elected Millard scholar, he worked under the writer (then Millard lecturer at Trinity) in the newly equipped laboratory in Balliol, between which and Trinity a doorway had been opened in 1879—a novelty in inter-college communications which was guarded with some anxiety by the college deans on each side, and usually referred to as "the scientific frontier."

As an undergraduate Nagel was distinguished by the width of his scientific interests; he was one of the few who attended professorial lectures outside their own subjects, and his enthusiasm may be said to have resuscitated and kept alive some of the courses in geology and mineralogy which did not form part of the usual honours schools. In addition to science he studied languages and gained a University exhibition in German.

Nagel took a first class in chemistry in 1886, and in the following Michaelmas term became demonstrator in the laboratory, and succeeded the writer as Millard lecturer in 1888.

The Balliol laboratory was soon extended into adjacent cellars to meet the needs of the two colleges, and in 1904 a considerable addition was made on the Trinity side of the "frontier," when the two colleges undertook to give practical training in physical chemistry as part of a general scheme for honours men in the University. In planning and supervising this course Nagel's knowledge and judgment found full scope.

At the opening of his Oxford career Nagel was one of the founders of the Junior Scientific Club, an institution which has been particularly successful in bringing together men engaged on different lines of scientific work, and of its members none were better equipped than Nagel by study and sympathy to understand and elucidate the relations of one branch of science to another. It was this faculty that gave him his unique position in Oxford when he settled down as fellow and tutor of his college.

It has been said of Nagel that he was too busy to do original work. This is partly true, but not the whole truth; on one side there were diffidence, some lack of the fighting spirit, and, perhaps, a fear lest the road he chose to pursue might lead nowhere; on the other, there were his keen delight in and critical appreciation of many lines of work, and the consciousness that his life would be more complete in unselfish devotion to others than in seeking fame for himself. Such being his nature, he was inevitably drawn into administrative work, and perhaps he found himself most completely as chairman of the board of the Faculty of Natural Science. In this position his wide knowledge, sound judgment, and kindly tact were invaluable, and it was largely under his guidance that the Department of Forestry was successfully instituted in the University.

As a delegate for local examinations and for the inspection and examination of schools Nagel exerted great influence on the study of science in schools, and his judgment and experience of school work have been largely utilised by the Board of Education.

To old Trinity men Nagel had become almost an institution; his pupils scarcely regarded him as a "don," for there was a wonderful *camaraderie* between them and their tutor. But they all came to him for help and counsel. His friends and colleagues did likewise, and we are all the poorer for his loss. H. B. DIXON.

DR. ADOLF BERBERICH, who was on the staff of the *Berliner Jahrbuch* for thirty-five years, and for some time its director, died at Berlin last April after a long illness. Berberich was born in Baden in 1861; his family was for many years in serious financial difficulties; nevertheless, he secured a good education, first at the Gymnasium at Rastatt, then at Strassburg University, where he studied astronomy under Winnecke and Schur. He suffered from extreme short-sight, which made astronomical observing difficult, so he turned his energies to the computational side of the science, in which he showed such energy and skill that his name was already known as an orbit computer in 1884, in which year he obtained a post on the staff of the Rechen-Institut. Berberich was soon led to take a special interest in reducing the computation of orbits and ephemerides of the minor planets to an orderly system, his work being invaluable in identifying and following the immense number of new planets that were discovered by photography. He was on terms of intimate friendship with Prof. Max Wolf and Dr. Johann Palisa, who were indefatigable on the observational side; he frequently received the observed places of a new planet at breakfast, and sent back its orbit and ephemeris before lunch. He had a marvellous memory, enabling him to keep the elements of many planets in his head, thus greatly facilitating their identification. The task of keeping the immense array of planets under sufficient observation is a Herculean one, only to be accomplished by systematic division of labour. International arrangements had been made in this direction before the war, largely under the initiative of the Rechen-Institut. Unfortunately, unnecessary duplication of work now prevails again. Berberich was much esteemed by a wide circle of friends as an earnest, religious, and benevolent man. He married not long before his death, and his wife survives him. An appreciation of his work by Prof. F. Cohn is contained in *Astronomische Nachrichten*, No. 5053.

THE death is announced, at the age of fifty-eight, of PROF. SAMUEL SHELDON, professor of physics and electrical engineering at the Polytechnic Institute of Brooklyn since 1889. Prof. Sheldon was at one time assistant to Kohlrausch, with whom he was associated in the former's determination of the ohm. In 1906 he was elected president of the American Institute of Electrical Engineers.

THE death of SIR LINDSAY WOOD, BT., on September 22, at eighty-six years of age, is announced in the Journal of the Royal Society of Arts. Sir Lindsay was born in 1834, and educated at the Royal Kepier Grammar School, Houghton-le-Spring, and King's College, London. He served as a mining engineer apprentice at Hetton Collieries, of which in 1866 he became managing director. He was also on the boards of several other coal companies and allied undertakings. From 1875–78 he was president of the Northern Institute of Mining and Mechanical Engineers, and in 1879 he served on the Royal Commission on Accidents in Mines. His chief work was a series of elaborate and exhaustive experiments on the pressure of gas in coal. Sir Lindsay was created a baronet in 1897, and served as Deputy-Lieutenant and High Sheriff of the County of Durham.

DR. HARMON NORTHRUP MORSE, professor of inorganic and analytical chemistry and director of the chemical laboratory at Johns Hopkins University, died recently in his seventy-second year. Having graduated at Amherst in 1873, Dr. Morse returned to that college as an assistant in chemistry in 1875, after a period of study at Göttingen. In the following year he was appointed associate professor at Johns Hopkins, and in 1891 was promoted to a full professorship. He carried out many original researches on osmotic pressure and related subjects.

Notes.

AT the concluding meeting of the International Congress of Physiologists, which was held in Paris on July 16–20, it was unanimously resolved, on the invitation of Sir E. Sharpey Schafer, to hold the next meeting in Edinburgh in 1923.

THE annual oration of the Medical Society of London is to be delivered in May next by Lord Dawson of Penn. The Lettsomian lectures of the same society are to be given in February and March next by Mr. George E. Gask.

THE British Electrical and Allied Industries Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The association may be approached through Mr. E. B. Wedmore, Electrical Research Committee, c/o Electrical Development Association, Hampden House, 64 Kingsway, W.C.2.

THE following arrangements have been made by the Royal College of Physicians of London:—The Horace Dobell lecture will be delivered by Sir William B. Leishman, at 5 o'clock on November 2, on "An Experimental Investigation of the Parasite of Tick Fever, *Spirochaeta Duttoni*"; the Bradshaw lecture by Dr. C. Wall, at 5 o'clock on November 4, on "Chorea"; and the FitzPatrick lectures by Dr. E. G. Browne, at 5 o'clock on November 9 and 11, on "Arabian Medicine after Avicenna."

THE council of the Chemical Society has arranged for the following lectures to be held during the coming session:—October 28, Emil Fischer memorial lecture, Dr. M. O. Forster; December 16, Some Properties of Explosives, Sir Robert Robertson; April 7, 1921, Mass Spectra and Atomic Weights, Dr. F. W. Aston; and June 16, 1921, The Natural Photosynthetic Processes on Land and in Sea and Air, and their Relation to the Origin and Preservation of Life upon the Earth, Prof. Benjamin Moore. By the courtesy of the council of the Institution of Mechanical Engineers, the first two lectures will be held in the lecture hall of that institution (Storey's Gate, Westminster, S.W.1). Informal meetings, at which fellows are invited to show experiments and apparatus, will be held at Burlington House on November 18 next and on February 3 and May 19, 1921.

PROF. F. SODDY's review of the activities of the Department of Scientific and Industrial Research published in the *Observer* of September 26 has been followed up in the same newspaper by letters from Dr. J. W. Evans and Mr. J. W. McConnell. Prof. Soddy remarked: "To-day a new kind of science—Government science—is being step by step built up, not for humanity, but its masters; not for the community, but big business"; emphasised the fundamental change of policy which accompanied the creation of the new department for the administration of funds for industrial research; and contrasted the generous treatment and comparative freedom from Government control accorded to industrial associations with the arbitrary methods of dealing with individual research workers. Dr. Evans suggests that the mistakes of the Department are attributable to the "fundamentally wrong-headed attitude adopted by the nation generally with regard to our scientific societies and the science faculties of our universities," and instances the disabilities under which these bodies suffer in carrying on their work. He deplores also the decision of some university authorities to raise their fees at a critical time in the nation's history. Mr. McConnell, who acted as chairman of the provisional committee for forming the Cotton Research Association, although in general sympathy with the views expressed by Prof. Soddy, is of the opinion, which is not shared, however, by scientific workers generally, that "the rewards of the research of whatever kind should have been primarily secured to those who found the money to pay for it."

The wonderful achievements of Rolf, the thinking Airedale terrier, bid fair to be eclipsed by the marvel of his daughter Lola. Lola passed at the age of two years into the keeping of Miss Kindermann when she could only say "yes" and "no," but after a few days of schooling the dog could read and count. In one day's lesson she could tell the hour by the clock. In the same way she acquired a knowledge of days, months, measurements, and musical notes, could forecast the weather, and gave evidence of "filosofia morale." Dr. W. Mackenzie, from whose "Gli Animali 'Pensanti'" (*Quaderni di Psichiatria,* 1920) these particulars are taken, vouches for Miss Kindermann's ability, veracity, love of animals, and ignorance of psychology. He does not attribute all the intelligence to Lola, but believes that there is a *rapporto medianico* between the supra-liminal consciousness of mistress and the sub-liminal unconsciousness of pupil. Seeing, however, that Dr. Neumann's experiments (duly discussed in the pamphlet) place Rolf's achievements in a new light, it may be well to await further observations on Lola before passing judgment on Dr. Mackenzie's conclusions. The trouble is that negative results may be explained as due to lack of the said *rapporto.*

The study of place-names, of great importance in American geography, has been much advanced by a monograph entitled "Yurok Geography," by Mr. T. T. Waterman, published in the series of publications of the University of California, vol. xvi., No. 5. This summarises a great mass of material collected by Dr. A. L. Kroeber and the writer among the Yurok Indians along the Klamath River and in the adjacent region of north-western California. Many of these primitive Indian names are now used by white settlers, and appear in the ordinary maps of this region in anglicised form. Their identification and interpretation naturally present much difficulty, but the present monograph, with its careful lists and maps, will be of interest to both the geographer and the philologist.

The system of geomancy or divination known as Raml, "sand," is common among the Arabs. At a propitious hour, noon, or one-third of the day before or after noon, the Khattāt, or "writer," prepares a smooth patch of sand, while his client places the tip of the middle finger of his right hand on the ground and states mentally the object of his quest. Then the diviner makes finger-prints at random in the sand and counts off the prints of each line in pairs to see if it contains an odd or an even number. There are, on the whole, sixteen possible figures in the diagrams which he makes, each of which has its special name and meaning. The nomad Arab in the Sudan, says Mr. R. Davies, who gives a full account of the system (*Sudan Notes and Records,* vol. iii., No. 2), spends much of his time in search of lost or stolen animals, and this system of divination has thus arisen. It seems to be successful, for Mr. Davies writes: "On the only occasions, three in number, when serious trial of the Khatt has been made in the presence of the writer, the forecast of the Khattāt has each time been justified by the result."

In an elaborate monograph (University of California Publications in American Archæology and Ethnology, vol. xvii., No. 1) Mr. Paul Radin discusses the sources and authenticity of the history of the ancient Mexicans. These sources, which are of great extent, fall into two types: the actual old Indian codices, of which there are but a few extant, and the works of Christianised Indians and Spaniards. The vast majority of the old manuscripts have disappeared, as well as the copies made of them. As late, however, as 1746 Boturini was able to make a large collection dealing with all the aspects of the ancient culture. Mr. Radin in this monograph has made a critical study of a large number of ancient documents, and provides English translations of the most important passages. The value of some of these materials is doubtful, but the Nahua peoples had a complex calendar system and a rude system of writing, and as they were deeply interested in the traditions of their migrations, it seems clear that these records contain information of much value to ethnologists. Mr. Radin has done good service to science in his careful account of these manuscripts and by his translations of the most important records.

During the Mahdist occupation of the Sudan (1885–98) coins were struck by the Mahdi at Khartum, and later by the Khalifa at Omdurman. Many of these coins have now become scarce, and Mr. H. S. Job, in *Sudan Notes and Records* (vol. iii., No. 3), has done good service to numismatics by giving a full account of this example of the debasement of currency in the hands of a despotic ruler, and by providing a full catalogue, with illustrations, of the various types of mintage. After the fall of Khartum in 1885 considerable treasure of Egyptian and English gold coins, the Mejidi and Maria Theresa dollars, with smaller Egyptian coins, fell into the hands of the Mahdi, who determined to have the bullion melted down and recoined. It was decided that two coins should be struck, a gold pound and a silver dollar, to which later a half-dollar was added. For the first the Egyptian gold piece of 100 piastres of Sultan Abd-al-Mejid was taken as the model, the name of the Sultan being replaced by the words "By Order of the Mahdi." Though these coins were of good quality they were regarded with mistrust, and circulated at less than their par value, while many foreign coins, though much worn, remained in circulation. It may be hoped that a full series of these interesting coins has been provided in our museums.

In a detailed analysis of the inheritance of hoariness in stocks, Miss Saunders (*Journ. Genetics,* vol. x., No. 2) shows that a graded series from the fully hoary form *incana* to the completely glabrous form can be obtained. Historical records indicate that the extreme glabrous form was probably the first to arise from *incana,* being mentioned as early as

1588, while Linnæus mentions the rare half-hoary *semi-incana* in 1762. Crosses of these forms produce a series of intermediate factorial combinations, including a type with a single hair on the tip of each leaf. It is concluded that the "factor" for a particular degree of hairiness represents a particular condition of physiological equilibrium subject to environmentally produced fluctuations.

IN the Journal of the Royal Microscopical Society (1920, part 2) Mr. T. E. Wallis describes a method of quantitative microscopy by use of Lycopodium spores. By a sufficiently thorough mixing of the materials to be tested with the spores and by the use of a suitable suspending medium, the author finds it possible, by making a number of counts of the spores in different fields of view, to obtain results of an order of accuracy equal to many of those obtained by chemical operations both qualitative and quantitative. As examples are cited the determination of the proportion of maize-starch that had been added to some ordinary wheat-flour, and the determination of the number both of starch grains per milligram of maize-starch and of pollen-grains per milligram of insect-powder; the last-mentioned supplies an index of the value of the powder.

DR. W. MACKIE has shown that monazite is widely distributed in the granites of the North of Scotland, and it has now been found by Dr. A. Gilligan in almost all the beds of the Millstone Grit of Yorkshire, doubtless derived from this northern source ("The Petrography of the Millstone Grit of Yorkshire," Quart. Journ. Geol. Soc., vol. lxxv., p. 271, 1920).

THE "Final Report of the Work of the Commission on Munition Resources, Canada" (Toronto, 1920), besides useful notes on recent prospecting, contains (pp. 58–88) an account of trenches made for the investigation of bog-manganese ore, which may be of service to those interested in such deposits in Ireland. There seems not much hope of competition between the bog material and the hard ores of the ordinary mines. We have yet to learn how far selective action by bacteria is responsible for the precipitation of manganese oxides in swamps. Mr. Uglow's practical report naturally leaves the matter open.

DR. R. S. LULL describes in the *American Journal of Science* (vol. l., p. 83, 1920) two "new Tertiary Artiodactyls" from remains discovered in Nebraska in 1914 by an expedition from Yale under his guidance. The deposits are of Late Miocene or Early Pliocene age. A very pleasing restoration is given of a new antelope, *Aletomeryx gracilis*, of which abundant material has been obtained, including nineteen skulls, both male and female. The name, meaning "wandering ruminant," is chosen on account of the migratory powers indicated by the delicacy of the limbs. The limb-bones are, indeed, generally broken.

FROM the General Report of the Survey of India for 1918–19 we learn that the curtailment of work owing to war conditions continued, several survey parties being engaged in Mesopotamia, East Africa, and elsewhere out of India. Of the topographical map on the one-inch scale 57 sheets were published during the year in place of the pre-war figure of 150 to 200. About 1500 one-inch sheets have now been published out of a total of 6218. Thirty half-inch and 11 quarter-inch, or "degree," sheets were published. The half-inch map is now the tactical map of India, and 177 of the 630 sheets are available. The "degree" sheets are making slower progress, and their total is now only 52 out of 450. No further sheets of La Carte Internationale (1 : 1,000,000) appeared during the year, but two sheets of the India and Adjacent Countries Series (1 : 1,000,000) were published. The report includes complete indices of all sheets published by the Survey of India.

THE Mines Branch of the Department of Mines of Canada has just issued a valuable monograph on graphite, written by Mr. Hugh S. Spence. It describes in detail the important Canadian occurrences of this mineral, and also reviews all other known sources of supply throughout the world. It is interesting to note that in 1913 Germany and Austria together produced practically one-half of the world's total supply, but that since then the American output has been nearly trebled. An interesting account is given of the various methods used for the concentration of graphite, for which purpose the flotation process appears now to be the most favoured, and the manufacture of artificial graphite is also described. An important section is devoted to the industrial applications of graphite; it is stated that the world's production of natural graphite is utilised in approximately the following proportions: For crucibles, 75 per cent.; for lubricants, 10 per cent.; for pencils, 7 per cent.; for foundry facing and stove-polish, 5 per cent.; and for paints, 3 per cent. The method of manufacture of all these articles is described, as well as that of others not included in the above list, such as graphite brushes for dynamos and motors, graphite electrodes, graphite for dry batteries, for electrotyping, and for various less important purposes. The monograph should prove valuable to all interested in the mining of graphite or the manufacture of graphite articles.

THE United States Geological Survey has just issued an elaborate monograph on the economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder Counties, Colorado, by Mr. E. S. Bastin and Mr. J. M. Hill. This district includes most of the mining camps of Colorado that are producing minerals of economic importance, including the well-known auriferous pyritic ores of Gilpin County, the gold and silver veins of Clear Creek County, the lead ores of Leadville, the telluric gold ores of Telluride, and many others. In addition to gold, silver and lead ores, the district here described produces also ores of zinc, copper, uranium and tungsten, the gold production being, however, economically by far the most important. The monograph describes the general topography of the area, spoken of here as the Central City quadrangle; the geology is described in detail, particular attention being devoted to the igneous rocks, amongst which the monzonites are the most important. Chapters are devoted to the economic geology and to the general features and origin of the various ore deposits, each of the more important ores being discussed separately. An interesting chapter is devoted to the methods of ore-treatment, the history of the development of the so-called Colorado or Gilpin County method of gold-milling being clearly traced, as also its displacement by the more recent processes of cyanidation and flotation. Justice is also done to the development of the smelting process, under Mr. R. Pearce, from its small beginnings at Blackhawk, removed afterwards to Argo, close to Denver. Statistical tables of the output are given, showing the economic importance of this district. The remainder of the book is taken up with a detailed description of all the mines of importance, the geological relationships of the ore-bodies being worked out in much detail.

THE Journal of the College of Science of the Imperial University of Tokyo for May 10 last contains an important paper, of interest to the students of the genesis of mineral deposits, under the title of "A Contribution to the Knowledge of the Cassiterite Veins of Pneumato-Hydatogenetic or Hydrothermal Origin: A Study of the Copper-Tin Veins of the Akénobé District in the Province of Tajima, Japan," by Takeo Katō. The district in question contains a system of practically parallel veins worked at first for copper, but afterwards found to contain important proportions of tinstone and wolframite. The author holds that "the veins of the Akénobé district are all consanguineous, and all gradations exist between the copper veins containing little or no cassiterite and the copper-tin veins containing much of the same mineral." The veins occur chiefly in Palæozoic slates. The abnormal feature of the occurrence is the fact that the district shows important exposures of intrusive dioritic rocks, forming either large masses or offshoots from these. There are, it is true, dykes of andesites and porphyrites, but these cut the veins "and are clearly later in generation than the latter." "No granitic or allied acid plutonic rocks have been observed," and the author concludes definitely that the veins are related genetically to the dioritic rocks—an occurrence which, though common enough so far as copper-bearing veins are concerned, is probably unique in respect of tin veins. The author's summary of the genesis of these veins is as follows: "The copper-tin veins of the Akénobé district were deposited from hydrothermal solutions, still containing fair quantities of mineralisers, at gradually decreasing temperatures, chiefly considerably below 360° C. The solutions had naturally a temperature far above the critical point of water (364° C.), and were gaseous in character, after emanation from the consolidating diorite magma. As they ascended through the surrounding slate complex the rate of fall of the temperature was very rapid, and they soon changed to superheated hydrothermal solutions."

THE chief periods of seismic activity of the well-known Comrie centre are from 1788 to 1801 and from 1839 to 1844. Since the latter year very few shocks have been felt. Some are recorded from time to time in Perrey's annual catalogues. During the last thirty years five have been felt, all of them slight and disturbing an area of at most a few square miles. Three of these occurred towards the close of last century—on July 12, 1894, July 12, 1895, and August 22, 1898. In the present year a slight increase of activity is shown by the occurrence of a shock of intensity 3 (Rossi-Forel scale) on July 21, and of a slightly stronger shock (intensity 4) on September 14.

CANADA is keeping well abreast of the times in meteorology, and its Monthly Record of meteorological observations, which includes data from the Colonies of Bermuda and Newfoundland, will add much of value to the general knowledge of the world's weather. Results for the early months of the present year are to hand. Tables and maps are given showing the monthly average temperature and precipitation, together with differences from the normal over the whole Dominion. The observations are classified for province and district. For many places temperature, atmospheric pressure, and humidity are given for each hour, and the mean monthly averages and totals are well set out, also the mean proportion of bright sunshine for each hour that the sun is above the horizon. Observations of wind direction and velocity and of cloudiness are also obtainable. The detailed observations of wind both from the first- and second-class stations will prove of much value to the aeronaut. No observations are made at present of the form of cloud, or of the direction and speed of either lower or upper clouds. Such observations would be useful in the elucidation of upper-air problems.

AN analysis of the rate of ascent of pilot-balloons has been made by Lieut. R. P. Batty, and is published by the Meteorological Office as Professional Notes No. 12. The observations were taken at Butler's Cross, Salisbury Plain, from June to December, 1919. The ascents were not made at fixed hours of the day, but when required by the School of Artillery; 75 per cent. of the ascents were between 9h. and 13h. G.M.T., and mostly during July, August, and September. Average rates of ascent are given for each of the first thirteen minutes. From 225 ascents 1464 minute readings were obtained, and the mean rate of all ascents is 530 ft. per minute. Ascents have been grouped for specified hours of the day, and the mean rate is shown to be greatest at about mid-day. Ascents are also classified according to the amount of cloud in the sky, and it is seen that more cloud gives an increased rate of ascent. Moderate and strong winds give a higher rate of ascent than light winds, and the rate of ascent for different wind directions is also classified. It is noticed that immediately prior to entering cloud the rate of ascent almost invariably increases, mostly to 600–700 ft. per minute. Rain is said to decrease the rate of ascent by about 20 per cent. The size of the pilot-balloons used was 70 in. or 90 in., and their weight varied from 20 to 30 grams. Tables and diagrams are given showing the variations under the different classifications.

FATHER FROC has added yet another contribution to his already valuable researches on the typhoons of the Far East, in the "Zi-Ka-Wei Observatory Atlas of the Tracks of 620 Typhoons, 1893–1918." The atlas contains a series of charts showing the actual tracks of the centres of 620 typhoons which have been reported in the Far East during the twenty-six years, 1893–1918. The original purpose of the author was to issue these charts as an appendix to a more general study of the subject, but since the publication of this more comprehensive report has been considerably delayed, it was decided that the appendix should appear at once. Consequently, the atlas contains little more than the charts themselves, with brief explanatory notes on each. It lays no claim to be a theoretical treatise on the structure and origin of these revolving storms. No attempt at classification is made, since the charts are intended solely for the nautical guidance of sailors. The cases are enumerated month by month as they occur, and to avoid confusion and overlapping of the tracks, three charts are allotted to each of the months of maximum frequency (July to October inclusive). The maps cover a wide geographical area, from Cochin China and the Philippines in the south, to Manchuria and the Kurile Islands in the north, while embracing a vast stretch of the Pacific eastwards from the Asiatic mainland to 150° E. longitude. The irregular west-south-westerly motion of occasional storms in this region—chiefly in the China Sea—is clearly shown in the charts, and the author lays stress on the point that navigators should be familiar with the possibility of this unusual movement, even though the vast majority of the storms follow a general north-westerly track, such as is customary in the northern hemisphere. In conclusion, twelve summary maps are given, showing the dangerous zones and the successive changes which take place throughout the year. The atlas is of additional value in that it gives a trustworthy and up-to-date measure of typhoon frequency.

WE have received a copy of Catalogue No. 23 of second-hand books in science just issued by Mr. R. S. Frampton, 37 Fonthill Road, Finsbury Park, N.4. The works listed (some 1100 odd) range over most of the sciences, and the prices asked are very reasonable. The catalogue will be sent free upon application.

DR. WALTER KIDD is publishing through Messrs. H. F. and G. Witherby a work entitled "Initiative in Evolution," which will contribute to the evidence in favour of Neo-Lamarckism, and give especial consideration to the arrangement of the hair in mammals. Messrs. Witherby also give notice of "A Naturalist in Himalaya," by Capt. R. W. G. Hingston, in which attention is given, among other subjects, to geometrical spiders and their work, various species of ants and their organisations, and the nesting instincts of birds.

THE reviewer of "Smithsonian Meteorological Tables" in NATURE of September 30, p. 142, stated that the Tables are not obtainable in the ordinary way. Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.2, remind us, however, that they are the agents for the Smithsonian Institution in London, and that the Tables can be purchased from them. The Tables form vol. lxix. of the Smithsonian Miscellaneous Collections, and not vol. lix., as given at the head of the review.

Our Astronomical Column.

PROF. PICKERING'S LUNAR OBSERVATIONS.—Prof. W. H. Pickering has for many years been making a careful study of certain lunar formations under all angles of illumination, finding striking changes of relative luminosity of adjacent markings in the course of the lunar day, which he ascribes to the presence of snow or hoar-frost, or in some cases to vegetation. There can be only one opinion as to the interest and value of the observations, whether Prof. Pickering's conclusions are accepted or not. His latest study (*Popular Astronomy*, August and September) is of the region round the crater Conon in the Apennines and the neighbouring formation of Bradley. He asserts that this region contains snowfields, clouds, and tracts covered with vegetation. He distinguishes the clouds from the snowfields as being more yellowish, less brilliant, and more subject to change. One note that he makes about them would seem to throw some doubt on their assumed nature. "No clear evidence of motion due to wind has ever been seen in the lunar clouds, which apparently merely form and dissolve *in situ*." The white snow-patches, on the other hand, which appear hazy at sunrise, are stated to show some drift; the "vegetation" regions darken conspicuously as the sun rises higher upon them. The author asserts that volcanic activity is by no means extinct on the moon, the floor of Plato being stated to be an active region emitting many steam-jets.

There cannot be much doubt about the relative change of brightness of the different markings, but it does not appear that the author has given enough consideration to the possibility that it may arise from differences in the composition of the rocks or of their degree of slope and of smoothness. While the occurrence of snow, cloud, and vegetation cannot be ruled out as impossible, it is at least somewhat difficult to reconcile with the tenuity of atmosphere that is demonstrated by the practical absence of refraction in occultations and eclipses.

THE SUN'S MAGNETIC FIELD.—The *Observatory* for September contains an article by Dr. F. H. Seares, written at Prof. Hale's request, giving an account of the researches made at Mount Wilson since 1908 on the sun's magnetic field. The investigation was suggested by the discovery of the Zeeman effect in the spectra of sun-spots, which were surrounded by hydrogen vortices. In the case of the general field the spectral shifts are extremely minute, less than one-thousandth of an angstrom, and it is only the remarkable accordance in the results that gives confidence that the effect is a real one, the shifts being of the same order as accidental errors in the measures. The precaution was taken that the measurer should not know in which direction the shift on any plate was likely to be, so that all bias was eliminated. Comparatively few of the spectral lines were found to be suitable for the research, and the results depend chiefly on iron and chromium lines. A first solution showed that the northern hemisphere had negative polarity, and that the magnetic axis was close to the rotational one. It was afterwards found that the inclination of axes is about 6°, and that the magnetic axis revolves about the other in 31·44 days. The investigation indicates that the field strength diminishes rapidly with increasing elevation, falling from 50 to 10 gausses in 200 km. It will be noted that the shifts in this investigation are much smaller than in the Einstein spectral test; but differential measures suffice here, while in the other case absolute ones are required.

Fossils and Life.*

By F. A. BATHER, M.A., D.Sc., F.R.S.

II.

THE argument for orthogenesis based on a race-history that marches to inevitable destruction, heedless of environmental factors, has always seemed to me incontrovertible, and so long as my knowledge of palæontology was derived mainly from books I accepted this premise as well-founded. But more intensive study generally shows that characters at first regarded as indifferent or detrimental may have been adapted to some factor in the environment or some peculiar mode of life.

Prof. Duerden's studies of the ostrich lead him to the opinion that retrogressive changes in that bird are destined to continue, and "we may look forward," he says, "to the sad spectacle of a wingless, legless, and featherless ostrich if extinction does not supervene." Were this so, we might at least console ourselves with the thought that the process is a very slow one, for Dr. Andrews tells me that the feet and other known bones of a Pliocene ostrich are scarcely distinguishable from those of the present species. But, after careful examination of Prof. Duerden's arguments, I see no ground for supposing that the changes are other than adaptive. Similar changes occur in other birds of other stocks when subjected to the requisite conditions, as the flightless birds of diverse origin found on ocean islands, the flightless and running rails, geese, and other races of New Zealand, and the Pleistocene Genyornis of the dried Lake Callabonna, which, as desert conditions came on, began to show a reduction of the inner toe. Among mammals the legs and feet have been modified in the same way in at least three distinct orders or sub-orders during different periods and in widely separated regions. [The instances were given.]

In all these cases the correlation of foot-structure with mode of life (as also indicated by the teeth) is such that adaptation by selection has always been regarded as the sole effective cause.

My colleague, Dr. W. D. Lang, has recently published a most thoughtful paper on this subject. His profound studies on certain lineages of Cretaceous Polyzoa have led him to believe that the habit of secreting calcium carbonate, when once adopted, persists in an increasing degree. Thus in lineage after lineage the habit "has led to a brilliant, but comparatively brief, career of skeleton-building, and has doomed the organism finally to evolve but the architecture of its tomb." These creatures, like all others which secrete calcium carbonate, are simply suffering from a gouty diathesis, to which each race will eventually succumb. Meanwhile, the organism does its best to dispose of the secretion; if usefully, so much the better, but, at any rate, where it will be least in the way. Some primitive Polyzoa, we are told, often sealed themselves up; others escaped this self-immurement by turning the excess into spines, which in yet other forms fused into a front wall. But the most successful architects were overwhelmed at last by superabundance of building material.

While sympathetic to Dr. Lang's diagnosis of the disease, still I think he goes too far in postulating an "insistent tendency." He speaks of living matter as if it were the over-pumped inner tube of a bicycle tyre, "tense with potentiality, curbed by inhibitions" [of the cover], and "periodically breaking out as inhibitions are removed" [by broken glass]. A race acquires the lime habit or the drink habit, and, casting off all restraint, rushes with accelerated velocity down the easy slope to perdition.

A melancholy picture! But is it true? The facts in the case of the Cretaceous Polyzoa are not disputed, but they can be interpreted as a reaction of the organism to the continued abundance of lime-salts in the sea-water. If a race became choked off with lime, this perhaps was because it could not keep pace with its environment. Instead of "irresistible momentum" from within we may speak of irresistible pressure from without. Dr. Lang has told us "that in their evolution the individual characters in a lineage are largely independent of one another." It is this independence, manifested in differing trends and differing rates of change, that originates genera and species. Did the evolution follow some inner impulse, along lines "predetermined and limited by innate causes," one would expect greater similarity, if not identity, of pattern and of *tempo*.

Many are the races which, seeking only ornament, have (say our historians) perished like Tarpeia beneath the weight of a less welcome gift: oysters, ammonites, hippurites, crinoids, and corals. But I see no reason to suppose that these creatures were ill-adapted to their environment—until the situation changed. This is but a special case of increase in size. In creatures of the land probably, and in creatures of the water certainly, size depends on the amount of food, including all body- and skeleton-building constituents. When food is plentiful larger animals have an advantage over smaller. Thus by natural selection the race increases in size until a balance is reached. Then a fall in the food-supply handicaps the larger creatures, which may become extinct. So simple an explanation renders it quite unnecessary to regard size as in itself indicating the old age of the race.

Among the structures that have been most frequently assigned to some blind growth-force are spines or horns, and when they assume a grotesque form or disproportionate size they are dismissed as evidences of senility. Let us take the case of certain spiny trilobites. Strange though these little monsters may be, I cannot, in view of their considerable abundance, believe that their specialisation was of no use. Such spines have their first origin in the tubercles which form so common an ornament in Crustacea and other Arthropods, and which serve to stiffen the carapace. A very slight projection of any of these tubercles further acts as a protection against such soft-bodied enemies as jelly-fish. Longer outgrowths enlarge the body of the tribolite in such a way as to prevent it being easily swallowed. When, as is often the case, the spines stretch over such organs as the eyes, their protective function is obvious. This becomes still more clear when we consider the relation of these spines to the body when rolled up, for then they are seen to form an encircling or enveloping *chevaux-de-frise*. But, besides this, the spines in many cases serve as balancers; they throw the centre of gravity back from the weighty head, and thus enable the creature to rise into a swimming posture. Further, by their friction they help to keep the animal suspended in still water with a comparatively slight motion of its numerous oar-like limbs. Regarded in

* Opening address of the President of Section C (Geology), delivered at the Cardiff Meeting of the British Association on August 24. Greatly abridged. Only the larger excisions are indicated by asterisks. Continued from p. 164.

this light, even the most extravagant spines lose their mystery and appear as consequences of natural selection.

The fact that many extreme developments are followed by the extinction of the race is due to the difficulty that any specialised organism or machine finds in adapting itself to new conditions. A highly specialised creature is one adapted to quite peculiar circumstances; very slight external change may put it out of harmony, especially if the change be sudden. It is not necessary to imagine any decline of vital force or exhaustion of potentiality.

What, then, is the meaning of "momentum" in evolution? Simply this: that change, whatever its cause, must be a change of something that already exists. The changes in evolving lineages are, as a rule, orderly and continuous. Environment changes slowly and the response of the organism always lags behind it, taking small heed of ephemeral variations. Suppose a change from shallow to deep water—either by sinking of the sea-floor or by migration of the organism. Creatures already capable of becoming acclimatised will be the majority of survivors, and among them those which change most rapidly will soon dominate. Place your successive forms in order, and you will get the appearance of momentum; but the reality is inertia yielding with more or less rapidity to an outer force.

* * *

But in all these apparent instances we should do well to realise that we are still incompletely informed about the daily life of these creatures and of their ancestors in all stages of growth, and we may remember that structures once adaptive often persist after the need has passed or has been replaced by one acting in a different direction.

The Study of Adaptive Form.

This leads us on to consider the influence of the mode of life on the shape of the creature, or, briefly, of function on form; and, conversely, the indications that form can give as to habits and habitat. For many a long year the relatively simple mechanics of the vertebrate skeleton have been studied by palæontologists and anatomists generally, and have been brought into discussions on the effect of use. These studies, however, have usually considered the structure of an animal as an isolated machine. We have to realise that an organism should be studied in relation to the whole of its environment, and here form comes in as distinct from structure. Similar adaptive forms are found in organisms of diverse structure, and produce those similarities which we know as "convergence." To take but one simple instance from the relations of organisms to gravity. A stalked Echinoderm naturally grows upright, like a flower, with radiate symmetry. But in the late Ordovician and in Silurian rocks are many in which the body has a curiously flattened leaf-like shape, in which the two faces are distinct but the two sides alike, and in which this effect is often enhanced by paired outgrowths corresponding in shape if not in structure. Expansion of this kind implies a position parallel to the earth's surface, *i.e.* at right angles to gravity. The leaf-like form and the balancers are adaptations to this unusual position. Recognition of this enables us to interpret the peculiar features of each genus, to separate the adaptive form from the modified structure, and to perceive that many genera outwardly similar are really of quite different origin.

Until we understand the principles governing these and other adaptations—irrespective of the systematic position of the creatures in which they appear—we cannot make adequate reconstructions of our fossils, we cannot draw correct inferences as to their mode of life, and we cannot distinguish the adaptive from the fundamental characters. No doubt many of us have long recognised the truth in a general way, and have attempted to describe our material—whether in stone or in alcohol—as living creatures; and not as isolated specimens, but as integral portions of a mobile world. It is, however, chiefly to Louis Dollo that we owe the suggestion and the example of approaching animals primarily from the side of the environment, and of studying adaptations as such. The analysis of adaptations in those cases where the stimulus can be recognised and correlated with its reaction (as in progression through different media or over different surfaces) affords sure ground for inferences concerning similar forms the life-conditions of which we are ignorant. But from such analyses there have been drawn wider conclusions pointing to further extension of the study. It was soon seen that adaptations did not come to perfection all at once, but that harmonisation was gradual, and that some species had progressed further than others. But it by no means follows that these represent chains of descent. The adaptations of all the organs must be considered and one seriation checked by another.

In applying these principles we are greatly helped by Dollo's thesis of the Irreversibility of Evolution. This is a simple statement of the facts as hitherto observed, and may be expressed thus:

(1) In the course of race-history an organism never returns exactly to its former state, even if placed in conditions of existence identical with those through which it has previously passed. Thus, if through adaptation to a new mode of life (as from walking to climbing) a race loses organs which were highly useful to it in the former state, then, if it ever reverts to that former mode of life (as from climbing to walking) those organs never return, but other organs are modified to take their place.

(2) But (continues the law), by virtue of the indestructibility of the past, the organism always preserves some trace of the intermediate stages. Thus, when a race reverts to its former state there remain the traces of those modifications which its organs underwent while it was pursuing another mode of existence.

The first statement imposes a veto on any speculations as to descent that involve the reappearance of a vanished structure. The second statement furnishes a guide to the mode of life of the immediate ancestors, and is applicable to living as well as to fossil forms. It is from such persistent adaptive characters that some have inferred the arboreal nature of our own ancestors, or even of the ancestors of all mammals.

The Study of Habitat.

The natural history of marine invertebrata is of particular interest to the geologist, but its study presents peculiar difficulties. The marine zoologist has long recognised that his early efforts with trawl and dredge threw little light on the depth in the sea frequented by his captures. The surface floaters, the swimmers of the middle and lower depths, and the crawlers on the bottom were confused in a single haul, and he has therefore devised means for exploring each region separately. The geologist, however, finds all these faunas mixed in a single deposit. He may even find with them the winged creatures of the air, as in the insect beds of Gurnet Bay, or the remains of estuarine and land animals.

The Upper Ordovician starfish bed of Girvan contains not only the crawling and wriggling creatures from which it takes its name, but also stalked echinoderms adapted to most varied modes of life, swimming and creeping trilobites, and, indeed, representatives of almost all marine levels.

In the study of such assemblages we have to distinguish between the places of birth, of life, of death, and of burial, since, though these may be all the same, they may also all be different. The echinoderms of the starfish bed further suggest that closer discrimination is needed between the diverse habitats of bottom forms. Some of these were, I believe, attached to seaweed; others grew up on stalks above the bottom; others clung to shells or stones; others lay on the top of the sea-floor; others were partly buried beneath its muddy sand; others may have grovelled beneath it, connected with the overlying water by passages. Here we shall be greatly helped by the investigations of C. G. J. Petersen and his fellow-workers of the Danish Biological Station. They have set an example of intensive study which needs to be followed elsewhere. By bringing up slabs of the actual bottom they have shown that, even in a small area, many diverse habitats, each with its peculiar fauna, may be found, one superimposed on the other. Thanks to Petersen and similar investigators, exact comparison can now take the place of ingenious speculation. And that this research is not merely fascinating in itself, but illuminatory of wider questions, follows from the consideration that analysis of faunas and their modes of life must be a necessary preliminary to the study of migrations and geographical distribution.

The Tempo of Evolution.

We have not yet done with the results that may flow from an analysis of adaptations. Among the many facts which, when considered from the side of animal structure alone, lead to transcendental theories with Greek names, there is the observation that the relative rate of evolution is very different in races living at the same time. Since their remains are found often side by side, it is assumed that they were subject to the same conditions, and that the differences of speed must be due to a difference of internal motive force. After what has just been said, you will at once detect the fallacy in this assumption. Prof. Abel has recently maintained that the varying *tempo* of evolution depends on the changes in outer conditions. He compares the evolution of whales, sirenians, and horses during the Tertiary epoch, and correlates it with the nature of the food.

* * *

Whether such changes of food or of other habits of life are, in a sense, spontaneous, or whether they are forced on the creatures by changes of climate and other conditions, makes no difference to the facts that the changes of form are a reaction to the stimuli of the outer world, and that the rate of evolution depends on those outer changes.

Whether we have to deal with similar changes of form taking place at different times or in different places, or with diverse changes affecting the same or similar stocks at the same time and place, we can see the possibility that all are adaptations to a changing environment. There is, then, reason for thinking that ignorance alone leads us to assume some inexplicable force urging the races this way or that, to so-called advance or to apparent degeneration, to life or to death.

The Rhythm of Life.

The comparison of the life of a lineage to that of an individual is, up to a point, true and illuminating; but when a lineage first starts on its independent course (which really means that some individuals of a pre-existing stock enter a new field), then I see no reason to predict that it will necessarily pass through periods of youth, maturity, and old age, that it will increase to an acme of numbers, of variety, or of specialisation, and then decline through a second childhood to ultimate extinction. Still less can we say that, as the individuals of a species have their allotted span of time, long or short, so the species or the lineage has its predestined term. The exceptions to those assertions are indeed recognised by the supporters of such views, and they are explained in terms of rejuvenescence, rhythmic cycles, or a grand despairing outburst before death. This phraseology is delightful as metaphor, and the conceptions have had their value in promoting search for confirmatory or contradictory evidence. But do they lead to any broad and fructifying principle? When one analyses them one is perpetually brought up against some transcendental assumption, some unknown entelechy that starts and controls the machine, but must for ever evade the methods of our science.

The facts of recurrence, of rhythm, of rise and fall, of marvellous efflorescences, of gradual decline, or of sudden disappearances, all are incontestable. But if we accept the intimate relation of organism and environment, we shall surmise that on a planet with such a geological history as ours, with its recurrence of similar physical changes, the phenomena of life must reflect the great rhythmic waves that have uplifted the mountains and lowered the deeps, no less than every smaller wave and ripple that has from age to age diversified and enlivened the face of our restless mother.

To correlate the succession of living forms with all these changes is the task of the palæontologist. To attempt it he will need the aid of every kind of biologist, every kind of geologist. But this attempt is not in its nature impossible, and each advance to the ultimate goal will, in the future as in the past, provide both geologist and biologist with new light on their particular problems. When the correlation shall have been completed, our geological systems and epochs will no longer be defined by gaps in our knowledge, but will be the true expression of the actual rhythm of evolution. Lyell's great postulate of the uniform action of Nature is still our guide, but we have ceased to confound uniformity with monotony. We return, though with a difference, to the conceptions of Cuvier, to those numerous and relatively sudden revolutions of the surface of the globe which have produced the corresponding dynasties in its succession of inhabitants.

The Future.

The work of a systematic palæontologist, especially of one dealing with rare and obscure fossils, often seems remote from the thought and practice of modern science. I have tried to show that it is not really so. But still it may appear to some to have no contact with the urgent problems of the world outside. That also is an error. Whether the views I have criticised or those I have supported are the correct ones is a matter of practical importance. If we are to accept the principle of predetermination or of blind growth-force, we must accept also a check on our efforts to improve breeds, including those of man, by any other means than crossings and elimination of unfit strains. In spite of all that we may do in this way, there remain those decadent races, whether of ostriches or human beings, which "await alike the inevitable hour." If, on the other hand, we adopt the view that the life-history of races is a response to their environment, then it follows, no doubt, that the past history of living creatures will have been determined by conditions outside their control, it follows that the idea of human progress as a biological law ceases to be tenable; but since man has the power of altering his environment and of adapting racial characters through conscious selection, it also follows that progress will not of necessity be followed by decadence; rather that, by aiming at a high mark, by deepening our knowledge of ourselves and of our world, and by controlling our energy and guiding our efforts in the light of that knowledge, we may prolong and hasten our ascent to ages and to heights as yet beyond prophetic vision.

International Catalogue of Scientific Literature.

AN international conference of delegates from scientific academies to consider the future of the International Catalogue of Scientific Literature was held last week by invitation of the Royal Society of London. Sir J. J. Thomson, president of the Royal Society, took the chair. The conference was attended by delegates from Denmark (Prof. Martin Knudsen), France (Prof. A. Lacroix), Holland (Prof. G. van Rijnberk), India (Sir H. H. Hayden and Dr. S. W. Kemp), Japan (Prof. H. Nagaoka), New Zealand (Prof. A. Dendy), Norway (Dr. Rolf Laache), Queensland (Sir Edw. Parrott), South Africa (Sir T. Muir), Sweden (Baron Alströmer), Switzerland (Dr. H. Escher, Dr. Marcel Godet, and Dr. H. H. Field), United States of America (Prof. L. E. Dickson, Mr. L. C. Gunnell, Dr. S. I. Franz, and Dr. Robert M. Yerkes), Victoria (Prof. E. W. Skeats), and Western Australia (Mr. G. B. Rushton). The Royal Society was represented by three of its officers (Sir J. J. Thomson, Sir David Prain, and Mr. J. H. Jeans), together with Prof. Henry E. Armstrong, Dr. F. A. Bather, Dr. P. Chalmers Mitchell, and Sir Arthur Schuster. The Italian delegates, having been delayed in the railway journey, were unfortunately not in time to take part in the proceedings.

The conference was called to consider whether any modifications in the present Catalogue are advisable and how the difficulties created by the war can best be overcome. It is well known that the Royal Society, in its "Catalogue of Scientific Papers," has undertaken to make an index of all books and papers on scientific subjects published during the nineteenth century. Sixteen quarto volumes of this important catalogue have already appeared. Four more volumes will probably be sufficient to complete the Author Catalogue for the period 1800–1900. A corresponding Subject Catalogue is also being published.

In view of the ever-increasing number of scientific publications, the Royal Society realised that it could not continue to index the scientific literature of the whole world, but that such an undertaking should be carried out by a division of labour, each country indexing its own literature, the several catalogues so prepared being sent to a central bureau in London, where they should be combined and published in annual volumes. The "International Catalogue of Scientific Literature" was the outcome. It undertook to index scientific literature published after January 1, 1901.

More than thirty countries joined in the scheme, each agreeing to index its own scientific literature upon cards which should be sent to London for incorporation in the printed volumes. Fourteen annual issues, each of seventeen volumes, have now been published indexing the scientific literature of 1901–14. It was found that the sales and subscriptions to the volumes very nearly covered the cost of production.

It might have been predicted that a work of this kind, requiring harmony between workers of so many nationalities, could not be carried out without international jealousy and friction. Such has not proved to be the case. The greatest goodwill has existed between the various regional bureaux in the different countries and the central bureau in London.

The outbreak of war interrupted the work by restricting intercourse between the nations. The finances of the catalogue have also suffered from the loss of subscriptions from Austria, Germany, Hungary, and Russia. At the same time the cost of printing and publishing has more than doubled. It was in these circumstances that the Royal Society convened last week's conference.

The delegates, while agreeing that it is essential that scientific literature should be fully indexed in order that the results of researches in every country might be made known quickly to all, entered into a full discussion as to how this indexing should be done, and passed in review the different agencies now engaged in such work.

They came to the conclusion that, even though a change be made in the future in the method of indexing, it is imperative to continue the International Catalogue of Scientific Literature in its present form until the literature published up to the end of the year 1915, and possibly also that up to the end of the present year 1920, has been catalogued. In this way the important scientific work carried out during the war period will become available for reference at an early date and continuity in the work of indexing be maintained. This recommendation of the conference will come before the council of the Royal Society at their October meeting, and we are confident that the council will wish to give effect to the proposal if sufficient funds can be obtained.

A considerable sum of money will be required. It is estimated that the rise in salaries, wages, paper, and everything connected with printing and publishing is so great that an annual issue of the International Catalogue will now cost about 17,000*l*. In addition to the annual expenses, working capital of considerable amount will be required. The sum mentioned at the conference was, we believe, 34,000*l*., this being the cost of two annual issues.

There is here an opportunity for someone to make a generous donation in aid of science. The Royal Society cannot be expected to provide the large sums now required out of its own resources. The society has already spent much money in the preparation of the Catalogue of Scientific Papers, and has lent 7500*l*. to the International Catalogue and made a further donation of 1100*l*. from its funds. Contributions from European countries are invited, but may prove difficult to obtain owing to the adverse rates of exchange. It would be a great misfortune if a work of this importance came to an end through lack of funds. We have here a league of nations engaged in making the results of scientific inquiry widely known; every effort should be made to help this league to live through what is evidently the critical period of its existence.

The question as to the future of the Catalogue after the completion of the twentieth issue was referred to a committee of the delegates for further consideration. Amongst other questions this committee will examine how far the work of the International Catalogue can be brought into relation with the many existing agencies for the publication of abstracts of scientific papers.

In addition to the abstracts prepared by many of the scientific societies and to those published in periodical collections dealing with special subjects, there are card catalogues such as that under the charge of Dr. H. H. Field, of Zurich. It was suggested at the conference that these should be taken into account in fixing the form which the International Catalogue should take in the future.

The immediate problem, then, is to secure the indexing of the scientific literature published during the war. While this is being done, arrangements can be made for the efficient continuation of the work of cataloguing the scientific literature of the world.

The International Congress of Mathematicians.

THIS congress was opened at Strasbourg University on September 22 by the Rector, M. S. Clarèty. The officers of the congress were then elected as follows:—*Honorary President:* M. Camille Jordan. *President:* M. Emile Picard. *Vice-Presidents:* Prof. Leonard Dickson, Sir Joseph Larmor, Prof. Nörlund, M. de la Vallée-Poussin, M. H. Villat, and M. Volterra. *Secretary:* M. Koenigs.

The delegates numbered 188 and represented 26 nations, amongst which may be mentioned Argentina (4), Australia (1), Brazil (1), Canada (1), Czecho-Slovakia (12), India (2), Japan (2), the Philippine Islands (1), Poland (4), Russia (1), and Serbia (2). The expenses of the congress, including the publishing of the proceedings, have been completely provided for. Of the sum required, 78,000 francs was contributed by public bodies, by industrial and commercial concerns, and by private persons. An interesting fact is that the French Government made its contribution of 10,000 francs through the Ministry of Foreign Affairs, thereby recognising, it would appear, that such a congress has a certain significance in international politics. The subscriptions of delegates produced a further sum of 12,000 francs.

On Thursday, September 23, a general lecture was given by Sir Joseph Larmor on "Questions in Physical Indetermination." Sir Joseph said that of the three physical deductions upon which the validity of Einstein's theory depended, the two which had been verified by experiment, namely, the motion of the perihelion of Mercury and the deflection of light-rays by the sun, could be made to result equally well from a theory involving an æther. But the third Einstein prediction, the displacement of solar spectral lines, was inconsistent with any æther theory. In his opinion, it would be found, when conclusive observations had been made, that the third prediction was not verified. The doctrine that the universe is completely "full" originated with Descartes. The same doctrine was held by Newton, Huygens, Faraday, Fresnel, and Maxwell, but as a much more precise conception. The vortex theory and the elastic solid æther theory had had their day, but there was no reason at present why we should not admit the existence of an æther—a new æther the properties of which were so different from those of ordinary matter that they could be expressed only in terms of non-Euclidean space. The alternative was complete abstraction, the absence of a basis on which to found our theories. The essence of Newtonian space, as enunciated in the works of Lie and Helmholtz, was the possibility of the existence of rigid bodies in motion. Newtonian space was the space of mechanics, for which $dx^2+dy^2+dz^2$ was invariant.

For Faraday and Maxwell, on the other hand, radiation was fundamental. The characteristic of Maxwellian space was *complete transmission.* A pulse travelled without change of form and without leaving anything behind—a principle that was in accord with experiments in light. This was the space of Minkowski, for which the corresponding invariant expression was $dx^2+dy^2+dz^2-c^2dt^2$.

As with Sir Joseph Larmor, so with most of the other contributors to the subject of relativity, the endeavour was directed towards the elimination of those paradoxes which the human mind finds it difficult to accept rather than towards the further development of the theory itself. Thus M. Guillaume, setting forth from the remark that in the theory of relativity we were dealing with the apparent positions of bodies and that the difficulties of the theory arose from the fact that their "real" positions were supposed unknown, offered an alternative analysis in which the initial "real" positions of bodies were supposed known. He obtained results in which some of the paradoxes disappeared. M. Guillaume stated, however, that he had been in correspondence with Prof. Einstein, and had not been able to bring about a reconciliation of the two points of view.

The second general lecture, on "Relations between the Theory of Numbers and other Branches of Mathematics," was delivered on Friday, September 24, by Prof. Leonard Dickson, of Chicago. Prof. Dickson showed how the problem of obtaining rational solutions of certain classes of homogeneous equations was connected with the known properties of certain surfaces and with the theory of hypercomplex numbers.

In a lecture on the teaching of mathematical physics M. Volterra said that what might be called "analytical physics" now constituted an integral whole. Newton had reduced the problem of the universe to a problem in ballistics, and upon this basis Lagrange had founded his analytical mechanics. In a similar way the constitution of matter was for the modern physicist a problem in electricity, and we awaited a new Lagrange. At the present time there were two distinct methods of teaching mathematical physics in universities. The first might be called the *monographical* method. The student followed in succession separate courses in hydrodynamics, optics, and so on. The weakness of this method was that there was no grasp of the subject as a whole. In the other method the student started with a course of mathematical analysis, and, so equipped, he proceeded to the various branches. The fault here was that in the first part of the course he was working without seeing his objective; he did not understand the purpose of his work or see its special difficulties. The course that M. Volterra advocated consisted of three parts. The first, on more or less historical lines, carried the student as far as the general equations. The second part was a discussion of those equations, including a classification of them according to their characteristics and a classification of the problems according to the methods of solution. The third part was the solution and discussion of specific problems. This scheme left for separate treatment those portions of analytical physics which depended upon the calculus of probability, as well as thermodynamics and some minor branches.

M. de la Vallée-Poussin in his lecture, "Sur les fonctions à variation bornée et les questions qui s'y rattachent," dealt with the fundamental theory of integration in the light of Baire's classification of functions. All classes of functions (Baire) are integrable in the sense of Lebesgue. Stieltjes's integral

$$\int_a^b f(x)d\alpha(x)$$

can be defined by the process of Lebesgue, and it exists for all Baire functions f. The functional $U(f)$ (Fréchet and Volterra), which has an assigned value for each of the elements f of a set, can be transformed into a Stieltjes integral. By making use of the univocal correspondence, established by Peano, between the points interior to a rectangle and the points on a segment of a line, functionals depending upon two arbitrary functions can also be reduced to simple Stieltjes integrals.

The subject of the fifth lecture, which was given by Prof. Nörlund, of Copenhagen, was "Les équations aux différences finies." The lecturer gave a very complete discussion of the solutions of equations of the types

$$\tfrac{1}{2}\{\phi(x+\omega)+\phi(x)\}=f(x), \quad \tfrac{1}{\omega}\{\phi(x+\omega)-\phi(x)\}=g(x).$$

In an interesting communication Prof. W. H. Young proposed a new definition, which does not involve an approximation by means of tetrahedra, for the area of a curved surface. The proposal is, first, to define the "area of a curve" as the square root of the sum of the squares of three integrals of the form

$$\int ydz - zdy.$$

Then, the surface being determined by the equations

$$x=f_1(u, v), \qquad y=f_2(u, v), \qquad z=f_3(u, v),$$

suppose the domain of u, v to be divided up into elementary rectangles in the u, v plane. The area of the surface is the limit of the sum of the areas of the corresponding elementary curves.

Prof. Weiss, the director of the Strasbourg Institute of Physics, gave an account of the methods of sound-ranging in use in the French Army during the war. The method normally employed was the same as that in use in the British Army. A useful alternative was the method *à courtes bases,* in which six or more microphones were placed in pairs. The microphones of each pair were about a hundred metres apart, so that the gun locus became a straight line (asymptote), and at once gave the direction of the hostile gun. The installation was very simple, and could be made in an hour, while single sets of observations could be reduced and reported in a minute. This method was used, not for the accurate location of gun emplacements, but for determining quickly which one of the known hostile batteries was in action. Guns were also successfully located by observations of the *onde de choque.* The normals to this wave-surface determine a caustic which is nearly constant in form for high-velocity shells. To locate the gun emplacement, a standard caustic drawn on tracing-paper was fitted by trial to the normals determined by the instruments. This method was used when atmospheric conditions made the spherical wave imperceptible, and, although less accurate, it gave very good results. A case was quoted where 80 per cent. of the hostile emplacements were correctly located solely by *ondes de choque.*

In the course of the congress receptions were held by the Committee of Organisation, the Société des Amis de l'Université de Strasbourg, the Mayor of Strasbourg, and the Commissaire Général (M. Alapetite).

At a concert organised by the Société des Sciences du Bas-Rhin, the delegates had the pleasure of hearing *'s Elsasslied* sung by the mixed choir of the Concordia-Argentina Choral Society. The delegates were entertained at the conclusion of the proceedings at a banquet given by the Organising Committee.

The invitation conveyed by Prof. Leonard Dickson to hold the next congress in New York in 1924 was accepted, and a further invitation was received to hold the congress of 1928 in Belgium. H. B. H.

Disorders of Symbolic Thinking.

DISCUSSION AT THE CONGRESS OF PHILOSOPHY AT OXFORD.

SEVERAL subjects of direct scientific interest were discussed at the Congress of Philosophy held at Oxford on September 24–27. One of the greatest importance, because based on recent clinical and experimental research, was the discussion introduced by Dr. Henry Head in a paper entitled "Disorders of Symbolic Thinking due to Local Lesions of the Brain." It raised the whole problem of the relation of language to thought while concentrating attention on the significance of certain definite observations—cases of young men who had received cerebral injuries in the war—in which the injury to the brain had affected the power of articulation.

Dr. R. Mourgue, of l'Asile de Villejuif, also contributed a paper, and was announced to take part in the discussion. He was unable to be present, however, and his place was taken by Prof. Bergson.

Dr. Head said that his general conclusion from the cases he had studied experimentally, where gross destruction of brain-tissue had resulted in loss of speech, was that there always remained elements in thought which were not associated with words. Speech is a discriminative movement capable of fine degrees of adjustment, essentially an intellectual mechanism. Even in the gravest cases of aphasia the patient is evidently fully aware of his emotions, and can express them clearly in gesture and action. Under the influence of emotion he may even use words or phrases which he is quite impotent to evoke voluntarily. Speech can be disturbed, or even totally lost, without reducing the patient's intellectual capacity or of necessity producing grave intellectual defect. All the early work of investigation of aphasia had been vitiated by the conception that speech was a well-defined intellectual function, strictly localised in some particular site in the brain. Attention was concentrated, therefore, on correlating the extent of anatomical destruction on this site with the character of the disorder of speech. The fundamental error at the root of all this work is its ignoring of the physiological changes which intervene between the anatomical lesion and the psychical states with which it is associated. Destruction of the substance of the brain disturbs the act of speech only because it interferes with the physiological processes necessary for its perfect execution.

Dr. Head then described the nature of his experiments and the means he had devised to discover the physiological processes with which the particular injuries had interfered. In the older theories auditory images were supposed to be responsible for "memories" of words, and these were said to be stored up in certain areas of the cortex. The hypothesis is entirely unable to explain the phenomena of aphasia. Patients who cannot name consecutively a series of objects in front of them can choose them correctly when the name is given either orally or in print. It is the name, not the auditory image, which is lacking. The loss of the power to use words is not due to a destruction of images.

What, then, Dr. Head asked, are the functions which are disturbed in aphasia? The true answer had been given so long ago as 1868 by Hughlings Jackson, though its significance was not then seen. The chief mental activity disturbed by unilateral lesions of the brain was declared to be the use of words in propositions. The loss of function in aphasia might therefore be indicated as that of "propositionising." But though this term suggests a conception which covers the larger number of facts, it does not comprise every aspect of the loss of function. Dr. Head suggested, therefore, that these functions should be spoken of as "symbolic thinking and expression," though even this phrase does not quite satisfactorily define the group of processes affected. It is not all symbolic representations, but symbols used in a particular manner which suffer in these disorders. There are four fairly well marked groups of functions into which he now proposed to divide "symbolic thinking and expression" on the ground that they are dissociated in different ways under the influence of organic injury. These are (1) verbal defects, (2) syntactical defects, (3) nominal defects, and (4) semantic defects.

Dr. Mourgue's contribution was in no sense opposed to Dr. Head's conclusions. It dealt with a rather different aspect of the case, and seemed indeed to supplement the general theory in a remarkable way. Dr. Mourgue had given particular attention to some characteristic cases of aphasia in which the sufferers were themselves skilled in the treatment of the disorder and able on recovery to record and analyse their experience. The particular cases cited were the autodiagnosis of Dr. Saloz and Prof. Forel, and also a case recorded by van Woerkem. In all these cases the speechlessness of the aphasic state was comparable with the kind of indistinctness of psychical elements often experienced in the dream state. There was complete preservation of intuitive thought, but absence of imagery, or at least of verbal imagery. The will is unaffected, and may even show exaltation, but there is an absence of discrimination and differentiation—characters which, from a somewhat different point of view, Prof. Bergson has described as essentially belonging to intelligence.

Prof. Bergson said that the communication which Dr. Head had presented constituted a complete rejection of the theory of aphasia which for a long time had been classic. It offered in its place the quite new theory that aphasia was the disorder of a special faculty of symbolising, which might be said to be a certain aspect of intelligence. The classical theory of aphasia might be described as a complete metaphysic. So long ago as the years 1892 and 1893 he had himself been led by a question of pure metaphysics to study the relation of mind and body. He found that philosophers had given us only very vague ideas on this subject, and he determined, therefore, to study the facts of the relation without any philosophical presuppositions. It was extraordinarily ambitious, for he had no technical scientific equipment. Gradually, however, the problem of the relation of mind and body transformed and narrowed itself into the problem of the relation of memory to the brain, then of the memory of words, and then of the meaning of words. Surprise followed surprise. The theory of Broca then held the field, complicated by the work of Kussmann and Lichtheim. Nerves converge on nervous centres, there are strange communications between the centres, the path from A to B is not the same as the path from B to A, and every theory called for some new theories to explain each particular case studied. He appealed to his neurologist and psychologist friends, but he was ill-received; and when some years later he attacked their theories in his book he was looked on with pity. He was not surprised, therefore, when Prof. Pierre Marie gave the results of his anatomical researches, based on Broca's work, and, indeed, on a restudy of the actual brain which Broca had dissected. Long before this, psychology had itself shown the old theory to be impossible. The theory had, in fact, broken down before a psychology of common sense which called for scarcely any effort of introspection. A perception, in fact, is already memory, for a perception has duration. A part of the perception is memory, therefore, even while the perception still remains. Where does perception begin to be past? All the hypotheses were contradicted by simple self-observation. Prof. Pierre Marie proceeded to demonstrate a new theory of aphasia. He reduced it to two things: (1) A certain disorder of articulation which he named *anarthrie*, and (2) a certain enfeeblement of intelligence.

Prof. Bergson then referred to his own studies of aphasia. What had struck him most forcibly in the records of a great number of cases was a certain powerlessness in the patient to analyse or decompose his perception. Deafness to words was a concomitant symptom rather than a distinct factor. There were cases where persons after complete recovery and restoration had described their experience by saying that they heard perfectly well, but seemed to be listening to a continuous sonorous blur. One of Charcot's patients could hear the clock strike quite well, but could not distinguish the strokes. In verbal blindness, another form of aphasia, it is very remarkable to observe in some of the cases the difficulty the person has to decompose and analyse his perception. He will want, for example, to write a letter of the alphabet, and may succeed, but he will begin where he would not ordinarily begin; he is seen to lack the sense of the organisation of the letter, and when he produces it he has not synthetically constructed it. When we listen to persons speaking a foreign language we are in the condition of some of these aphasics. We hear perfectly, but we cannot repeat the whole of the sounds; they appear to us crushed, as it were, into a formless mass without bones or joints, a sonorous continuity. He had himself, following another line of investigation, been led to attribute capital importance to nascent movements, tendencies, and outlined actions—movements sketched, as it were, and not carried out. An idea is a grouping together of virtual actions. The continuity of thought is simply a continuity of attitudes and of virtual movements not executed, sometimes scarcely delineated. The brain, and in particular the cerebral cortex, indicates an enormous number of initiated actions. Instead of considering the spinal cord as a diminished brain, we ought to think of the brain as a completed spinal cord. Coming back to the special case of aphasia, he asked himself whether, in order to understand speech, we had not got to undertake a work of disintegration of the movements of articulation, neither completely voluntary nor completely automatic. There are certain beginnings of movements which are not carried out. They are partly automatic, partly voluntary, for our mind projects our actions in advance of their accomplishment.

Prof. Bergson concluded by expressing his profound admiration of Dr. Head's researches on the question of aphasia; they appeared to him of capital importance for psychology, and even for metaphysics.

University and Educational Intelligence.

BIRMINGHAM.—An appeal is being issued for 500,000*l.* in aid of the funds of the University. The finances are in a critical condition; there is a debt of 130,000*l.*, which absorbs at present 8000*l.* per annum, necessary extensions of building have had to be made, the staff is deplorably underpaid, and the entry of new students is a heavy one. In spite of the 25 per cent. increase in the fees of new students, these fees will still represent only about 30 per cent. of the cost of providing the instruction, so that the greater the entry the greater the need for money.

This session the working of the faculty of science will be rearranged, much of the work previously done by the meetings of faculty being delegated to Boards of Studies. The latter consist of professors and selected members of the non-professorial staff, and the following boards have been constituted: Mathematics, physics, chemistry, engineering, and biology. It is hoped that the new arrangement will do something towards relieving the congestion of business in the faculty, which has recently been serious. The boards will report to the faculty.

CAMBRIDGE.—Dr. Ff. Roberts, Clare College, has been appointed junior demonstrator in physiology, and Mr. T. R. Parsons, Sidney Sussex College, additional demonstrator in physiology.

The Vice-Chancellor has announced a very generous gift of 25,000*l.* from Sir Dorabji Tata, Gonville and Caius College, towards the expense of new buildings for the engineering school. A further anonymous gift of 2000*l.* has also been received. Part of the new buildings are already very nearly complete. Amongst the large entry this year are to be found fifty officers of the Royal Engineers and a small number of officers from the Royal Air Force and the Corps of Signals—a welcome connection between the Services and the scientific side of the University. The number of naval officers in residence has been reduced owing to the heavy pressure on the accommodation. The question of the admission of women to the University comes up for discussion in the Senate House on Thursday, October 14.

DR. JAMES G. GRAY, lecturer in physics at the University of Glasgow, has been appointed to the newly established Cargill chair of applied physics in the University.

THE *Times* announces that Mr. T. D. Owen, a leading Welsh metallurgist, has given 10,000*l.* to the University College of North Wales for the foundation of a chair in his name of electrical engineering and hydro-electrics.

DR. J. NEWTON FRIEND, hitherto headmaster of the Science and Technical School, Victoria Institute, Worcester, has succeeded Dr. T. Slater Price as head of the chemistry department of the Birmingham Municipal Technical School.

DR. MARION B. RICHARDS, of the chemistry department of Aberdeen University, has been appointed assistant to Dr. R. H. A. Plimmer, head of the biochemical department of the Rowatt Research Institute in Animal Nutrition, Aberdeen.

IT is announced by the *Times* that Prof. A. B. Macallum, professor of biochemistry in the University of Toronto, and administrative chairman, honorary Advisory Council for Scientific and Industrial Research of Canada, has accepted the new chair of biochemistry at McGill University.

DR. C. DA FANO will begin a special course of eight lectures on "The Histology of the Nervous System" in the physiology lecture theatre of King's College, University of London, on Wednesday, October 13, at 4.30 p.m. The course is free to all students of London colleges and to medical men and others on presentation of their visiting-cards.

AT a meeting of the Old Students' Association of the Royal College of Science to be held on Tuesday next, October 12, at the Imperial College Union, Prince Consort Road, South Kensington, London, S.W.7, Mr. J. W. Williamson will deliver an address entitled "The Proposed University of Science and Technology: Can a Useful and Worthy University be Based on Pure and Applied Science?" The chair will be taken at 8 p.m. by the president of the association, Sir Richard Gregory.

IN connection with the University Extension Board of the University of London, Prof. John Cox will commence on October 8, at 7.30 p.m., an interesting course of lectures on "The Bases and Frontiers of Physical Science" at Gresham College, Basinghall Street, E.C.2. The first part of the courses will be devoted to a review on the broadest possible lines of the concepts and laws of Nature on which traditional physics has been built up. The later lectures will deal with Einstein's views and the principle of relativity. Admission to the first lecture is free.

Societies and Academies.

PARIS.

Academy of Sciences, September 13.—M. Léon Guignard in the chair.—F. E. **Fournier**: The apparent displacement of some stars in the total eclipse of the sun of May 29, 1919.—A. **Blondel**: The calculation of electric cables by the use of vectorial functions with real notation. The method described has the same advantages as when imaginary quantities are employed, but only real quantities are utilised in the demonstration. It is based on the introduction of vectorial series.—V. **Smirnoff**: Some points of the theory of linear differential equations of the second order and automorphic functions.—E. **Jouguet**: The velocity of waves in elastic solids.—C. **Camichel**: The transmission of energy by the vibrations of water in pipes. Remarks on some recent publications of M. Constantinescu, and a statement of the work done by the author on the same subject.—E. **Canals**: The estimation of calcium and magnesium in different saline media. A study of the conditions under which, in acetic acid solutions, it is possible to separate completely calcium and magnesium from salts of iron and aluminium.—G. **Zeil**: The *rôle* of building corals in lithospheric re-adjustments.—C. **Störmer**: Some rays of aurora observed on March 22, 1920, which reached a height of 500 km. The aurora borealis of March 22 was photographed from seven stations under favourable conditions. The stations were connected by telephone, and simultaneous photographs were taken from two or three stations at a time. About 620 photographs were obtained, and they show that the summits of some of the rays reached an altitude of 500 km. above the earth.—A. **Chevalier**: The origin of the cider apple-trees cultivated in Normandy and Brittany.—F. **Vlès**: The spectral properties of the tetanus toxin. Spectrophotometric studies of the ultra-violet absorption spectra of the effects of heating and of the addition of antitoxin to solutions of the tetanus toxin.—A. **Marie** and L. **MacAuliffe**: The influence of life in Paris on the race. A study of 1509 Parisians of the poorer classes, 850 of whom were born of provincial parents, 294 of Parisian parents, and the remainder of one Parisian and one provincial parent. The Paris climate and town life lead to modifications which are thus summarised: The hair and eyes less pigmented than in the rest of France, more marked cranial development in proportion to height, and shortening of the limbs.—J. L. **Dantan**: Budding in *Antipathella subpinnata* and *Parantipathes larix.*

HOBART.

Royal Society of Tasmania, August.—His Excellency Sir W. L. Allardyce, president, in the chair.—H. H. **Scott** and C **Lord**: *Nototherium Mitchelli.* Its evolutionary trend: the skull and such structures as related to the nasal horn. In their third paper on the

Smithton discovery the authors deal with a mass of data relating to the evolutionary trend of the Nototheria and the structure of the skull. They also deal with a reclassification of the genus. The Nototheria are a group of animals that in Tasmania became extinct late in Pleistocene times. They were generalised, and yet in part specialised. They retained the racial characteristics that can be relegated to five geological periods—that is, from the pre-Eocene to the latest Pleistocene. They show similar developments to those of the perissodactyl ungulates, and, without leaving a single modern representative to carry on their race in totality, they left many characters scattered through their marsupial allies, the kangaroos, wombats, and native bears, which still grace our woodlands to-day. In dealing with the taxonomic data relating to the skull the authors recognise two well-marked groups, namely: Group i., Megacerathine, and group ii., Leptocerathine.—H. T. **Parker**: Mental efficiency. A study of the results obtained by testing children by the Binet-Simon scale.

Books Received.

The Cactaceæ: Descriptions and Illustrations of Plants of the Cactus Family. By N. L. Britton and J. N. Rose. Vol. ii. Pp. vii+239+xl plates. (Publication No. 248.) (Washington: Carnegie Institution.)

Geometrical Investigation of the Formation of Images in Optical Instruments. Embodying the Results of Scientific Researches Conducted in German Optical Workshops. Edited by M. von Rohr. (Forming vol. i. of "The Theory of Optical Instruments.") Translated by R. Kanthack. Pp. xxiii+612. (London: H.M. Stationery Office.) 2*l.* 5*s.* net.

Technical Handbook of Oils, Fats, and Waxes. By P. J. Fryer and F. E. Weston. Vol. i.: Chemical and General. Third edition. Pp. xii+280+xxxvi plates. (Cambridge: At the University Press.) 15*s.* net.

Commonwealth of Australia. Papua. Annual Report for the Year 1918–19. Pp. 119. (London: Australia House, Strand.)

The Human Atmosphere (The Aura). By W. J. Kilner. Pp. vii+300. (London: Kegan Paul and Co., Ltd.) 10*s.* 6*d.* net.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College and Papers in Elementary Engineering for Naval Cadetships and Royal Air Force. November, 1919, and July, 1920. Edited by R. M. Milne. Pp. 34. (London: Macmillan and Co., Ltd.) 1*s.* 9*d.* net.

Diary of Societies.

THURSDAY, OCTOBER 7

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major-General Sir F. H. Sykes: Civil Aviation.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: The Handwriting of the Future.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—The President: Spoon-shaped Depressed Birth Fracture of the Frontal Bone treated by Elevation.—Dr. M. Kerr: (1) The Surgery of the Uterus Bicornis Unicollis, with a case of Resection of the Uterus followed by two Normal Pregnancies; (2) The Intra-vesical Repair of Inaccessible Vesico-vaginal Fistula.—Dr. A. J. McNair: A Case of Placenta Prævia with Vasa Prævia.—H. Briggs: (Presidential Address), The Female Pelvic Floor. (Neurology Section), at 8.45.—Dr. H. Head: (Hughlings Jackson Lecture), A New Conception of Aphasia.

FRIDAY, OCTOBER 8.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Z. Cope: The Clinical Significance of Shoulder-pain in Upper Abdominal Lesions.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—R. A. Malby: A Miniature Alpine Garden.

MONDAY, OCTOBER 11.

BIOCHEMICAL SOCIETY (at King's College), at 5.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Wing-Commander Martin Flack: Medical Requirements for Air Navigation.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.—Annual General Meeting. At 8.30.—Sir William Hale-White: (Presidential Address), Then and Now.

TUESDAY, OCTOBER 12.

SOCIETY FOR THE STUDY OF INEBRIETY (at Medical Society of London), at 4.—Dr. J. A. Davidson, and others: Discussion on Special Clinics for Inebriates.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—(Annual Traill Taylor Memorial lecture), Prof. A. E. Conrady: The Present State of Photographic Optics.

WEDNESDAY, OCTOBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Sir Henry Fowler: Presidential Address.

HUNTERIAN SOCIETY (at Sion College), at 9.—Sir George Newman: The Ministry of Health as an Instrument in Preventive Medicine.

THURSDAY, OCTOBER 14.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—H. A. Hughes and P. F. Everitt: The Field of View of a Galilean Telescope.—B. K. Johnson: The Calibration of the Divided Circle of a Large Spectrometer.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. E. S. Reynolds: (Presidential Address), The Causes of Nervous Disease.

FRIDAY, OCTOBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: An Evening in Lakeland.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—S. Gilbert Scott: Presidential Address.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.30.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4.

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