THURSDAY, MAY 4, 1911.

THE GOLDEN BOUGH.

The Golden Bough: a Study in Magic and Religion. By Prof. J. G. Frazer. Third edition. Part i. (in two vols.), The Magic Art and the Evolution of Kings. Vol i., pp. xxxii+426. Vol ii., pp. xi+417. (London: Macmillan and Co., Ltd., 1911.) Price 20*s*. net, two vols.

THE third edition of Prof. Frazer's book will be in six parts, comprising at least seven volumes. As the subject of "the dying god," to which the last four parts will be devoted, has proved, in the author's words, to be "a fruitful subject," the number of volumes will probably reach a total of nine. The two volumes of the first part, which lie before us, contain more than eight hundred pages of octavo.

In its new form of "a series of separate dissertations loosely linked together by a slender thread of connection" with the original subject (to which the book owes its title), it has been resolved into its elements. But the result is that we have a closer study of each element, while the whole inquiry actually gains in organic unity. Thus in the two volumes of the first part, dealing with "The Magic Art, and the Evolution of Kings," the space devoted to these subjects in the second edition is more than doubled, but we have a fuller analysis of each on one hand, and on the other we gain a clearer notion of the passage from magical control of the forces of nature to the system of Departmental Gods.

This first part presents no striking newness of theory as did the second edition. The author has been credited with a proneness to hypothesis to which actually he is not liable. There are few writers who are more content to be led by the facts. But interesting subjects which before were incidentally treated are now more or less exhaustively studied. Such are "The Sacred Marriage," or "The Marriage of the Gods," "The King's Fire," "The Fire Drill," "Father Jove and Mother Vesta," and "The Origin of Perpetual Fires." The latter group was the subject of one of the author's earliest papers, printed in *The Journal of Philology,* in which, among other results, he exposed the unscientific character of the orthodox German school of mythological inquiry.

Some new terms are introduced. Magic is divided into homœopathic and contagious. The former "commits the mistake of assuming that things which resemble each other are the same"; the latter assumes "that things which have once been in contact with each other are always in contact." The latter, again, generally involves an application of the former. The older term, imitative, obscured the mechanical nature of sympathetic magic, but the above description seems to show that the new terms are far from satisfactory. The former suggests to the ordinary student a theory of medicine, the latter a theory of disease; and thus a wrong impression of the nature and application of magic may be conveyed. There is also a good deal more to be said on the origin and meaning of these primitive forms of the inductive methods, than is given either by the author or by Mr. Hirn, to whom is due the term homœopathic. In fact, there is a fruitful field here awaiting the psychologist. The methods of primitive thought, adequately analysed, would throw light on much that is obscure in the evolution of logic and the elementary processes of mind.

After all the details recounted so minutely and illustrated so clearly by Prof. Frazer, one still does not really understand either the meaning or mental process of the savage principle that "things which have once been in contact with each other are always in contact." No academic principle of association of ideas will help us here, nor even the author's happy comparison with modern physical theory, "the impulse being transmitted from one to the other" (of two things in magical rapport)

> "by means of what we may conceive as a kind of invisible ether, not unlike that which is postulated by modern science for a precisely similar purpose, namely, to explain how things can physically affect each other through a space which appears to be empty."

The savage does not so think, and Prof. Frazer does not suggest that he does so think, of the matter of "secret sympathy." Is it not more probable, for example, that a solution of the problem will begin with the obvious fact that in these matters the elemental intelligence simply ignores the categories of space and time?

Under magic is included an interesting suggestion as to the origin of circumcision, originally put forth by the author in *The Independent Review.* The suggestion is that the mutilation was

> "originally intended to ensure the re-birth at some future time of the circumcised man by disposing of the severed portion of his body in such a way as to provide him with a stock of energy on which his disembodied spirit could draw when the critical moment of reincarnation came round."

The question raised is applicable generally to the method of "The Golden Bough," and the author's other work in the explanation of origins. The point is not whether barbarous or civilised men can or do continue to practise such operations as painful mutilation because of a superstitious fancy or religious dogma—that is abundantly proved in human history. The point is, Did primitive men, not far removed from *Homo alalus, institute* such mutilations for so slender and so unpractical a reason? Any *a priori* discussion of the point must take into account the fact that such rites are always organised by the old men, and also the possibility that they were instituted at a stage of culture very little less advanced than that in which we see them now.

In an analogous problem, Prof. Frazer observes:—

> "While I have shown reason to think that in many communities sacred kings have been developed out of magicians, I am far from supposing that this has been universally true. The causes which have determined the establishment of monarchy have no doubt varied greatly in different countries and at different times."

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It is difficult to imagine *any* kingship at any period or in any country being originally instituted for any other reason than the practical need of a *leader*. Facts, however, show that other reasons, of superstition, have actually operated.

"Writers," says the author, "on the origin of political institutions . . . have not laid their account sufficiently with the enormous influence which superstition has exerted in shaping the human past."

Of course, the solution of the difficulty is that, when superstition creates a monarchy, it *does create a leader*, whose power is no less real because it is merely magical. Once more, we may note that such questions invite the attention of the psychologist, in this case the student of the mind of society rather than of the individual.

This new edition is, as we have hinted, something more than a mere enlargement. It is a new book, or a series of books; yet it is the same "Golden Bough." The reader will find it full of good things, new and old. He will also realise that "The Golden Bough" is a great book, one of the great books of our time. As such, it has a character and an aim. It is extraordinarily simple, hence its powerful appeal. Every fact is presented, as it might be by a demonstrator, completely, minutely, and luminously; but each fact is a human document. The aim of the book has, perhaps, grown with its growth; the author's words, cited above, may describe it:—To show "the enormous influence which superstition has exerted in shaping the human past." There is, indeed, no better introduction to the social and political history of the world than "The Golden Bough"; it is a book every statesman should be acquainted with, for it enables us to understand something of the workings of the mind of man in the mass, not only when it leads us from early savagery to the great world-religions which still exercise a profound influence on man's fate, but also when it deals with politics. Men in the mass are nothing if not superstitious, whether the superstition be a religious dogma or a political principle. It is not too much to say that this book, now in its majority—the first edition was published in 1890—has already helped the world towards a scientific view of nature and of man, the lack of which has made history a panorama of atrocity and error.

A. E. Crawley.

AN INDIAN FOREST FLORA.

A Forest Flora of Chota Nagpur, including Gangpur and the Santal-Parganahs: a Description of all the Indigenous Trees, Shrubs, and Climbers, the Principal Economic Herbs, and the most commonly cultivated Trees and Shrubs. By H. H. Haines. Pp. vii+634+xxxvii. (Calcutta: Superintendent of Government Printing, India, 1910.)

THE author of this work, who has served largely and travelled extensively in the region with which it deals, and has studied its vegetation long and carefully, ought to be well qualified to give a satisfactory account of its flora. That area constitutes the north-eastern portion of the highland region of Central India, which forms part of the province of Bengal. It includes the administrative division of Chota Nagpur with the tributary State of Gangpur in its south-western border, and one other district—the Santal-Parganahs to the north-east—which belongs to the Bhagalpur division. This district, though an outlying one from the point of view of the administrator, is topographically and botanically an integral part of the upland tracts to the west of the Lower and to the south of the Upper Gangetic Plain. Its annexation is therefore fully justified on scientific grounds, and, as the work is prepared primarily with reference to forest requirements, has the practical advantage of enabling the author to deal with all the western forest subdivisions of Bengal.

In his treatment of the task before him the author does not disappoint us. The concise and well-arranged introductory remarks show that he is intimately acquainted with his country, and fully appreciates the factors which have determined the character of its vegetation. One only regrets that departmental exigencies have debarred him from dealing with those elements which fall outside the category of "economic" plants, and from giving us the complete review of the flora which he is so clearly competent to provide.

The technical portion of the work affords constantly recurring evidence of careful and independent study, and demonstrates that it is in no sense a compilation. Where his field observation of critical species has led him to adopt individual views, these are stated with judgment and caution. There are doubtless cases in which those with material from more extended areas before them may not be able to accept the author's conclusions; even so, the close study on which these conclusions have been based will still be fully appreciated. We may doubt, more particularly, whether the author has done well in departing from the sequence of the natural families observed in most standard Indian floras. No serial presentation of natural units can be wholly satisfactory, and the question is not as to whether the sequence adopted by the author be an improvement on the sequence it replaces, but whether the adoption of an improved sequence, in a work of "local" scope, can compensate for the inconvenience which results when that work has to be consulted simultaneously with another treatise of a more "general" nature.

The characters given for the species, if few and briefly stated, are well selected and clearly expressed. The economic notes and the local names, which are added when possible, increase the practical value of the work; this is further enhanced by the addition of an excellent map. This map, prepared by the Forest Survey, and published by the Survey of India, is worthy of these two State departments, but the appearance of the book itself is unattractive and disappointing. In spite of this drawback, however, our author's flora cannot fail to prove a useful companion to those resident in the area with which it deals, who may be interested in its vegetation.

ORDERS OF INFINITY.

Orders of Infinity: the "Infinitärcalcül" of Paul du Bois-Reymond. By G. H. Hardy, F.R.S. Pp. iv+62. (Cambridge: University Press, 1910.) Price 2s. 6d. net.

THE subject of this tract has been hitherto inaccessible to English readers, and it is not altogether easy to give a brief account of its contents. Perhaps the simplest method is to start from the familiar facts that $\log x$ and e^x both tend to infinity with x, but in very different ways, namely, $(\log x)/x^\delta$ tends to zero, however small δ may be, and e^x/x^Δ tends to infinity, however large Δ may be (it is understood that δ, Δ do not vary with x). These results would be expressed in du Bois-Reymond's notation by the symbols

$$\log x \prec x^\delta \text{ and } e^x \succ x^\Delta;$$

in addition to these two symbols, du Bois-Reymond used another to imply that the ratio of two functions f, ϕ lies between finite limits (when x tends to infinity). But later writers have found it convenient to make the notation rather more precise, and to write

$$f \asymp \phi$$

to imply the relation just mentioned, and further to use $f \sim \phi$ to imply that $\lim (f/\phi) = 1$; there are also other sub-cases for which reference must be made to Mr. Hardy's tract.

The ideas mentioned above lead very naturally to the *logarithmic scale of infinity*, represented by the sequence of functions

$$\ldots, l_3x, l_2x, l_1x, x, e_1x, e_2x, e_3x, \ldots$$

where

$$l_nx = \log (l_{n-1}x), \ l_1x = \log x,$$

and

$$e_nx = \quad (e_{n-1}x), \ e_1x = e^x.$$

This scale has the property that any element tends to infinity more slowly than any positive power δ of the following element, and more rapidly than any positive power Δ of the preceding element; and it is possible to utilise the scale to classify all ordinary functions of analysis. Mr. Hardy has considered (pp. 16–36) the question as to what more or less artificial functions do and do not fall into place in the scale; we must content ourselves with mentioning the comparatively simple function $\Sigma x^\nu/\nu!$ obtained by selecting certain terms from the exponential series; this *does* fit into the scale if ν takes the values 1, 4, 9 . . . $(\nu = n^2)$ but does *not* if ν has the values 1, 8, 27, . . . $(\nu = n^3)$, nor if $\nu = 1, 2, 4, 8, \ldots (\nu = 2^n)$.

In Appendix ii. (pp. 48–57) Mr. Hardy has made a most interesting summary of recent results in analysis, in which du Bois-Reymond's ideas have proved helpful, and readers who are less interested in logic than in results may be advised to turn to this appendix first. Appendix iii. gives a large variety of numerical results to emphasise the amazing rapidity of increase of the logarithmic scale at the upper end, and its corresponding slowness of increase at the lower end.

We may, perhaps, quote the largest number suggested by physical considerations, namely, the number of molecules in the earth, which is found to be of the order

$$1{\cdot}08 \times 10^{51} \text{ or } 42! \text{ or } e_2(4{\cdot}77).$$

This is considerably larger than the number of sodium wave-lengths which light could traverse in geological time, a number of the order 30! or $e_2(4{\cdot}32)$. Both of these numbers are quite small when expressed in terms of second order exponentials, and are far smaller than ${}_9 9^9$, the largest number expressible in terms of three digits; this last number contains 369,693,100 digits when written at full length, and (printed with 16 digits to the inch) would cover more than 350 miles.

T. J. I'A. B.

MAYA ASTRONOMY.

The Numeration, Calendar Systems, and Astronomical Knowledge of the Mayas. By C. P. Bowditch. Pp. xviii+346+xix plates. (Cambridge: University Press, 1910. Privately printed.)

THIS volume offers to the reader "a statement of the knowledge which we possess of the numeration, calendar, and astronomical attainments of [a] wonderful people."

The sources of information are primarily the records of the Mayas themselves; secondarily, the writings of Spaniards and others about the Mayas. The first source may be subdivided into:—

(i) The books of Chilan Balam.
(ii) The codices.
(iii) Inscriptions.

The Book of Chilan Balam of Mani (Mani being the name of a village added to the title for the purposes of identification) was composed before 1595. All books of this class were copies of older manuscripts, with occasional addenda of current interest. They were regarded with superstitious veneration by the village to which they belonged.

The codices, of which three are extant, contain accounts of Mayan histories, ceremonies, sacrifices, and calendar.

Bishop Landa, at Mani, in 1562, carried out so far as possible a "general destruction of everything which related to the ancient life of the nation." He was a Franciscan friar, and subsequently became Bishop of Yucatan. He was a sincere friend and protector to the natives; he has preserved the Maya alphabet, and with it the key to the inscriptions, a service which "wipes out over and over again his faults, which were those of the century."

The Mayas used a series of twenty day-names in an invariable order, Kan, Chicchan, &c., the first following the last without a break, just as the days of the week do with us. The period of twenty days is referred to as a month.

In addition to this, a device was used of counting up to thirteen, and then beginning again, so that the complete cycle becomes 260 days; just as we should have a complete cycle of 210 days if every month contained thirty days, and if it were usual to name only the day of the week and the day of the month without naming the month. The series of 260 days is called Tonalamath.

As an illustration of the ingenuity that has to be applied in deciphering the results, we transcribe here from p. 28 an example in which we have merely changed the notation for the convenience of printing. Thus we use four symbols, p, q, P, Q, where the original uses lines and dotes either black or red. We have replaced red signs by small letters, black signs by capitals, dots by p or P, lines by q or Q. We use brackets to divide one group of symbols from another. Then we have to decipher (p)(PPQQQ)(q)-(PPPPQQQ)(pqq)(PQ)(pppp)(QQ)(p). The following interpretation may be considered correct, because it makes sense (the process may be compared with solving an equation by trial and error):—Let p or P denote unity, q or Q denote five; then the sentence reads: One, add seventeen, leaves remainder five; add, nineteen, leaves remainder eleven; add six, leaves remainder four; add ten, leaves remainder one. By "leaves remainder" we mean on dividing by thirteen. It is, as we might say, Sunday; in ten days it will be Wednesday; in five more, Monday; in twelve more, Saturday; and in eight more, Sunday again.

With this sample of the contents we must leave the book to our readers. Some will, no doubt, be interested in the problems of decipherment, others in the results obtained; perhaps still more will feel that they cannot be interested in everything, and other problems and other people have greater claims upon their attention. The world at large would regret to see any branch of knowledge die out or remain stationary, and will, in consequence, feel grateful to the author for his labours.

A MONOGRAPH OF DENDROBIUM.

Das Pflanzenreich, Regni vegetabilis conspectus. Edited by A. Engler. N. 50, II., B. 21, Orchidaceæ, Monandræ, Dendrobiinæ. Pars i., genera n. 275–277. By Fr. Kränzlin. Pp. 382. (Leipzig: W. Engelmann, 1910.) Price 19.20 marks.

THE present volume is the forty-fifth of a series of monographs, comprising the "Pflanzenreich," and the third which deals with the great family of orchids. Of the three latter, the few diandrous genera formed the subject of the first, the work of the late Prof. Ernest Pfitzer, while the second volume, begun by Pfitzer, and completed by Dr. Kränzlin, dealt with the small group of the Coelogyninæ. The bulky "Heft" by Dr. Kränzlin, which is the subject of this notice, is devoted to the great genus Dendrobium and its immediate allies. It is evident therefore that there is still very much to be done before we have, what has been a desideratum since the time of Lindley, a complete monograph of this large and important natural order.

The plan of arrangement of tribes and genera adopted in the "Pflanzenreich" is that which was elaborated by Pfitzer in his account of the Orchidaceæ in the "Pflanzenfamilien." Dr. Kränzlin, however, takes a somewhat different view of the limitations of genera. He is here treating of that portion of the section Dendrobiinæ which is characterised by the presence in the anthers of four pollinia without appendages, and in Pfitzer's arrangement included three genera, Latourea (a monotypic genus), Dendrobium (with 300 species), and Aporum (with twelve species). Dr. Kränzlin points out that the first of these was founded on a misconception, and must be regarded as a synonym of the larger genus, in which he also includes the small genus Aporum. On the other hand, he finds reason for resuscitating the very doubtful genus Callista of Loureiro, which depends on a fragmentary specimen of Loureiro's in the British Museum herbarium, and the genera Sarcopodium of Lindley and Desmotrichum of Blume. He also raises to generic rank the sections Inobulbon and Diplocaulobium, and maintains the genus Adrorhizon, founded by Sir Joseph Hooker on a single species from Ceylon.

The number of species admitted is more than double the estimate given by Pfitzer in the "Pflanzenfamilien" in 1889. The great genus Dendrobium includes more than 600 species, which are distributed among ten subgenera, and the grand total of species contained in the seven genera recognised is more than 700. This great increase in number of species is an index of the large and widespread interest which has been taken in the family of orchids during the last twenty years, a period which, by a strange coincidence, starts from the date of the abrupt termination of the work of the younger Reichenbach. During the whole of this period Dr. Kränzlin has been working continuously and steadily on the order, and with the completion of his monograph of one of the largest genera, as well as one of great interest, to botanists and horticulturists, he has earned a new debt of gratitude from workers both in the pure and applied aspects of the science. A. B. R.

ANTHROPOLOGY.

History of Anthropology. By Dr. A. C. Haddon, F.R.S., with the help of A. H. Quiggin. Pp. x+158. (London: Watts and Co., 1910.) Price 1*s.* net.

THIS is a fascinating little volume, and deals in a masterly manner with the history of anthropology in so far as that can be done within the compass of some 150 pages. Anthropology is now so vast a subject that it is necessary for the individual student, if he wishes to become a specialist, to confine his attention to a comparatively small fraction of the whole, and very often the specialist in one department knows little or nothing of what has been done in other departments. To such specialists this short history will be of the greatest value, and the science of anthropology as a whole will benefit by the coordination of results obtained in different departments.

The authors divide their subject into the two main divisions of physical anthropology and cultural anthropology, and these again are divided into chapters with somewhat eclectic titles, dealing with the more important and interesting sections. We have, for example, chapters on the "Pioneers of Physical Anthropology," "Anthropological Controversies," and "The Unfolding of the Antiquity of Man," under the first division; and chapters on "Ethnology, "The History of Archæological Discovery," "Technology," and "Sociology and Religion," under the second division.

It is, we think, unfortunate that the authors have to a great extent followed the somewhat confused and redundant classification of Dieserud, in the subdivision of their material; it is impossible, for example, to prevent some overlappng in chapters dealing with "The Unfolding of the Antiquity of Man," and "The History of Archæological Discovery." Similar difficulties are met with in connection with other chapters in the book. The question of the classification of the subject-matter of anthropology is confessedly full of difficulties, and the authors no doubt found themselves to a certain extent tied down to the illogical systems at present in use.

The authors confess that their limited space necessitated many omissions, but we were surprised to find no mention of the Gibraltar skull in the chapter on "The Antiquity of Man." The chapter on "Anthropological Controversies" is full of interest, as showing how theology, politics, and economics interfered with the progress of the science.

There have been few, if any, complete histories of anthropology published before the appearance of this work, and the origin of each branch of this subject is so thoroughly explored to its source, that, we are impressed with the fact, that a great deal of original historical research must have been carried out by the authors in the collection of their material.

SOME BOOKS ON CHEMISTRY.

(1) *Inorganic Chemistry for Advanced Students.* By the Right. Hon. Sir H. Roscoe, F.R.S., and Dr. A. Harden, F.R.S. 2nd edition. Pp. viii+476. (London: Macmillan and Co., Ltd., 1910.) Price 4*s.* 6*d.*

(2) *Chemistry for Beginners.* By T. Jenks. Pp. x+309. (New York: F. A. Stokes Co.; London and Edinburgh: W. R. Chambers, Ltd., 1910.) Price 3*s.* 6*d.* (Chambers's Wonder Books.)

(3) *The M.C.C. Periodic Chart of the Elements.* Pp. 45 (introduction) and chart (folded and bound). (London: Metallic Compositions Co., n.d.) Price 8*s.* 6*d.*

(1) THE new edition of Roscoe and Harden's "Inorganic Chemistry for Advanced Students" differs from its predecessor (reviewed in NATURE of December 7th, 1899), mainly in the addition of new lessons or chapters on carbon compounds and on the radio-active elements. It is, however, very gratifying to see the new method of making hydrazine from ammonia incorporated so quickly in a text-book, and to find calcium cyanamide duly described as an inorganic compound amongst the compounds of calcium in a chapter which includes a brief but accurate description of the technical preparation of the metal by electrolysis of the fused chloride. The lesson dealing with crystals and isomorphism remains in some need of revision, as three distinct methods are used to indicate the faces of the crystals in the various diagrams that are reproduced; as the symbols used are not explained the simplest remedy would probably be to omit them altogether from the diagrams. The issue of the new edition has supplied an opportunity for introducing the system of atomic weights in which O=16 instead of H=1, and these values are now used throughout the book. The larger volume is intended to be used as a sequel to Roscoe and Lunt's "Inorganic Chemistry for Beginners," and an element such as chlorine, which has already been described in the smaller volume, is now referred to only under its metallic derivatives. In this way space has been saved for the introduction of more advanced work than could otherwise have been included within the limits of less than 500 pages.

(2) The "Wonder Book" on chemistry is the third venture which the author has made in seeking to interpret to the non-technical reader some of the more important facts and theories of modern science; the preceding volumes on electricity and photography are dedicated to "Young Readers"; the third volume is for "Beginners." The story is a readable one, and the statements made are usually accurate, at least when dealing with the facts of chemistry; the introduction of theories is responsible for a certain number of errors, as, for instance, where the existence of monatomic molecules is denied (p. 67), or ions are described as "even smaller than atoms" (p. 243); but the author has not hesitated to introduce his youthful readers not only to the atomic and molecular theories, but also to the periodic law and the theory of electrolytic dissociation. A less ambitious programme might have deprived reader and writer alike of the satisfaction of having covered the whole of the subject; but it is precisely because such a sense of perfected knowledge might arise after a perusal of the volume that one would hesitate to commend it to any but the lay reader who intends to remain a layman. As an introduction to the further study of chemistry its value would be very doubtful, since a teacher would probably prefer to deal with a beginner who had not made any attempt to study the subject rather than with one who had imbibed the theories somewhat vaguely outlined by the author. The book is well illustrated, and contains an excellent series of portraits of famous chemists, from Priestley to Mendeléeff.

(3) "The Chart of the Elements," compiled by the Metallic Compositions Company, is intended to summarise in diagrammatic and tabular form the properties of the elements as elucidated by the periodic system. It is intended largely for non-chemical readers who have occasion to make use of metals in various ways, and desire to know something of the properties of related elements which may possibly prove to have valuable technical qualities. An introduction of forty-eight pages is provided, the second part of which, on "The Periodic Law and its relation to Speculative Thought," differs fundamentally from the earlier descriptive and explanatory pages and reveals the author at work on what is evidently a favourite hobby or recreation.

T. M. L.

OUR BOOK SHELF.

Das Radium in der Biologie und Medizin. By E. S. London. Pp. vi+199. (Leipzig: Akademische Verlagsgesellschaft m. b. H., 1911.) Price 6 marks.

IN the fourteen years since the discovery of radium a large mass of observations has arisen on the effects of radium rays on the various tissues of the living organism. The present work aims at collecting data from the publications of all countries and systematising the results obtained with normal as well as pathological tissues; and the effects on plants and animals as well as on man. The author expresses his keen desire to arrange his material so as to show some definite general principles resulting from the physiological actions of radium rays. Unfortunately he has had to own himself quite unable to achieve this ambition. He has therefore decided to divide the work into a biological and a medical section, and to divide each of these into an experimental and a clinical side. The work does not pretend to be a text-book; it is offered merely as a complete compilation up to date.

The physiological properties of radium rays are fully described, including the decomposition of lecithin, with the separation from it of cholin, a substance which is capable of producing considerable changes in the organism. The author then passes on to the action of radium rays on bacteria and on the lower fungi. The results here are not very striking. In dealing with the ferments, toxins, and antitoxins of the body, some very interesting facts are brought to light, and it is shown that radium, whether inhaled or injected in the form of solutions of emanation, has the power of increasing the activity of certain of the body's ferments. Other ferments appear actually to be reduced in activity by radium rays. This leads us to the recent use of radium and of radium emanation in the treatment of gout, in which perfectly definite results have already been obtained, although far more observations are required before this treatment can be applied extensively. The action of radium on the skin and on cancerous tissues is also fully described.

The book is a careful and conscientious compilation, and must prove of great value to those engaged in practical work with radio-active substances. A. C. J.

Die Adamellogruppe, ein alpines Zentralmassiv, und seine Bedeutung für die Gebirgsbildung und unsere Kenntnis von dem Mechanismus der Intrusionen. By W. Salomon. II. Teil, Quartär, Intrusivgesteine. Pp. vi+435–603+Taf. ix–xi. (Wien: R. Lechner (W. Müller), 1910.) Price 12 kronen.

THE first part of Herr Salomon's great monograph on the Adamello group was noticed in our columns on July 22, 1910. In this second one he describes the diluvium (for he retains this term consecrated by ancient error), such as the different types of moraines, the erratics from the central mass (which have been carried far), and the erosive effects of the ice. In regard to the last, considerations of space forbid us to say more than that he has a firm faith in the excavating powers of glaciers, and regards them as agents of no small importance in the sculpture of the Alps. The remaining and larger portion is devoted to a study of the intrusive rock of the *massif* and its enclosures. The former, as might be expected, exhibits several varieties, which are often closely associated, and indicate a differentiation in the original magma, before it arrived at its present position, with an approach to solidification in the more basic portions. Thus sometimes the latter have been carried away as actual fragments (not very happily named *Lacerationssphäroide*) in the more liquid material, while sometimes a kind of mottling or streaking is produced, as may be seen in the Guernsey diorite. Not seldom also the rock is cut by aplitic and pegmatitic veins, representing the most acid residue, as the fragments do the earliest and most basic segregate. Of these we find some excellent photographs, with others of a more general character.

Every detail is so elaborately worked up that the memoir bids fair to rival the mountain in magnitude, and we cannot but think, since the counterparts of many of the facts occur elsewhere in well-known places, that greater brevity would have been an improvement. These monumental memoirs, thought containing much that is really valuable, sometimes tempt the student to doubt, as in the well-known instance, whether it is worth going through so much to get to so little.

Cassell's Cyclopaedia of Photography. Edited by B. E. Jones. Part i. (London: Cassell and Co., Ltd., 1911.) Price 7*d.* net.

MESSRS. CASSELL'S "Cyclopædia of Photography," of which the first part is before us, is edited by Mr. Bernard E. Jones, who is assisted by about twenty "chief contributors," well known in the photographic world in connection with that particular branch of the subject that each is associated with. The work is to be completed in twelve parts, to be published at fortnightly intervals. The editor aims at including every accepted photographic term, and at paying particular attention to the requirements of both amateurs and professionals. As an indication of the wide range of subjects included, we give the headings that occur on the first page of the first number:—"Abat-jour," "Abaxial," "Abbe Condenser," "Abbe, Ernst," "Aberration," "Abrading Powder." The articles in this number that exceed one page in length, are titled:—"Acetylene Generator," "Albumen Process," "Aphengescope," and "Autochrome Process."

New Ideas on Inorganic Chemistry. By Prof. A. Werner. Translated, with the author's sanction, from the second German edition, by Dr. E. P. Hedley. Pp. xvi+268. (London: Longmans, Green, and Co., 1911.) Price 7*s.* 6*d.* net.

THE first German edition of Prof. Werner's treatise was reviewed in these columns on March 8, 1906 (vol. lxxiii., p. 433). As compared with the first, the second German edition was to a great extent re-written, and in part extended. The chief object of the revision was the harmonising of the sections discussing the problem of valency. New sections on work done between the dates of the two editions were added. But on the whole the book has preserved its original character. An index would add to the usefulness of the work.

The Natural History of Selborne. By Gilbert White. With Notes by Richard Kearton, and 123 illustrations and photographs by Cherry and Richard Kearton. Pp. xvi+294. (London: Cassell and Co., Ltd., 1911.) Price 3*s.* 6*d.*

THE first edition of this very attractive production of a widely known classic was reviewed in the issue of NATURE for March 5, 1903 (vol. lxvii., p. 419). The fact that the book has been reprinted three times since then shows that the notes and illustrations of Messrs. Kearton have been very successful in extending the knowledge of White's letters on natural history.

How to Build an Aëroplane. By Robert Petit. Translated from the French by T. O'B. Hubbard and J. H. Ledeboer. With 93 illustrations. Second edition. (London: Williams and Norgate, 1911.) Price 2*s.* 6*d.* net.

THE present differs in no essential respects from the first edition, reviewed in NATURE of August 25 last (vol. lxxxiv., p. 229). The translators have not felt justified in incorporating details of the numerous variations of original types of aëroplanes.

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.*]

Caliature Wood.

DURING the preparation for the press, in 1895, of the "Diary and Consultation Book of the Agent, Governor and Council of Fort St. George," for 1682–5, Mr. A. T. Pringle, the editor, inquired if I could throw any light on the origin of caliature, a name for redwood (*Pterocarpus santalinus*), frequently referred to as an article of trade in Madras. Presuming the name to be that of a port on the east coast, it has evidently disappeared from nearly all the available gazetteers and modern atlases. Inquiries were made in London, Holland, and Java with no results; but recent researches in the libraries of Calcutta have been more successful, and the following notes on the early trade of the country form an interesting chapter on the history of red-sanders wood.

To Rumphius belongs the credit of giving the origin of the term "caliture." In "Herbarium Amboiense," 1750, vol. ii., 48, he speaks of "Santalum rubrum" being known in his country and in Europe, and as coming from a tree from which "lignum calitour" is derived. The wood is very hard, solid, and dull-red, which he says could be obtained in great abundance from the northern parts of the Coromandel coast. Various kinds of furniture were made of it, as benches and elegantly carved chairs. Only the mature trees afforded good sandalwood, as was shown in letters sent to him in 1689. The wood was also used as a tincture in the arts, and the Armenians in Shiraz and Ispahan added it to distilled spirit of wine to give it a beautiful and intense red colour. The identity of the town by Rumphius I will quote in the original Latin:—"Hisce addo ex iisdem litteris locum Caliatour quondam dictum, hodie in ora Coromandelensi hoc nomine non amplius esse notum, sed tempore mutatum fuisse in *Krusjua-Patanum*, seu *Kisjua-Patan*, ita ut primi nominis memoria inter Europæos tantum conservetur."

The town of Kistnapatam, referred to in this paragraph, is in the Nellore district of the Madras Presidency. It is now a village, situated at 14° 17′ north latitude, 82 miles north of Madras; it has a fine backwater of great depth, and is a shelter for native craft during the monsoon. In an old glossary it is said to be the Greek σωπατμα, and "title otherwise Calitore." In a map accompanying "A True and Exact description of the most celebrated East India Coasts of Malabar and Coromandel" (1672), by (Rev.) Philip Baldæus, Callerture is shown between Armagon and Penne (Penner River). In a map of the "Peninsola deli India" (dated 1683), by Giacomo Cantelli da Vignola, a Portuguese, the town is indicated as "Caletur." It is evident that while the town was known to foreigners as Calitore or Caletur, it was not recognised by that name by the British factors.

The trees yielding red sandal-wood occupy a small area including portions of the Cuddapah, Nellore, and North Arcot districts, chiefly on the Sashachellam, Lankamali, and Veligonda ranges of hills. Mr. Gamble remarks that "in range there is perhaps no important Indian tree of so circumscribed a distribution." We need not suppose that the area under *P. santalinus* has shifted its position during the past two hundred years. A glance at the map of India will show that produce from this area would find outlets on the coast at Caleture, Armagon, and Pulicat, frequented by Dutch ships in the seventeenth century. Turning to the text of Baldæus's description of the Coromandel coast, we do not, however, find reference to the trade in redwood, but on p. 654 he says that between "Penna and Caleture" the best "Essaye Roots" are found, referring to chayroot (*Oldenlandia umbellata*); and he refers to the bark of a tree, of a darker colour, which is probably *Ventilago madraspatana*. Numerous vegetable dyes must have been in use at this time to prepare the large quantities of coloured cotton goods exported from this coast.

The earliest English factory was planted in 1625 at Masulipatam, where trade was carried on with varying fortune for several years. In 1628 the agent, pressed by the Dutch rivalry, migrated southwards to Armegam. In 1639 Armegam in its turn gave way to Fort St. George, Madras, which in 1653 was raised to the rank of an independent presidency. Between this young growing factory and the Court of the Hon. East India Company there was considerable correspondence, and interesting extracts are made in the Diary and Consultation Book of the Agent and Governor. In their despatch dated February 8, 1681, the Court wrote as follows:—"And we do further order that you make the like provision of 300 tons Reddwood for our next yeares shipping. The Dutch call this Reddwood by the name of Calliature wood, and we do p̄ the Nathaniell and Williamson send a pattern therof which came from India. We are informed that it costs about 2½ Pag° p̄ candy, they are usually in pieces of about 3 yards long but you may have it sawed into pieces of about 2 foot more or less as the Co̅manders shall desire for conveniency, it being to be ground to powder here and used in dying."

Contracts for the supply of the wood were negotiated by the Governor, and the question of advances was settled with the merchants. In September, 1682, the following entry in the Diary occurs:—"The Calliature or Redwood merchants having made a contract with y° Agent, &c., for — candy of red wood, declared that without they might have half the money before hand they could not comply with their contract w^{ch} upon their promise of giving security was granted them."

Redwood was frequently used as ballast in home-going ships. A specific case is recorded in the Diary for 1682:—"Captain Willshaw of the Resolution complained that he would not be able to ride out y° storm without sufficient Quintelage [ballast] therefor ordered that the warehousekeeper doe lade on board him 100: Tonns saltpetre and what Calliature wood can be got to stiffen his ship and inable him the better to ride out y° storm."

In 1683 the Governor found it necessary to define the terms of freight with Captain Willshaw, a skipper of somewhat independent character. On January 1 the following official letter was sent to him:—"Wee do likewise acquaint you concerning Redwood or Calliature wood that (provided you are fully laden) except you are contented to receive but half freight for it wee shall not lade any upon your ship wee being ordered to send none home upon any other terms than that to which wee desire your answer that accordingly wee may lade or not lade the same upon you." Willshaw replied:—"As to the other particulars of the redwood I shall be willing to take it in for £9 10 p̄ Tunne being the ½ freight of Grosse goods provided that according to contract your wor^p may have men aboard to saw and split it to which if yo^r wor^p and Councell will not condescend I am as ready to deliver both the petre and wood as I was willing to request the Lading it on board for the securitie of his Ma^{ties} subjects and the Companys concern therefore desire to know your Resolution till when none of the Petre or wood shall be stowed away but what is already stowed."

During the years 1683 and 1684 various payments were ordered to be made to the redwood merchants for the Honble. Company's account, and orders were regularly issued to the warehousemen to load the wood on English ships in the harbour. In order to maintain the supply in Madras, "Generalls" or letters were addressed to the northern factories in Vizagapatam and Masulipatam with requisitions for the wood to be sent down in coasting vessels.

In 1685 as much as 1337 pagodas were paid to the local redwood merchants in seven instalments during the year. Calculating the pagoda at 9*s*., this amounts to 605*l*. This, however, indicates only a portion of the trade for the year.

Reference to "The Private Diary of Ananda Ranga Pillai from 1736 to 1761" proves that the trade in red-sanders wood was still brisk. In 1743 the ship *Fleury* sailed for France with 1000 candies (candy = 500 lb.), and the *Phénix* with 2000 candies of redwood. It might be mentioned that the *James and Mary*, that gave its name to the dreaded sandbank in the Hooghly, and was wrecked on September 24, 1694, carried a cargo of redwood taken up at Madras.

In the "Letters received by the East India Company from its Servant in the East, 1602–1617," there are numerous references to the various kinds of sanders wood, but they are easily distinguished. The red sanders wood always came from the Madras coast, and was sent to Europe for dyeing purposes. The white sandal wood (*Santalum album*) was used as a perfume, for medicinal baths, and for presents. Sappan wood, sapang, patanga, or Brazil wood came from Malaya and Siam from the tree called *Caesalpinia sappan*. It was one of the "vendiblest" commodities in the trade between Siam and Japan in 1615.

There is still a demand for red sanders wood, but the drug is not of so much importance as it was years ago. The reasons are well known—on account of the artificial substitutes now employed for dyeing purposes. Evidence of this is seen in the last issue of a Madras newspaper just to hand. It describes the visit of the Governor of Madras to a large modern cotton mill. One sentence reads:—"His excellency passed on to the reeling room and then to the dye house, where the dyes used are mostly aniline dyes." DAVID HOOPER.

Indian Museum, Calcutta.

Anguillula glutinis—Paste Eels.

IN Carpenter's work on the microscope, the eighth edition, so ably edited by the late Dr. Dallinger, occurs the following passage (p. 945): "This last [*A. glutinis*] frequently makes its appearance spontaneously in the midst of paste that is turning sour; but the best means of securing a supply for any occasion consists in allowing a portion of any mass of paste in which they may present themselves to dry up and then laying this by so long as it may not be wanted, to introduce it into a mass of fresh paste, which, if kept warm and moist, will be found after a few days to swarm with these curious little creatures."

As he also says that "a writhing mass of any of these species of 'eels,' is one of the most curious spectacles which the microscopist can exhibit to the unscientific observer," very many young microscopists have been led to try to obtain the eels by allowing paste to stand until sour, and also by getting dried paste known at one time to have contained "eels." Unfortunately, in this country at least so far as I know, such attempts have always failed, and I have received many letters asking for the cause of such failure.

Of course, it is generally acknowledged that no animals of the grade of these nematoid worms ever appear *spontaneously*; they were probably present in the water used to dilute the paste, but in paste that has been boiled and diluted with water that has been boiled they never appear, and I have tried hundreds, perhaps thousands, of experiments in this direction. And even when cold water from a pond or brook was used to dilute the paste, I never found them.

In regard to dried paste also, my experience has been different from that of Dr. Carpenter. When paste has been thoroughly dried in the open air in our climate, no eels can be made to appear by transferring some of this paste to fresh material and keeping it warm and moist. Paste may dry up to a stiff mass and the eels still live, but I have never been able to keep paste in a thin layer exposed to the air in our dry climate for one month and then resuscitate the eels. I have tried it over and over again, and the eels always disappeared. By keeping the paste slightly moist, however, the eels (or their progeny) may be kept indefinitely.

The fact that Carpenter could keep them alive after the paste had apparently dried up, may perhaps have been due to the moistness of the English climate in comparison with ours.

Fortunately, the "eels" may be found in most bookbinder's paste tubs, and a sufficient amount for a start may, if properly packed, be sent by mail provided the time of transit is not more than two weeks. JOHN PHIN.

Paterson, N.J., U.S.A.

The Fox and the Fleas.

THE story of the fox and the fleas, published in NATURE of March 23, is not current among Celtic people only. As Bohemia is a country full of fields, pastures, ponds, brooks, and forests, the last often being inhabited by foxes, it is no wonder that my father, who was a close observer of nature, told me the same story nearly fifty years ago. But the Bohemian fox was in one point distinguished from the English fox, for, being unable to find sheep-wool and probably not trusting to hay, and yet wishing to get rid of the fleas, he was obliged to sacrifice his own fur, and so he plucked out as much of his own wool or hair with his teeth as might easily serve to collect the fleas; and the effect was superior, for the fleas could creep into the hair without noticing any change of medium during the water trick.

As regards the question about the origin of the fleas, raised by Prof. Hughes in NATURE of April 13, my experience as an old hunter is that, at least in our comparatively dry climate, the animals living in forests have an ample opportunity of gathering fleas there. If you happen to shoot a squirrel, never put it into your bag or pocket, or else in a few minutes you will be swarming with fleas which are quickly leaving the dead animal.

Once I placed a freshly shot squirrel on a newspaper, and was surprised to find what an enormous quantity of little fleas of a peculiar kind (all these different kinds of fleas were studied by Baron Rothschild) were leaving the dead animal; and yet the squirrel lives more in the trees than on the ground, and hardly approaches stables or inhabited buildings; how much more easily can a fox collect his parasites on the ground of the forest!

Some readers of NATURE may ask what means the crayfish on the immersed tail of the left-hand side fox in the interesting figure on p. 211. To this I found an answer in the invaluable book on "Animal Intelligence" by Romanes, p. 432, according to which "Olaus witnessed the fact of a fox dropping his tail among the rocks on the *sea* shore to catch the *crabs* below, and hauling up and devouring such as laid hold of it." On the contrary, it is not clear what is the matter with the tail of the right-hand fox in the figure.

I may add that while ski-ing in deep winter in the Bohemian Forest I often watched the footsteps of different wild game in the snow, and once I found a trace of a fox without being able to tell which way he was going. After having followed it for about half a mile to the summit of a mountain, I found that the fox made a turn there and walked a long way back exactly in his own footsteps. Did he intend to conceal in which direction he was going? That the fox has sometimes this intention is shown by the fact that in the proximity of inhabited places the footsteps of the fox in the snow suddenly disappear, the fox having effaced them by his tail.

BOHUSLAV BRAUNER.

Bohemian University, Prague, April 21.

Belladonna Plaister for Bee-Stings.

SOME years ago it occurred to me to try the experiment of treating bee-stings with belladonna plaister; and, as this remedy is remarkably efficacious, and as I have met no one who was aware of the cure, I have intended for a long time to ask you to put the fact on record in your columns. If the sting is but slight, there are no unpleasant effects at all when belladonna is at once applied, and the plaister may be removed after a comparatively short time; if the sting is severe—*i.e.*, as I suppose, if it has entered a vein—it may be necessary to retain the plaister for several days; and in such case, although there will be swelling and some irritation, both these unpleasant effects will be very notably less than in cases where no belladonna has been used. Of course, as some people are extremely susceptible to bee-poison, it is quite possible that they may not find a belladonna-treated sting so small a matter as I find it; but I presume that they will find at least a proportionate alleviation. In the summer-time my children run about the garden bare-footed, and not unfrequently they step upon a bee and get stung. At once there is a shout for "belladonna"; it is put on; and we never hear another word about the sting. I have also found belladonna give great relief from a wasp-sting. I should be very glad to hear the result if anyone living in a "mosquito"-ridden part of the country would try the experiment of applying belladonna to mosquito-bites. It might well be quite useless; but, on the other hand, it might serve.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, R.S.O., Cornwall.
April 25, 1911.

THE TOTAL SOLAR ECLIPSE, APRIL 28, 1911.

NEWS of the results of this eclipse arrived in England from Vavau on Saturday afternoon, April 29, in the form of a cable through Reuter's Agency from Mr. P. Baracchi, Government astronomer at Melbourne, Australia. He reported that the observations of the eclipse were considerably interfered with by passing clouds, and that the results were only partially successful.

No news regarding the experience of the English parties observing at Vavau was available until Sunday morning, April 30, when Sir Norman Lockyer received a cable from Dr. Lockyer, sent by wireless from H.M.S. *Encounter*, at Vavau, to H.M.S. *Pegasus*, at Auckland, thence by cable, stating that the expedition from the Solar Physics Observatory had not been successful, in consequence of bad weather. With regard to the two most important spectroscopic instruments—a 6-inch prismatic camera with four large objective prisms of 45° angle, and a concave grating spectrograph of 10 feet radius of curvature—poor results have been secured by the first; photographs of the corona, with the two large coronagraphs of 16 feet and 8 feet focal length, were obtained, but of inferior quality.

A general description is given of the visual observations made of the form of the corona, from which we learn that it was of the typical minimum type, with long equatorial extensions. The general description of the eclipse is that it was not a dark one, and in consequence comparatively few stars were observed during totality.

The second English party under Father Cortie has been also unfortunate, but as yet no news is to hand regarding the experience of the German and American astronomers who proposed to occupy one or more of the islands to the north-east of Vavau.

In an interesting letter received from Dr. Lockyer he emphasises the generous and enthusiastic help afforded to the expedition by the Australian authorities. Mr. H. A. Hunt, the Commonwealth Meteorologist, at the request of the Government, invited Dr. Lockyer to inspect the site of the new Solar Physics Observatory, which is to be established near the new capital; this is a little more than twelve hours' railway journey from Sydney. It will be the only southern observatory having solar observations as its prime duty, and it fills a longitude gap between India and the United States. It is therefore anticipated that the results from such a locality will be of the greatest importance.

Towards the end of March the heavy equipment taken out from England was safely stored on board H.M.S. *Encounter*, of the Australian squadron, and the official party, in company with that of Father Cortie and Mr. Baracchi, sailed from Sydney on March 25, reaching Vavau on April 2. On the way arrangements would have been made for the organisation of the various parties, taking charge of each section of observation. Captain Colomb, R.N., assisted the expedition in every way, and from a telegram received last week we learned that on the call for volunteers more than 100 of the ship's company signified their willingness to take part in the observations. Parties would be formed for sketching the corona, observations of shadow bands, landscape colours, aids for the working of each of the large instruments, timekeepers, &c. By means of pictures of rmer eclipses which have been successfully observed and general descriptions by the astronomers in charge, all the members of these different sections would soon be rendered conversant with their individual duties. On landing steps would first be taken to select the most suitable site: then the ground would be roughly surveyed, and the positions selected for the pillars of the large instruments. This done, more accurate observations of the meridian line would be made, so that each instrument could be adjusted exactly in the proper orientation. When the instruments were satisfactorily installed and protected, periodical drills would be instituted, when all the operations, down to the smallest detail, would be practised, exactly as if the eclipse were really taking place. After two or three of these drills everyone becomes very proficient in their duty, and it is only such unavoidable misfortune as has attended the present occasion which can prevent good observations from being secured.

The latest information is that a second message has been received from Mr. Baracchi stating that some of the results of the Australian party are better than was at first anticipated. Thirty pictures of the corona have been obtained.

CHARLES P. BUTLER.

STANDARD BREAD.

ALMOST every people boasting the rudiments of agriculture makes use of cereals as part of its food. The cereals comprise all grains or corn-bearing plants, and are grasses which by long cultivation and selection have developed a maximum of food material with a minimum of husk. Wheat, barley, oats, rye, maize, millet, and rice are the principal cereals, and the first four have an extraordinarily wide geographical distribution. The following is the average composition of cereals:—

	Per cent.
Proteins	10–12
Carbohydrates	65–75
Fat	0·5–8
Mineral salts	2
Water	10–12

Maize and oats are the richest in fat, wheat and rye contain respectively 1·7 and 2·3 per cent. of fat, while rice contains the maximum of carbohydrate and the minimum of protein and fat. Regarded as a diet the cereals contain a large excess of carbohydrate and a deficiency of protein and fat. Wheat and rye are alone suitable for bread-making; this is due to the fact that they contain a peculiar protein "glutin," which becomes viscid when mixed with water, and determines the binding properties of the dough. Glutin does not exist as such in the grain or flour, but is developed by the interaction in the presence of water of two proteins, gliadin and glutinin.

For the preparation of flour the grain is ground or milled, and in the process, which by means of modern machinery in the iron roller mills has been brought to an extraordinary degree of perfection, various constituents of the grain are

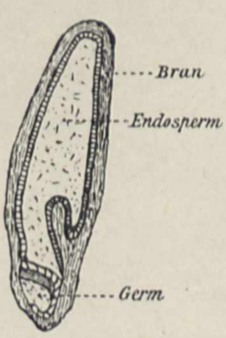

FIG. 1.—Diagram of structure of wheat grain.

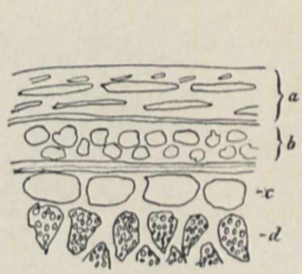

FIG. 2.—Diagram of layers of wheat grain.

separated. A grain of wheat consists of (1) an outer envelope or husk, which constitutes the bran, (2) the kernel or endosperm, and (3) the germ (see Fig. 1). The husk has an outer cuticle from which delicate hairs spring (Fig. 3), under which are three other layers, the two outer consisting of elongated cells (Fig. 2, *a*), the third of well-defined rounded cells (Fig. 2, *b*). Then comes the envelope of the seed proper, the "testa" or "episperm," under which is a layer of large quadrilateral "cerealin" cells (Fig. 2, *c*), which encloses the endosperm; the latter consists of numbers of large cells with delicate walls filled with starch granules (Fig. 2, *d*). The husk, constituting the bran, consists mainly of cellulose with pigment and

FIG. 3.—Outer cuticle with hairs of grain.

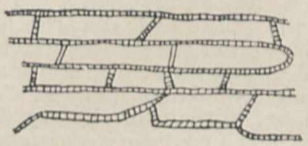

FIG. 4.—Inner skin or epicarp of grain.

mineral salts, the endosperm consists largely of starch, and the germ, relatively a small portion of the whole, is rich in protein and fat. In the process of milling the grain is broken up and various "mill products" are obtained. The outer coats yield bran, fine pollards, sharps, and middlings, the germ is removed as offal, while ordinary flour is derived almost solely from the endosperm. The flour itself is divided into a larger portion, "bakers" or "households," and a smaller, very white and poor in protein, known as "patents," from which genuine Vienna bread and the best class of fancy breads and pastries are made. The semolina, derived from the central part of hard wheat, and rich in glutin, is also lacking in white flour.

It will thus be seen that ordinary white flour and white bread made therefrom contain little or none of the bran, germ, and semolina, and valuable food con-

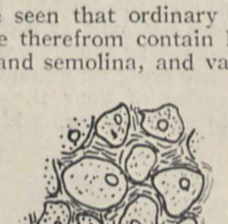

FIG. 5.—Large-celled endocarp layer of grain.

stituents—mineral matter and protein of the bran and semolina, and fat and protein of the germ—are lost. Wholemeal bread is therefore richer in the nutritive constituents and has more flavour, but is darker in colour than white bread, owing partly to the inclusion of the bran and partly to an interaction by which dextrin and sugar are formed which undergo darkening in the oven. Wholemeal bread is, however, apt to be irritating on account of the cellulose and silica of the outer coat, but by removal of the outer layers of the husk the irritant material may be excluded, and the valuable mineral, protein, and fatty constituents of the inner branny coat, semolina, and germ, are retained. Such a flour constitutes the "80 per cent. flour" employed in making the so-called "standard" bread. The term "80 per cent. flour" means that a wheat a bushel of which weighs 64 lb. yields 80 per cent. flour. In the old method of milling the wheat is ground between stones, the flour being separated by sifting, and in this way some of the "offal" is retained; hence the term "stone-ground."

"Standard" bread is distinctly cream-coloured, and contains pale brown particles derived from the branny coats of the grain. It has more flavour and is moister than ordinary white bread, and contains more phosphates and other mineral salts. Microscopically various branny constituents can be recognised, *e.g.* cuticle with hairs (Fig. 3), inner skin or epicarp (Fig. 4), and large-celled endocarp layer (Fig. 5), and these figures are reproduced from actual drawings of a sample of "Standard" bread examined. There is doubtless some difference of opinion as to the relative values of ordinary and "Standard" flour, and the bread made therefrom. The roller mills cleanse the wheat in a very efficient manner. Chemical analysis, except as regards salts, shows little difference between the two; "standard" bread may even be slightly poorer than ordinary bread in protein, owing to the greater percentage of moisture. On the whole, however, we think there can be little doubt that "Standard" flour and bread are to be preferred. Their use will also tend to revive wheat growing and the small miller in England.

THE HOME LIFE OF THE SHANS.[1]

THE Shan States under the control of the Government of Burma form two groups, the northern and the southern, separated for some distance by the Nam Tu or Myitnge River in the eastern portion of the province. Ethnologically, the Shans are a branch of the great Tai people, "the free," who at present exercise sovereignty only in Siam. The affinities of the branches of this people are obscured by the bewildering variety of names which disguises their identity, while the dialects are mutually incomprehensible, and, as if this were not enough, are recorded in at least six forms of written character. Even the origin of the name Shan is a puzzle, the only reasonable explanation being that of Sir J. G. Scott, who points out that they were known to the Burmese as Tarok or Taret, and possibly gained their present title from their Chinese designation, Han Jen. Our knowledge of them is derived from the accounts of earlier travellers like Dr. Richardson, Captain Macleod, and Sir H. Yule; from the translation of tribal chronicles by Mr. Ney Elias and Sir J. G. Scott, and of Chinese authorities by Mr. G. H. Parker; and, in particular, from the monograph on their history and ethnography written for the Census Report of Burma, 1892, by Dr. J. N. Cushing. In the present book the information thus collected has been carefully summarised in two chapters on tribal history and literature by Mr. W. W. Cochrane.

Mrs. Leslie Milne spent about twenty months in a Shan village with the object of studying the language of the Palaung or Palē, a neighbouring hill tribe who

[1] "Shans at Home." By Mrs. L. Milne. With Two Chapters on Shan History and Literature by the Rev. W. W. Cochrane. Pp. xxiv+289. (London: J. Murray, 1910.) Price 15*s*. net.

trade with the Shans, but are allied to them neither by race nor language. She is a careful and sympathetic observer, and has profited by information received from the officials of the American Mission. At the same time, she has not avoided that almost idyllic conception of their character and beliefs which is prominent in the accounts of Burman life and psychology by enthusiasts like Sir J. G. Scott and Mr. Hall Fielding. The truth is that their views are largely based upon the obvious contrast between the races of Burma and those of the Indian plains. While the latter, mainly owing to the bondage of the caste system, are reticent, suspicious, and unwilling to associate with the foreigner, the former are cheerful, kindly, and beset by none of those taboos of food and personal pollution which in India proper form an effective barrier between the people and their rulers.

FIG. 1.—Circles of sand made by Shans in shallow parts of muddy streams, in order to act as water filters. From "Shans at Home."

Such views naturally lead to exaggeration. In the case of religious beliefs, for instance, Mrs. Milne has failed to grasp the fact that their beliefs are almost purely animistic, and that Buddhism is only a thin veneer concealing the predominant workship of Nats or spirits. It is true, as she observes, that among them "there is no great fear of death; they all feel that they have all lived and died so often that death and its mystery is not talked of in a whisper, but is a favourite topic of discussion in Shan houses." "They place," she goes on to say, "religion and the study of their scriptures, and a temperate life on a higher level than money or the comforts and luxuries that money brings. Their lives are very happy. Any man may marry the girl he loves if he can persuade her that she loves him better than any other man. There is always money enough, and food for the children that come to gladden their homes. Starving people do not exist, and there are few unemployed, because any man or woman may easily earn a livelihood by asking for jungle land, by clearing and cultivating, and by selling the produce that is grown upon it." When British rule was introduced

FIG. 2.—Market Day. From "Shans at Home."

we found them harassed by raids of the neighbouring Kachins and torn by internecine war. Now they are clamouring for roads which will enable them to bring their produce to the railway. It will be interesting to watch how long this almost idyllic social state remains unaffected by the pressure of commercialism.

Mrs. Milne's account of their home life and industries is clear and comprehensive; and the value of her book is increased by an excellent collection of photographs. It is certain to survive as the standard account of a most interesting people recorded at a time when they were little affected by external influences.

BELGIUM'S CONTRIBUTION TO THE PLAICE PROBLEM.[1]

THE plaice problem still occupies a prominent position in the foreground of the international investigations. The reason is not that the plaice is the sea-fish which contributes most wealth to the countries concerned. In respect of total value landed the fish is surpassed in England by the haddock, the herring, and the cod, while in Belgium the total value of soles annually landed is more than twice that of plaice, which stands fourth in the list, after haddock and herring.

The reasons why the plaice is of such importance that it has been made the principal object of investigation on the parts of England, Germany, Denmark, Holland, and Belgium are as follows:—

(1) This fish constitutes a proportionately large as well as much appreciated element in the ordinary dietary of the poorer classes in the five countries named.

(2) The livelihood of large numbers of fishermen in these countries depend on their ability to maintain an adequate supply of this fish in the markets.

(3) It is especially in regard to the plaice that the cry of "depletion" of the fishing grounds, and of the undue destruction of undersized and immature fish, has been, and is still being, raised.

(4) The plaice lends itself perhaps more readily than any other fish to protective legislation, on account of its comparatively restricted range, its regular distribution from the coast seawards according to size, and its slow rate of growth.

In view then of the urgent need which was expressed in discussions on the plaice at Royal Commissions and fishery conferences of a satisfactory knowledge of the natural history of the fish on one hand, and for trustworthy statistics showing the actual condition of the fishery in time and space on the other, it is not surprising that the International Council took the matter in hand at the outset of its career and arranged for a thorough investigation of the plaice fisheries both from the biological and from the economic point of view, an investigation in which each of the five countries most interested was appointed a share. The result of the large amount of research which has been expended on the plaice during the past few years is that we now possess a considerable amount of information respecting the movements of the fish at all stages of its career, the age of the fishes, and their growth-rate in different parts of the sea, their age and size at maturity, and so forth, while the sea fishery statistics of the various countries bordering on the North Sea have been so completely reorganised that they now show us, for a quinquennial period at least, something like the actual yield of different fishing grounds from year to year and from month to month.

[1] Contribution à l'Etude biologique et économique de la Plie. Par G. Gilson. Délégué de la Belgique au Conseil international pour l'exploration de la mer. Travaux de la Station de Recherches relatives à la Pêche maritime. Ostende. Fascicule IV. (Bruxelles: Imprimerie Polleunis et Ceuterick, 1910.)

Although we have no continuous or sufficiently exact statistics of the plaice fishery extending into last century, there can be no reasonable doubt that the condition of the fishery and the composition of the plaice population on the fishing grounds are very different to-day from what they have been in the memory of the older fishermen, and fragmentary statistics of the number of baskets formerly taken are not altogether wanting to show this. If the destruction of an "accumulated stock" of old fishes (such as is to be found in the Barents Sea at the present day, and not so many years ago at Iceland) was inevitable, and quite rational and economic, the same can scarcely be said if the supply of fish at the present day is being maintained at the sacrifice of an increasing proportion of the smaller and much less valuable sizes. If this actually is the trend of the fishery at the present day, then, apart from the possibility of an ultimate shortage of supply which is at any rate threatened, it is obvious that the fishery is not being exploited in a rational way. As Prof. Gilson, in his important memoir, says:—"On sait qu'il faut considérer la capture en grande masse de jeunes plies, inaptes à la reproduction pour la plupart et *capable de gagner en une année le double et même le triple de leur valeur,* comme une opération anti-économique appelant une reforme."

It is greatly to the credit of Prof. Gustav Gilson, of Louvain, the Belgian delegate to the International Council, that he has been able to carry out a plan of researches in accordance with the international programme, in spite of the great disadvantages attending the lack of a special research steamer able to work on the fishing grounds at all seasons, and of a coastal laboratory where material could be examined fresh and continuously.

The institution in Belgium which has assumed the task of participating in the international investigations is the Royal Museum of Natural History, which maintains a station for sea fishery research at Ostend. Solely with the aid of the resources of this institution and entirely outside the official machinery, Prof. Gilson has reorganised the sea-fishery statistics at Ostend. Previous to 1904 these gave only the total quantities and value of fish landed at the port without distinction of species, size, number of baskets or fishes, place of capture, &c. From 1904 onwards, thanks to Prof. Gilson's efforts, all these and other essential particulars are given in the statistical returns, so that now the Belgian statistics are equally precise and detailed as those of other countries bordering the North Sea.

In the memoir under review the data collected with regard to the plaice landed at Ostend are analysed and coordinated from two points of views:—(1) So as to show the principal features in the evolution of the Belgian plaice fishery during the quinquennial period (1904–8), and (2) to furnish indications of the influence which a raising of the minimal size legally established (18 centimetres) would probably exercise on one hand on the reserves of plaice in the sea, and, on the other, on the product of the fishing industry in weight and value.

It is impossible to indicate all the features in the evolution of the Belgian plaice fishery during the period 1904 to 1908 which are revealed by Prof. Gilson's analysis of the Ostend statistics. It will suffice to point out the most important feature from the point of view of the present discussion. This is to be found in the progressive increase from year to year of the proportion of small fish in the catches of the *sailing* trawlers, which boats are responsible for the great bulk of the plaice landed at Ostend at the present day. Now it is clearly shown that this increase in the proportion of small fish is not due to a change in the field of action of the boats concerned, for the displacement which has actually occurred has been of such a nature that it ought to have produced a *contrary* effect. It is in consequence of a modification of the composition of the reserves of plaice inhabiting the Southern Bight of the North Sea. The curves for the various divisions of the Southern North Sea show this very clearly. The proportion of small fish in the annual catches in *each* of these divisions shows a gradual rise from 1904 to 1908. That the change in the composition of the plaice population on these fishing grounds consists in a diminution in the number of large individuals and *not* in an increase in the number of small is also fairly clear.

This is the important point: the supply of plaice in the Belgian market is apparently being maintained at the sacrifice of an increasing proportion of the smaller and much less valuable sizes. Researches on similar lines which have been made by the other four nations most interested have apparently much the same tale to tell; but, as these have not been co-ordinated and compared, it would be premature to make any general statement about the condition of the plaice fishery in the North Sea as a whole.

As a remedy for the state of things revealed in the Belgian statistics, Prof. Gilson suggests the *tentative* imposition of a minimum size of 23 centimetres, below which it should be illegal on the part of the sailing trawlers to land or sell fish, and a similar standard of 25 centimetres for steam trawlers. The reasons for the selection of these particular size limits and for a distinction between the two classes of vessels in this respect are fully discussed in the report and hardly need be recapitulated. Very similar size limits for plaice have been suggested by certain of Prof. Gilson's colleagues on the International Council, who will probably be found unanimous in agreeing with him that all such measures designed for the protection of undersized plaice should be of an experimental and elastic nature. In view of the still very incomplete state of our knowledge of the plaice problem, which is far more complex than was at first supposed, certainly no State would be justified in making such legislation final or irrevocable. It would be impossible to predict the effect of the imposition of a given size limit, or the amount of inconvenience attending its enforcement. It is inevitably a case of "try and see." Moreover, a size limit is not the *only* possible means of bettering the plaice fishery. Transplantation to the Dogger Bank, and other grounds richer in food, has been tried on an experimental scale with striking results, in view of which it is worth considering as a possible commercial enterprise.

Finally, one cannot but agree with Prof. Gilson that if we are ever to have experimental legislation for plaice, then it is clear that the scientific control of its effects is indispensable. In other words, there ought to be a permanent International Commission to continue researches on points not yet elucidated, to study the statistics from year to year, and to carry out biological investigations designed to show the changes in the composition of the plaice population on the fishing grounds and in the rate of growth of the fishes which might be expected to result from the legislation. As Prof. Gilson truly says:—"C'est à ce prix seulement que l'on peut espérer de réparer le mal accompli et de porter remède à la rupture encore récente de l'équilibre qui s'était établi, au cours des siècles, entre la puissance alimentaire des mers, le pouvoir reproducteur des espèces et les causes de destruction aux quelles celles-ci étaient soumises avant l'intervention de l'homme."

WILLIAM WALLACE.

NOTES.

MR. A. E. SHIPLEY, F.R.S., has been elected a foreign corresponding member of the Helminthological Society of Washington.

WE regret to announce the death, on April 15, at seventy-nine years of age, of Prof. J. Bosscha, correspondant of the physics section of the Paris Academy of Sciences, and formerly permanent secretary of the Dutch Society of Sciences at Haarlem.

THE National Geographical Society of America is sending out in the summer an expedition for the further study of the glaciers of Alaska. It will be led by Prof. Ralph S. Tarr, of Cornell University, and Prof. Martin, of the University of Wisconsin.

AN expedition, under the charge of Prof. Homer R. Dill, taxidermist of the University of Iowa, has left San Francisco for Layson Island. This island, which is situated in the Pacific about midway between California and Japan, is only about three and a half square miles in area, but is estimated to support a bird population of about eight millions.

THE tenth International Congress of Geography will be held at Rome on October 15 and the six following days. Excursions in northern and central Italy, as well as southern Italy and Sicily, will be arranged, of which the details will be published later. The subscription for membership of the congress is 1*l*., and all persons desirous of joining are requested to remit this sum at an early date to the treasurer of the committee, 102 Via del Plebescito, Rome.

THE Victoria League has in operation a scheme for sending newspapers and magazines, when done with, to addresses in distant parts of the Empire. Although more than 81,000 newspapers and magazines are being sent away annually there are still many applicants unprovided for, and in South Africa and Victoria, Australia, particularly, we are informed copies of NATURE would be gratefully received. Any reader willing to help the movement should apply to the hon. sec. of the Newspaper Scheme, 2 Millbank House, Wood Street, Westminster, S.W.

PROF. HANS MEYER will undertake in May his fourth journey in East Africa. Starting from Bukoba, on the west shore of Lake Victoria, he proposes to march to Lake Kiva and the Kirunga group of volcanoes, in order to study the relations of the volcanic phenomena to the tectonic structure of the western rift system at this point. From Kiva the expedition will travel by Lake Tanganyika and, if time permits, also to Lake Nyassa. Besides geological studies, the botany, zoology, and ethnology of the region traversed will also be investigated.

DR. PÖCK, in the April number of *Petermann's Mitteilungen*, discusses the distribution of plague during recent years, and illustrates it by two maps. The first shows the location of areas where it is endemic, and also those over which it has recently spread, as well as the places where isolated cases have occurred in different years. The second map shows the probable area of origin of the recent outbreak in Manchuria, and the region which was affected

The influence of modern facilities of communication on the spread of the disease is insisted upon as constituting a factor acting against and sometimes having greater effect than the resources of modern sanitary science in some regions.

At a meeting of the Research Department of the Royal Geographical Society on April 27, Mr. A. R. Hinks discussed recent progress in geodesy. Invar tapes and wires have revolutionised base measurement; gravity surveys have been carried out over large areas, while abnormalities of gravity in more restricted regions have been determined with remarkable accuracy by the torsion balance; arcs of meridian have recently been measured in Spitsbergen, Africa, and Peru. In view of so much activity in geodetic work, it is to be regretted that so little has been done of late years in the United Kingdom. The measurement of an arc of meridian and a detailed gravity survey were instanced as pieces of work which should be carried out in these islands, and discussion on these matters was invited.

A Reuter message from Sydney states that the schooner *Kainan Maru*, the ship of the Japanese Antarctic Expedition, arrived there on April 30, the object of the expedition having been abandoned. The vessel, which left New Zealand in February for the Antarctic continent, was obliged to turn back on account of the ice packs and icebergs which she encountered, and reached Coulman Island, off the coast of Victoria Land. The decision of the explorers to abandon the attempt to reach the Pole was also influenced by the fact that ten of the twelve Eskimo dogs which were to have been used to pull the sledges succumbed to the cold. After cruising in the vicinity of Coulman Island for four days, the *Kainan Maru* set out for Sydney. A Reuter message from Hamburg reports that preparations are complete for the departure of the German Antarctic Expedition on May 3 on board the 598-ton barque *Deutschland*. The vessel will go first to Bremerhaven, whence she will start for Buenos Aires on May 7.

We regret to announce the death, on April 28, in his fifty-third year, of Dr. J. Tatham Thompson, the well-known ophthalmic surgeon of Cardiff. He had suffered for many months from a painful and incurable illness. Dr. Thompson was born at York, educated at Bootham School in that city, and received his medical training at the University of Edinburgh, where he had a distinguished career and graduated M.B., C.M., in the year 1885. For some time he acted as assistant to the late Dr. Argyll Robertson, of the Edinburgh Royal Infirmary, and afterwards he obtained the appointment of ophthalmic surgeon to the Edinburgh Western Dispensary. During his stay in Edinburgh, he was distinguished by his artistic abilities, and many of the drawings in Berry's "Diseases of the Eye" were from his clever pencil. Dr. Thompson, however, soon went to South Wales, where he obtained the appointment of ophthalmic surgeon to the Cardiff Infirmary, which he held for many years. During this time his pen was seldom idle. He found time to write upon many ophthalmic subjects, including the influence of school life upon eyesight, nystagmus among Welsh miners, and the removal of foreign bodies from the interior of the eye by the aid of the magnet. At the time of his death Dr. Thompson was one of the vice-presidents of the Ophthalmological Society of the United Kingdom.

The death is announced of Dr. F. J. C. Terby, who worked long and assiduously to promote astronomical science. In a private observatory, which he constructed at Louvain, he mounted a Grubb equatorial of 8 inches aperture, and employed it mainly and usefully in the study of the surface markings of the planets. Mars particularly interested him, and he made a careful discussion of the physical features of this planet, recorded from the time of Fontana. This is a very valuable contribution to observational history. It puts into the hands of astronomers an accurate and ready summary of a great amount of detailed information, acquired by industry and sifted with intelligence. His observations of Venus appear to have been accurate and systematic, supporting Schiaparelli's view of the coincidence of the period of rotation with that of revolution. As an amateur astronomer, comets naturally attracted his attention, and the record of his observations of the physical features of many will be found in the pages of the Memoirs of the Royal Academy of Belgium and in the Bulletins. Of late years his observations appear to have been less frequent, probably on account of ill-health, but for many years he worked zealously, and his memory should be treasured as of one who laboured to inspire others with enthusiasm, and to make the science of astronomy respected.

The Times records the death of Mr. Henry Scherren, at his residence in Cavendish Road, Harringay, on April 25. Mr. Scherren had been a Carthusian monk, but abandoned his orders in the year 1878, and subsequently resided in London, where he devoted himself to journalism, more especially in regard to its natural history side. One of his favourite subjects was the zoological gardens of Europe, on which he wrote many articles, the last appearing in *The Field* of April 29, after his death. He also wrote an interesting history of the Zoological Society of London, of which he was elected a fellow in 1889. Among his contributions to zoology may be mentioned an account of the early history of Grèvy's zebra, and another of the giraffe presented to King George IV. Mr. Scherren was born at Weymouth in 1842, and educated at the Romanist College at Mill Hill. For a period of twenty years he was in the employ of Messrs. Cassell, during which he acted as sub-editor of their "Encyclopædic Dictionary." He also wrote for *The Leisure Hour* and other journals.

Three letters have recently appeared in *The Times* (April 24, 25, 27) relating to a mysterious heraldic animal known as the "jall" or "eall," of which the effigy has been recognised in St. George's Chapel, Westminster, on a stall-plate supporting the arms of John Duke of Somerset, 1440. Later, the jall appeared among the Sovereign's cognizances. Although described as having horns, tusks, and a short fluffy tail, the jall has been identified with the goat, but the Rev. H. F. Westlake, custodian of Westminster Abbey, adopts the view that it was "the" antelope. In an old document quoted by Mr. G. C. Druce, the eall is stated to be as large as a horse, with a tail like that of an elephant, goat-like jaws, and horns capable of movement, its colour being black. Other accounts state, however, that it has jaws like a wild boar and cloven hoofs. It may be suggested, if the beast ever had corporeal existence, that the African wart-hog may have formed the original type, that animal having a black hide, cloven hoofs, an elephant-like tail, large tusks, and big face-warts which might perhaps be regarded as elastic horns.

Much interest attaches to the description, by Mr. O. Thomas at the meeting of the Zoological Society on April 25, of a new form of takin from the Tsin-lin range of southern Shen-si, Central China. The typical Mishmi takin (*Budorcas taxicolor*) is a dark-coloured animal with a large tawny area—traversed by a black spinal stripe—on the back. In the Sze-chuen takin (*B. tibetanus*) nearly the whole of the upper parts, exclusive of the face and ears, which are black, have become either golden-yellow or whitish-grey, and this tendency to the development of yellow culminates in the new Tsin-lin takin, in which all the black has disappeared, so that the whole fur, which is very long, is a beautiful golden-yellow. Mr. Thomas has named this takin *Budorcas bedfordi*, in honour of the Duke of Bedford, who is defraying the cost of the expedition which resulted in its acquisition. Whether the three forms are regarded as distinct species or as colour phases of one species, they are of great interest as showing the evolution of a golden from a black and chocolate type of colouring. What renders this the more remarkable is the fact that a similar development occurs in the case of the snub-nosed monkeys (Rhinopithecus), in which the comparatively low Mekon species is slate-coloured, while the elevated Sze-chuen form is bright golden-yellow.

THE second Irish Road Congress, held in Dublin on April 19, 20, and 21, attracted a large attendance of members, most of whom were men actually engaged in the construction and maintenance of Irish roads. The work of the congress was divided into three sections, dealing respectively with the laws and procedure relating to road construction, statistics, &c.; road construction and maintenance; and modes of locomotion. Twenty-five papers were submitted, mainly of a practical nature; but the chief subject dealt with in the discussions was the treatment of Ireland by the newly constituted Road Board, the general opinion of the members finding expression in a unanimous resolution to the effect that, in allocating the funds at its disposal, the Board had not carried out the avowed intentions of the sponsors of the Development and Road Improvement Act in Parliament, viz. that the proceeds of the special taxes raised with this object would be distributed without reference to the sources from which the money was drawn. The address of the president, Mr. P. J. O'Neill, J.P., chairman, General Council of County Councils, was almost entirely confined to this aspect of the road question, and gave the key-note to the proceedings; but the discussions, in which Sir George Gibb, president of the Road Board, and Colonel Crompton, consulting engineer to that body, took part, also included subjects of practical importance, such as the testing of materials, direct labour as opposed to the contract system, and the effect of motor traffic on the roads.

AT a meeting of the Royal Dublin Society held on April 25, the Boyle medal of the society was presented to Prof. John Joly, F.R.S. A report upon his work was read by Dr. J. M. Purser, and some of the subjects mentioned in it are here summarised. Prof. Joly's researches deal with physics, geology, mineralogy, botany, and biological theory. In 1886 Joly published the method of condensation in calorimetry, and investigated the specific heats of minerals. He also determined the specific heats of gases at constant volume. By the meldometer he determined the fusion points of minerals, and showed the use of the instrument in carrying out reactions of pyrochemistry. He determined the volume change of rocks and minerals on fusion. He also invented the incandescent electric furnace. Joly advanced a physical theory on the origin of the canals of Mars, accounting for the linear markings on the planet. In 1896, he invented a method of colour-photography to reproduce with accuracy the colours of nature on a transparent plate. In 1898 he showed how the sodium content of the ocean could be used as a measure of geological time. The theory of sedimentation has also been advanced by his researches on electrolytic precipitation. By many researches he has laid the sciences of petrology and mineralogy under obligations to him. We would specially notice his invention of a polariser whereby the value of birefringence as a means of identification is increased, and his application of the microscope to the determination of the quality of paving-sets and road-metal. In connection with radioactivity, he has advanced our knowledge of the properties of radio-active substances. His explanation of Pleochroic Haloes in rocks as due to radioactivity leads to conclusions as to the non-existence of alpha-radiation from common elements. By the determination of the thorium content of rocks, he has established a mean value for its distribution in the surface-materials of the earth.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1910–11:—Telford gold medals to Mr. W. J. Wilgus (New York) and Mr. J. Walker Smith (Edinburgh); a George Stephenson gold medal to Mr. Philip Dawson (London); Telford premiums to Messrs. G. W. Humphreys (London), H. K. G. Bamber (Greenhithe), A. E. Carey (London), William Dawson (Crewe), and C. S. R. Palmer (London); and the Trevithick premium to Mr. A. T. Blackall (Reading).

AT the annual general meeting of the Institution of Civil Engineers, held on April 25, the result of the ballot for the election of officers was declared as follows:—*President*, Dr. W. C. Unwin (London); *vice-presidents*, Mr. R. Elliott-Cooper (London), Mr. A. G. Lyster (Liverpool), Mr. B. Hall-Blyth (Edinburgh), and Mr. J. Strain (Glasgow); *other members of council*, Mr. J. A. F. Aspinall (Liverpool), Mr. J. A. Brodie (Liverpool), Mr. W. B. Bryan (London), Colonel R. E. B. Crompton, C.B. (London), Mr. W. Davidson (Australasia), Mr. J. M. Dobson (London), Mr. H. F. Donaldson, C.B. (London), Mr. E. B. Ellington (London), Mr. Maurice Fitzmaurice, C.M.G. (London), Mr. J. P. Griffith (Ireland), Dr. C. A. Harrison (Newcastle-on-Tyne), Mr. W. Hunter (London), Mr. G. R. Jebb (Birmingham), Mr. H. E. Jones (London), Mr. E. H. Keating (Canada), Sir Wm. Thos. Lewis, Bart., K.C.V.O. (Aberdare), Sir Thomas Matthews (London), Mr. W. Henry Maw (London), Hon. C. A. Parsons, C.B. (Wylam-on-Tyne), Mr. F. E. Robertson, C.I.E. (London), Mr. Alexander Ross (London), Mr. J. W. Shores, C.M.G. (South Africa), Hon. F. J. E. Spring, C.I.E. (India), Sir Philip Watts, K.C.B. (London), Mr. W. B. Worthington (Derby), and Mr. A. F. Yarrow (Glasgow). This council will take office on the first Tuesday in November.

AMERICAN scholars are at present busily engaged in exploring the materials for the study of the history of their continent which are stored in the record-rooms of Europe. A useful contribution to this inquiry is the catalogue of the Italian documents, which has been prepared by Prof. C. R. Fish, and recently published by the Carnegie Institution of Washington. Students of the history of countries other than America will be interested in the descriptions of the manuscript collections at the Vatican, the Propaganda Fide, and other repositories at Rome, Naples, Venice, Turin, and Florence, with the conditions under which they are available for examination.

IN one of those comprehensive discussions of special anthropological problems, of which the French reviews hold an almost complete monopoly, M. B. P. Van der Voo in the April issue of *La Revue des Idées* examines the origin in the belief in metempsychosis. Finding its origin to lie in the same group of conceptions which include the passage of the soul into animals and plants, he discusses in order the Indian evidence, the conception of the moon as the abode of spirits and the deity of life, its influence on the rain, and that of the rain on human life. He next deals with the various forms of reincarnation—in the Carnivora, snakes, birds, and, finally, in human beings. This essay, with its abundant references to the literature of the subject, must be of the greatest value to students.

THE Ethnographic Survey of India, with a view to the preparation of revised editions of the accounts of the tribes and castes of Bengal, the United Provinces, and other parts of the Empire where the information has been tabulated, publishes occasional monographs on special subjects of interest. The most recent of these is an account of the marriage rites of the Prabhus of western India, who, like many castes engaged in literary pursuits, now claim to be of Kshatriya or warrior origin. The monograph, as Mr. Annandale remarks in his prefatory note, would be improved by compression; but it supplies abundant evidence of the predominating belief in the efficacy of magic to counteract the power of malignant spirits and the evil eye, which is the chief basis of the domestic rites of the Hindus. Its value for European readers would be much enhanced by a few photographs illustrating the arrangement of the marriage booth, the sacred fire, and the other appliances of the rites, which would assist students of the ceremony who have not enjoyed the chance of witnessing a high-caste marriage.

WE have received a copy of the second report of the Jerusalem Society for the Prevention of Cruelty to Animals. In view of the ill-treatment to which domesticated animals are subjected in many parts of the East, the movement is well worthy of sympathy and support.

THE second number of the Journal of the East Africa and Uganda Natural History Society contains a large amount of interesting matter relating to the fauna of our East African possessions, Mr. F. J. Jackson contributing a synopsis of the game-birds of the district, while Mr. C. W. Hobley discusses spitting cobras. For a long time naturalists were very shy in accepting the assertions of settlers that an African snake possesses the power of ejecting their venom to considerable distances. The statement has, however, of late years been verified by indisputable evidence, and Mr. Hobley has now been able to identify the species as the black-necked cobra (*Naia nigricollis*). Additional testimony as to the spitting power of these serpents is given by the author himself, who on one occasion in the Athi saw a dog put up a cobra from a bush. "It swayed its head slightly and gradually drew it back, and I expected any second to see it strike the dog, but, instead of that, a stream of colourless liquid shot out of its mouth into the dog's face, and the snake dropped and wriggled into the bush." The flashlight photograph by Mr. Cherry Kearton of a lion going to drink is unsurpassed.

PART V. of the Ceylon Marine Biological Reports is devoted to an account of the scientific work on the local pearl-banks during 1910, and in one section of the report Mr. T. Southwell discusses the present condition and future prospects of the banks. As these cover an area of more than 700 square miles, it will be obvious that the task of ascertaining their general condition—let alone any attempt at controlling the natural factors—is of stupendous difficulty. Furthermore, the Ceylon pearl-oyster has the sexes separate, instead of being, like the continental species, hermaphrodite, while it thrives best in the open sea at a depth of about 6 fathoms in place of in inter-tidal waters, consequently the system of culture which has been found to succeed in the case of the mainland species proved practically useless when applied to the Ceylon banks. At the present time these banks are almost unproductive; and it seems that there are periodical spells of barrenness, when not a single adult oyster is to be found over the whole area. During such a period the banks may, however, become suddenly replenished and covered in countless numbers with spat over several square miles, and the problem now awaiting solution is the origin of this presumably foreign spat. The second problem is connected with the disappearance of the oysters, both old and young. Although it has been proved that predaceous fish and boring molluscs have a share in the destruction, there still remains a considerable percentage of oysters which die for some reason at present unknown, although disease may be the cause. When these problems are solved, and measures taken to counteract the evil, hopes are entertained for the future of the beds.

IN our issue of January 19, 1911, we gave a full account of the paper read by Dr. Johan Hjort before the Royal Geographical Society, describing the oceanographical expedition of the s.s. *Michael Sars* in the North Atlantic. The April number of *The Geographical Journal* contains the first instalment of the complete paper, which is illustrated by three excellent plates showing some of the deep-sea fishes which were captured by the expedition, as well as by a considerable number of text figures. The vertical distribution of the two fishes, *Cyclothone microdon* and *Cyclothone signata*, is clearly shown by a series of diagrams representing the numbers of fishes of different sizes captured at various depths down to 1500 meters. These results prove the value of the methods adopted by the expedition of making simultaneous hauls, lasting for a considerable time, at many different depths.

DR. JOHAN GEHRKE (Publ. de Circonstance, No. 52, Internat. Comm. Marine Invest.) gives an account of the hydrography of the Baltic, with details of the salinity, temperature, and oxygen content of the waters of different regions of that sea. Dr. Arwidsson (No. 54) records detailed observations on the mass, colour, reproductive organs, scales, and food of 148 examples of salmon (*Salmo salar*) from the river Laga, in south-west Sweden, and concludes that, in all probability, the fish go down this river to the sea for the first time in the spring following the completion of their second year.

PROF. ERMANNO GIGLIO-TOS, formerly of the Royal University of Cagliari, has succeeded the late Prof. Giglioli in the chair of zoology, anatomy, and physiology of vertebrates in the Reale Istituto di Studi Superiori of Florence. His introductory address dealt with the subjects of organic evolution, natural selection, and the origin of species. He distinguishes somatic variations of two kinds:—(1) somatogenous, produced by the environment, and not giving rise to modifications in the germ, and therefore of no importance in regard to the origin of species (*e.g.* in Artemia); (2) blastogenous, which do produce germinal modification, and are therefore of great importance. Prof. Giglio-Tos believes that cytological investigations of the gametes may reveal variations of their structure, for instance, alteration of the number of chromosomes, sufficient to be the cause of somatic changes leading to the formation of new species.

THE April number of the *Quarterly Journal of Microscopical Science* (vol. lvi., part iii.) is an unusually attractive one. This is, in part, owing to the beauty of the lithographic plates, nearly all of which, we notice, have been executed in Germany. Mr. C. Clifford Dobell contributes a long memoir on the much-discussed question of the presence of a nucleus in bacteria. He concludes that "all bacteria which have been adequately investigated are—like all other protista—nucleate cells," but a good deal seems to depend, in making this generalisation, upon how one chooses to define the term nucleus. If, for example, we are prepared to admit that "a discrete system of granules (chromidia)" may legitimately be called a nucleus, well and good, but probably many biologists will hesitate before accepting this view. Mr. Dobell also contributes a memoir on those remarkable unicellular organisms, the spirochæts, with special reference to *Cristispira veneris*, a form occurring in the crystalline style of a lamellibranchiate mollusc (*Venus casta*). Mr. Cresswell Shearer's paper on the trochophore larva of Eupomatus will be welcomed by embryologists as a valuable contribution to our knowledge of Annelid development. The illustrations accompanying this paper are particularly worthy of admiration.

A SEQUEL to the information regarding precipitation and absorption of iron, submitted by Prof. H. Molisch in his book on iron bacteria, is furnished by a note in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna (October, 1910), in which he states that various aquatic plants induce precipitation of iron from iron salts, and that Elodea readily absorbs and accumulates oxide of iron in its leaves, in the outer walls of the epidermal cells.

THE elementary species obtained by Prof. de Vries as a break from *Œnothera Lamarckiana*, and designated by him as *Œnothera nanella*, forms the subject of a communication by Mr. H. H. Zeijlstra in the *Biologisches Centralblatt* (March 1). It is indicated that the type of the original diagnosis is an abnormal plant deformed by the internal growth of bacterium colonies, presumably a species of Micrococcus, and that similar characters and form are transmitted to the descendants of abnormal plants. In addition to this, the common form, there is said to be an uncommon but normal form of the species, distinguished from the abnormal chiefly by certain stem and leaf characters, and resembling *Œ. Lamarckiana* except for its dwarf habit; up to the present, seeds of the normal form have not been obtained.

IT is apparent from the experiments on transpiration and sap flow, recorded by Mr. J. B. Overton in *The Botanical Gazette* (January and February), that the umbrella plant, *Cyperus alternifolius*, is a convenient plant for ordinary transpiration experiments. It was particularly suitable for the requirements of the author, whose chief object was to study the effects of killing portions of the stem by immersion in steam or poisonous solutions, as the apical tuft of leaves can be readily slipped through a glass cylinder, which is then fixed at the desired position on the stem. So long as the portion of the stem killed is short, the plant withers less rapidly than a cut piece, but immersion in steam proved to be an unsatisfactory method for killing, as the contents of the cells are disorganised. It was also found that the application of certain poisonous solutions, particularly of corrosive sublimate, causes increased transpiration.

AN extensive and important investigation into the nature of crown-gall of plants has been published by the United States Department of Agriculture as Bulletin No. 213 of the Bureau of Plant Industry, in which is provided a detailed account of experiments extending over six years. A bacterial origin was suspected by Dr. E. F. Smith, one of the authors of the bulletin, in 1904, but definite proof was not obtained until two years later, when a bacterium was isolated, and infection resulting in gall-production was transmitted from pure cultures; to this organism, a short, rod-like form, was given the name *Bacterium tumefaciens*. The inquiry started with galls upon hot-house plants of *Chrysanthemum frutescens*, but subsequently similar malformations were examined on apple, peach, grape, sugar-beet, and other plants; there are probably different physiological races of the bacterium, but cross-inoculation was generally possible. Dr. Smith suggests that the manner of growth resembles certain malignant animal tumours.

Two short papers on seismograms of the great Turkestan earthquake of January 4 are contained in the Journal of the Meteorological Society of Japan for last February. Prof. Omori estimates that the epicentre was situated at about 5230 km. in the direction of N. 65° W. from Tokio, or in the Kashgar province of Turkestan, and that the earthquake occurred at 11h. 16m. 42s. p.m. on January 3 (Greenwich mean time). Two maxima of the principal portion of the movement were recorded, the second 2h. 8m. 27s. after the first, and due to surface-waves travelling over the longer portion of the great circle through Tokio and the epicentre giving the usual mean velocity of 3·1 km. per second for the surface-waves. The total duration of the disturbance was more than four hours at Tokio and 2h. 20m. at Osaka.

IN a recent number of the valuable publication *Aus dem Archiv der Deutschen Seewarte* (No. 4, 1910), Dr. O. Steffens gives an account of new meteorological apparatus constructed or improved by himself. It includes an arrangement, beautifully illustrated, for exhibiting the indications of the aneroid-barometer, thermometer, and hygrometer, either separately or on one cylinder, with rectilinear instead of the more usual curved ordinates. Various anemometers registering direction and velocity separately or on the same cylinder, with damping arrangements for eliminating the small oscillations of the wind-vane, are also described and clearly illustrated.

SOME of the results of the international balloon ascents specially arranged for the week July 27 to August 1, 1908, are summarised by Mr. W. H. Dines in *Symons's Meteorological Magazine* for April. He states that the figures show several points of interest, and would repay a careful analysis; we can only quote here a few facts relating to the particular ascent for each day in which the greatest height of trustworthy record in miles was attained, with the temperature (F.) at the greatest height, the height in miles of the commencement of the isothermal column, the temperature at the bottom of the column, and direction of falling point of the balloon.

		m.	°	m.	°	
July 27	Pavia	14·3	−58	7·5	−78	S. by W.
July 28	Crinan (N.B.) ...	10·7	−58	6·4	−76	E.S.E.
July 29	Pyrton Hill (Oxon)	14·3	−62	8·5	−92	S.
July 30	Zurich	11·2	−72	8·1	−69	W.S.W.
July 31	,, ...	11·3	−65	8·3	−89	S.S.W.
Aug. 1	Strassburg... ...	11·0	−53	7·5	−80	S.E.

No large changes of pressure occurred during the week. On July 27 it was high over the Azores and Lapland; by July 29 it had disappeared over Lapland, but increased over the Azores and moved to the south of Ireland. On July 30 and 31 it had again decreased, but still lay over England, with low pressure on July 31 in the Gulf of Bothnia. On August 1 there was little change.

THE April number of the Journal of the Franklin Institute contains a well-illustrated article on the properties of the new metallic filaments used in incandescent lamps, by

Mr. G. S. Merrill, of the National Electric Lamp Association, Cleveland, Ohio. The properties dealt with are the resistance, melting point, emissivity, and mechanical strength, and the tungsten filament receives most attention. The strength is determined by loading a short length of filament placed on two knife edges half a centimetre apart, at a point half-way between the supports, and measuring the depression under increasing load till the filament breaks. The change in the structure of the filament from a mixture of finely-divided tungsten and binding material, to pure crystalline tungsten as the temperature is raised during manufacture, is well shown by a series of micro-photographs. The effect of use in increasing the size of the crystals and in roughening the surface of the filament is shown in the same way. These changes are accompanied by a decrease in strength of the filament, which occurs mainly in the first 100 hours of use. The conclusion drawn from the observations is that a compact fine-grained structure is most desirable in lamp filaments.

AN extension for a further term of seven years of the major part of Sir Oliver Lodge's patent No. 11,575 of 1897 for "Improvements in Syntonised Telegraphy without Line Wires" has recently been granted as a result of a case argued before Mr. Justice Parker, the extension being allowed mainly on the grounds that the patentee had not been adequately remunerated for his invention. The patent covers the radiating and receiving apparatus of a complete system of wireless telegraphy and the methods of tuning the sending and receiving circuits to the same frequency, and describes how messages may be sent to each of a number of suitably tuned receiving stations by change of the frequency of the oscillations that are generated. The aërials described are of different forms, but all consist of a pair of "capacity areas" connected by inductances the magnitudes of which control the period of oscillation. The eleven claims of the specification are concerned with the insertion of these inductances into the radiating and receiving circuits; with the adaptation of a single aërial for sending and receiving the insertion in turn of inductances of various magnitudes in order to attain the selectivity already referred to; with the details of a coherer consisting of a fine metal point resting on a flat metallic spring; and, lastly, with methods of setting up the oscillations by discharges into the oscillator across air-gaps and receiving through an oscillation transformer, in order to separate both the oscillator and the resonator from metallic connection with other circuits, thus enabling them to vibrate in their own free periods so as to get precise tuning. The whole specification has been extended for the further term except the portions covering the use of the same circuits for sending and receiving, the use of various frequencies to select various receiving stations, and the use of the particular form of coherer. It thus appears that the patentee holds a master-patent covering the tuning of electrical circuits by means of inductances, and as the use of such tuned circuits is common to methods of signalling used by wireless telegraph companies operating in England, the situation will probably give rise to interesting developments.

THE report of the council of the Hampstead Scientific Society for the year 1910 shows that the object for which the society was founded in 1899, namely, the encouragement of a popular interest in science, has been pursued diligently and successfully. During the year eighty new members were elected, the membership rising to 334, the largest in the history of the society. Twenty-nine meetings, general and sectional, were held in 1910, in addition to five vacation meetings, a summer excursion organised by the photographic section, and four Christmas lectures to juveniles. The feature of the society's work for the year was the development of the astronomical section since the establishment of the observatory near the Whitestone Pond. The meteorological station at the same place has been efficiently conducted. An observer attended at 9 a.m. and 9 p.m. every day during the year, without intermission, and the results, after reduction, have been published monthly by the Meteorological Office.

THE Carnegie Institution of Washington has issued a list of the various works which it has published, together with those it has in the press. Copies of each publication, except the Index Medicus, are sent gratuitously to a limited number of the great libraries of the world, and the remainder of the edition is on sale at cost price. As the catalogue shows, this arrangement enables workers in science to obtain accounts of many important researches at a minimum cost. Descriptive lists of the books available will be sent to any interested person on application to the Carnegie Institution of Washington, Washington, D.C.

A SUPPLEMENT—covering works added to the library during the years 1908–9—to the Catalogue of Lewis's Medical and Scientific Circulating Library has been issued from the library at 136 Gower Street, London. The catalogue, the price of which is sixpence, contains a classified index of subjects with the names of the authors who have treated upon them, in addition to the ordinary alphabetical list of titles.

OUR ASTRONOMICAL COLUMN.

NEW MINOR PLANETS.—A Central News telegram of Tuesday states that the Transvaal Observatory reports the discovery of two minor planets. The discovery was made during an attempt to photograph the eighth satellite of Jupiter. The following are the positions of the new planetoids:—No. 1, R.A. 14h. 41m., Dec. 12° 34′ S.; No. 2, R.A. 14h. 48m., Dec. 15° 18′ S. It is stated that these are the first minor planets found by an observatory south of the equator.

NOVA LACERTÆ.—Photometric measures of Nova Lacertæ, made between January 4 and March 15 by Mr. H. Shapley at the Laws Observatory, are recorded in No. 4493 of the *Astronomische Nachrichten*. During that period there was a general decline of brightness from mag. 7·67 to mag. 9·23. Four neighbouring B.D. stars were used for comparison, and it is suggested that one of them, B.D.+51° 3420 (mag. 8·7), is a variable with a range of at least 0·4 magnitude; if this is so, several anomalies in the photometric results may be explained.

In the same journal Dr. Slocum records observations of two coloured B.D. stars near the nova, to which M. Luizet previously directed attention and suggested that B.D. +51° 3414 diminished in brightness by 1·5 magnitudes between January 2 and February 21. The photographic observations at Yerkes, with coloured screens, indicate that both stars are abnormally coloured, B.D. +51° 3416 showing a greater preponderance of red rays and B.D. +51° 3414 a greater preponderance of rays of shorter wave-length than a normal star of the A type.

HALLEY'S AND FAYE'S COMETS.—An observation by Prof. Barnard, using the 40-inch refractor, showed that on March 19 Halley's comet was of magnitude 13·5, and very easy to observe. It was round, and the middle showed a slight brightening, with possibly a faint, but uncertain, nucleus; its measured diameter, probably too large, was 45″ (*Astronomische Nachrichten*, No. 4492).

Dr. Ebell continues his ephemeris, giving places and magnitudes for Faye's comet (1910*e*) up to May 14. At present the comet is about 20 m. and slightly north of ξ Geminorum, and its calculated magnitude is 15·0. The observation by Dr. Wolf on March 19 showed the actual brightness to be about one magnitude fainter than the ephemeris value (*Astronomische Nachrichten*, No. 4485).

PROPER MOTIONS IN SUN-SPOT GROUPS.—Dr. W. Brunner, Zurich, has an important and interesting paper in No. 3, vol. xl., of the *Memorie di Astrofisica ed Astronomia*, in which he discusses the relations existing between the proper motions observed in spot-groups and the solar activity producing the groups. The discussion is based on the examination of Wolfer's Zurich drawings for the period 1887–1905, and the spots born on the visible hemisphere are considered separately from those which, having first broken out on the invisible hemisphere, are first seen at the eastern limb; only the proper motions in longitude are discussed, and, in general, these are in the sense which makes the various members of the group diverge *inter se*.

The general conclusions, in brief, are that this divergence is not accidental, but is connected with the phase of development of the group. In the early stages of development the diverging tendency is strongly marked, but it rapidly wanes until it disappears seven or eight days after the first outbreak, unless a recrudescence of activity takes place, when the same phenomena reappear. Taking as positive the proper motion, which is in the direction of the diurnal motion, it is found that the groups in which negative motion is dominant are more numerous at the epochs of maxima in the undecennial period. But it is found that the magnitude of the proper motion is independent of the phase of the solar activity and also of the heliographic latitude. As naturally follows from the first conclusion, those spots born on the invisible hemisphere, being several days old when first seen, exhibit the proper motions in a less marked degree than those of which the primary phases of development are observed.

THE RATIO BETWEEN THE DIAMETER OF A PHOTOGRAPHIC IMAGE AND EXPOSURE.—In the measurement of photographic magnitudes by measuring the diameter of the star images it is assumed, in the formula usually employed, that the diameter is proportional to the square of the intensity of the light. Not agreeing with the principle of this assumption, Dr. Kenneth Mees recently made some experiments, under laboratory conditions, in which he produced easily measurable images with greatly differing exposures. He finds that the diameter of the small image of a fine slit or point is proportional to the logarithm of the exposure given, and assuming that increase of exposure is effectively equivalent to increase of intensity, this would mean that the diameter of a star image should be proportional to the logarithm of the intensity of the light-source rather than to its square. Dr. Mees suggests that the astronomical equation is based upon a modification of the true law dependent on the conditions of the formation of images in telescopes (*Astrophysical Journal*, vol. xxxiii., No. 1).

PHOTOGRAPHIC MEASURES OF STELLAR TEMPERATURES AND DIAMETERS.—In No. 4483 of the *Astronomische Nachrichten* Herr Adolph Hnatek publishes an interesting paper on a photospectroscopic method of determining the effective temperatures and relative diameters of stars. The photographic intensities of various parts of the spectrum are compared, and from the resulting data a temperature scale is formed. This ranges from 4000° for η Pegasi to 11600 for Algol, eight stars being considered, and agrees fairly well with the Potsdam values where comparable. It also places the eight stars in the progressive order shown by the Kensington temperature curve. The comparison of diameters shows that α Lyræ is 6·1 greater than the sun, whilst α Aquilæ is but 1·9 times greater.

CANADIAN OBSERVER'S HANDBOOK FOR 1911.—An excellent handbook for amateur and other astronomers is issued by the Royal Astronomical Society of Canada, and edited by Mr. C. A. Chant. The first two numbers were published in 1907 and 1908, and then the experiment of publishing the information in instalments in the society's Journal was tried. This proved unsatisfactory, and the former custom of having a separate volume has been reverted to. The book should prove of invaluable assistance to the rapidly growing body of amateur astronomers in the Dominion, and it is hoped to publish the volume for 1912 before the beginning of the new year.

THE IMPERIAL EDUCATION CONFERENCE.

THE public sessions of the first conference of delegates summoned by the British Government to represent the Overseas Dominions were held in London on four afternoons, April 25–28. The President of the Board of Education welcomed the representatives, and presided at each meeting. Administrative problems were, it is believed, discussed at the morning sessions, to which only the official delegates were invited. The proceedings at these morning meetings were private, the conference agreeing at its first meeting that, in order not to hamper discussion, no report should be made until the close of the conference, when an official summary will be issued. At the time of writing, all that can be said with certainty is that the private sessions are being prolonged into the week following the public meetings. Admission to the afternoon discussions was by tickets issued to representative administrators and teachers. The attendance of the overseas delegates in the afternoons was not large. The programme drawn up by the Board of Education included papers on the teaching of geography, history and arithmetic, manual work, the organisation of secondary education in Scotland, engineering, and vocational education. All the papers were by well-known British workers in the educational field.

Chairman's Prologue.

Mr. Runciman said that the conference originated from requests made in 1907 to the Imperial Government to summon an Imperial Conference to deal purely with educational affairs. ("The Federal Conference on Education," held in 1907, was initiated by the League of the Empire, and was unofficial and highly successful.) Since 1907 the Department of Special Inquiries and Reports had been in direct communication with the Dominions, India, and the Colonies, there had been improved circulation of reports, and memoranda had been compiled during the four years which would be issued shortly. Assistance was being given every day in the week in the selection of teachers, *e.g.* for Alberta, Australia, and South Africa. They had also arranged through the Department that the privileges now given to the teachers in the United Kingdom in French and German schools should be extended to teachers throughout the Empire. Assistance was continually being given to visiting officials. A library of considerable dimensions had grown up containing carefully selected and organised contributions from all over the world. The problems to be faced here and overseas were very similar. There were the difficulties of the supply and training of teachers, the problem of giving freedom of organisation while retaining control of finance. All the subjects of pedagogy were of universal interest. They had to deal with the puzzle of the classification of schools, with rural, urban, and technical problems. The United Kingdom might learn from Canada, Canada from Australia, Australia from South Africa, and so forth. They wished to bring to the common stock the intellectual forces of the whole Empire, and feed the very root of Imperial strength. The Empire was a practical working concern, not merely a sentimental vision, and they were met to discuss practical questions.

Imperial History and Geography.

Mr. H. J. Mackinder, M.P., read a paper on the teaching of geography from an imperial point of view, and the use which could and should be made of visual instruction. He asked for attention to a mode of teaching which might have peculiar value in the consolidation of the Empire, a work in which the part of the teacher must be as great as that of the statesman. The Empire existed by the free consent of the peoples, and this consent must be based on a reasonable agreement in regard to aims and sympathy in regard to difficulties. It was the part of the teacher to exorcise the devils of ignorance and local prejudice. Geography should be taught as a special mode of thought—a special form of visualisation which he would not describe otherwise than as "thinking geographically." He went on to describe the work of the Visual Instruction Committee, and concluded by urging that geography should be the chief outlook subject in our school curriculum, and should be taught by methods which demand visualisation. We should aim at educating the citizens of the many parts of the British Empire to sympathise with one another and to understand Imperial problems by teaching geography visually, not only from the point of view of the Homeland, but also of the Empire. Among many other excellent aids to such teaching, there was now becoming available an apparatus of illustrated lectures prepared under the authority of the Visual Instruction Committee of the Colonial Office. Prof. H. E. Egerton, Beit professor of colonial history (Oxford), followed with a paper on some aspects of the teaching of imperial history. He dealt mainly with three subjects:—(1) the mercantile system; (2) the evolution of Colonial self-government; (3) the development of the Federal principle. The mercantile system assumed colonies to be plantations, *colonies d'exploitation*; what was to happen when they proved *colonies de peuplement*, settlements of men? The idea of a self-sufficing Empire postulated a general controlling Parliament; what was to happen when this Parliament represented the selfish interests of one particular portion of the Empire? Round the single principle of the mercantile system they had all the causes which led to the development and dissolution of the first English colonial empire. They would all admit that the evolution of Colonial self-government was a subject which, on a smaller scale and with simpler material, would bring out the underlying principles of the British Constitution. Referring to the Federal principle, Prof. Egerton declared that a more systematic organism must be found for the disjointed portions of the British Empire. For such an undertaking there could be no better preparation than the study of what has been done by our kinsfolk in the past.

The discussion was well maintained by well-known English teachers, but unfortunately no Colonial delegate spoke.

Arithmetic in Elementary Schools.

At the second public session Mr. Marshall Jackman read a paper on experimental work in connection with the teaching of arithmetic in elementary schools. The word "experimental" was justified by the fact that the methods employed were a departure from the Code at the time, ten years ago, when Mr. Jackman adopted the principles on which he has successfully worked ever since. These principles may be inferred from the facts that (1) the concentric method is adopted; (2) no set method of solving a problem is insisted upon; (3) the terms used in the problems are familiar to the children and the problems dealt with transactions within their grasp; (4) no problem is set which cannot be solved mentally. He claimed that, in addition to securing the teaching of arithmetic on more rational lines, the methods pursued set free more than eighty minutes a week in the three lower classes of the school; this time was devoted to reading with most beneficial results. Mr. J. V. Thompson (Fiji) said he had attempted to teach arithmetic to young Fijian chiefs in a language not their own. The Fijians delighted in exercise books, and the native master liked to set his class an enormous division sum, knowing that he would then have a most restful half-hour. He would take Mr. Jackman's scheme with him and use it.

Practical Education in Elementary Schools.

Mr. J. G. Legge, Liverpool Director of Education, read a paper on the above subject, and directed attention to the influence of the changed social conditions brought about by the industrial revolution. Of old, education was as much the work of the home as of the school. But the home side had been fading away, and despairing—perhaps too soon—of ever recovering it, we were rushing in where angels might hesitate with proposals for feeding and clothing, medically treating, and apprenticing. After the child is officially taught, officially fed, officially clothed, and officially placed in employment, there but remains the prime condition, to which eugenics is already pointing the finger, that he shall be officially begotten. As a result of a study of educational history, we discovered that manipulative exercises were not mere counter-irritants to bookwork, but the right method of applying the universally accepted principles of Pestalozzi. Recently, experimental psychology has taught us that hand training *must* precede trade training if dexterity is to mature in perfection. Henceforward we may base our claim that manipulative exercises shall find a place in our elementary-school curricula, for six reasons, viz.:—(1) to develop centres in the brain; (2) to develop manual dexterity at the age when it must be developed if it is to reach the pitch it should in maturer years; (3) to afford scope for self-expression; (4) to make school subjects more real to the child and to bring in the third dimension; (5) to keep the child in touch with its environment; (6) to give the child something to do which it recognises as definitely useful, and thereby to implant the germ of the idea of usefulness, the fruit of which is social service. Variety of schemes will be necessary; but in any case the limit of the manual side is the point at which it ceases to develop the all-round, intellectual as well as physical, development of the child. By manual work a boy is taught to think clearly towards an end believed by him to be useful. The child should make something for its own use or the use of its home. In a slum school a boy should learn to mend his own breeches, socks, or boots—for educational reasons.

Secondary Schools in Scotland.

Mr. J. Strong described the development of the organisation of secondary education since the passing of the Act of 1872. By control of the leaving certificate examination and virtual control of grants, the Scotch Education Department had a great hold on the secondary school. Curricula, buildings, and the qualifications of teachers were subject to the approval of the Department. A virtual register of teachers had been made, and a high standard fixed for training. To the Department was entrusted the administration of the teachers' superannuation scheme of the 1908 Act, which applies to secondary as well as elementary teachers. Mr. Strong explained the classification of schools and the system of certificates and transition to higher schools, university, or vocations in a lucid manner. Mr. Board (New South Wales) said that in New South Wales they had followed very closely on the lines of Scotland, with the important exception that they had no local control. Centralisation had some disadvantages, but on the whole the gain was greater than the loss. They would hesitate before dividing into such small areas as in Scotland.

Engineering and Technical Education.

Dr. J. A. Ewing, Director of Naval Education, said that the ideal training for the engineer was one which comprised, in addition to means of getting experience, a properly organised course of study in the relevant sciences taught with reference to their practical application. Science helped to determine everything the engineer did. After explaining some features in the organisation of leading engineering schools, he said the engineering professor ought to encourage his better senior students to undertake research, which was vital to the progress of engineering science, and was one of the duties of the college. Experience had proved that the use of tools could be so taught in a college workshop as to have solid professional value. He did not suggest that such an element in the training of engineers could entirely take the place of practical work done on a larger scale under commercial conditions, but much of what apprenticeship was designed to teach could be taught more effectively that way and in less time.

Mr. J. H. Reynolds (Manchester) read a paper on higher technical instruction. In his opinion, no reform in England was more urgent than that secondary schools should receive State recognition, be relieved from external examinations, and have their leaving certificates accepted by higher institutions as giving complete and satisfactory evidence of fitness to enter upon a further stage of advanced study. In 1869 this country was a generation behind Germany, and it was hardly less so to-day. In the United Kingdom the enrolments of students in higher institutions possibly reached 40,000; but in the German Empire the total enrolments were nearly 74,000, whilst the age of entrance and the state of preparation required was admittedly much beyond that prevailing in this country. The doom of the nation was surely set unless they rose up and provided for the people the means of the highest education, alike in their best interests as human beings and as needful for the maintenance and development of her trade and industry.

The discussion was maintained by several men of eminence in English engineering education, but no Colonial representative took part.

Trade Schools and Continuation Schools.

Mr. R. Blair (London Education Officer) read a paper on the recent development of day schools for boys or girls following immediately on the close of the elementary-school career, the schools being so closely associated with the industry for which they are preparing their students that the preparation is a substitute for the earlier years of apprenticeship. He directed attention to the extent and peculiarities of London's needs, and his valuable remarks were supported by a large amount of useful statistics appended to his paper. He selected for detailed description the work of the Brixton School of Building. The paper is one to be read in full and kept for reference; we must content ourselves with noting that Mr. Blair attributes the success of the schools to the thoroughness of the investigation made into the conditions of a trade before establishing a school or class, and to the appointment of a consultative committee of experts. The striking success of the girls' schools was due to the high standard of devotion and enthusiasm of the staff.

Mr. Graham Balfour (Staffordshire) showed how complicated and varied were the difficulties in organising continuation schools, and the need for resourcefulness and judgment in dealing with each individual locality.

Mr. C. E. Bevan Brown (Christchurch, N.Z.) said that recently an Act had been passed in New Zealand allowing local authorities to make continuation classes compulsory.

A Criticism and a Hope.

Had the papers and discussions been the British part of proceedings to which the Overseas Dominions had contributed a similar share, we should feel that these conferences had made a good beginning. It is to be hoped that when the report of the private sessions appears it will reveal the fact of a useful interchange of experience and ideas between the delegates of the various parts of the Empire. So far as the public sessions are concerned, it cannot be said that a programme consisting solely of contributions from the United Kingdom fulfils even approximately the aspirations with which we regard an Imperial Education Conference. It has been stated in the daily Press that the Colonial Governments were not invited to make suggestions for the business of the conference. In face of the fact that the Board of Education had four years for preparation, this statement appears to us incredible, or, if credible, then discreditable. We hope that one result of the private sessions will be to evolve a method by which the various parts of the Empire can act in concert, so as to carry out in future those aims of the conference which were stated with clear insight by the President of the Board in his opening address.

G. F. D.

BIRD NOTES.

TO the April issue of *British Birds*, Messrs. Witherby and Alexander contribute an account of the visitation of crossbills to the British Isles in 1909. The birds made their appearance on Fair Isle on June 23, and before the end of that month were seen in the Shetlands, Orkneys, Outer Hebrides, Merionethshire, and Durham; while in July they were observed all over England except the extreme south-west, as well as in a number of places in Wales, and a few scattered localities in Ireland. The latest record of their being seen at sea was in the Shetlands early in August. The first nest recorded was taken on January 12, 1910, near Thetford, while the latest nests were seen respectively in Sussex and Kent on May 25, the height of the breeding season being in March and April. Nests were recorded from thirteen English counties. The dates of departure of the birds varied locally; in some districts all had gone by the end of 1909, in others there was little or no diminution in the numbers till well on in the following year, but, as a whole, the records indicate that the main departure took place either in February or in April and May. From a second paper in the same issue, it appears, however, that a few crossbills remained to breed in certain localities in the spring of the present year. A note is added in the latter paper on the thin-beaked Scots crossbill (*Loxia curvirostra scotica*), which breeds regularly over a considerable area in Scotland.

The Irish Times of March 31, as quoted in *The Field* of April 8, reports an enormous influx of migratory birds into Ireland, especially the south-eastern districts, during the last week of March. In New Ross on the night of March 29 the town was practically invaded by a vast swarm of starlings, while in Kilkenny on the same day the streets were strewn with the dead bodies of various species, including curlew, while much the same thing happened in Carlow on March 30. There can be little doubt that the influx and subsequent destruction were in some way connected with the abnormally cold weather prevalent at the time.

In *The Emu* for January, Mr. A. J. Cambell describes, under the name of *Erythrotriorchis rufotibia*, a new species of so-called Australasian goshawk, characterised by the rich rufous or chestnut brown of the shank of the leg. This bird inhabits north-western Australia; the other members of the genus are *E. radiatus* of eastern, northern, and central Australia, and *E. doriae* of south-eastern Papua.

To *The Selborne Magazine* for April, Mr. A. H. Macpherson contributes notes on London birds in 1910, in which reference is made to the visit of a great crested grebe to the Serpentine on January 29. To illustrate the article on account of this casual visit with a figure of a nesting grebe, is, perhaps, a little misleading.

Mr. V. Franz gives, in *Himmel und Erde* for March, an illustrated account of the bird-observing station at Rossitten, with figures of the modes of ringing birds' feet, and notes on some of the results which have been obtained by the system of bird-marking.

From a paper by Mr. Grinnell issued in vol. vii., No. 4, of the Zoological Publications of the University of California, it appears that the Californian linnet (*Carpodacus frontalis*) was introduced into the Hawaiian Islands about forty years ago, and that the males of the race now established there differ from the normal form of their continental brethren by the replacement of the crimson head and breast colouring by yellow or orange. This pale colouring of the cock Hawaiian linnet is paralleled sporadically by the linnet of the mainland in a wild state, and constantly in birds kept in confinement. As the change in the Hawaiian bird does not appear to be due to differences in temperature or humidity, change of food, or a diminution in the number of foes, it appears to be connected with deep-seated factors, one of which may be insularity of habitat. "A deficiency in capacity, of the germ, for the formation of the appropriate enzyme may have been intensified through close breeding until the condition was reached where the amount of enzyme produced in the feather anlage is insufficient to carry on oxidation of tyrosin beyond the yellow, or, at farthest, the orange stage.

R. L.

OPTICALLY ACTIVE ALCOHOLS.

THE January issue of the Chemical Society's Journal contains an important paper by Dr. R. H. Pickard and Mr. J. Kenyon on the "Dependence of Rotatory Power on Chemical Constitution." Hitherto much of the work that has been done in order to find out the influence on optical rotatory power of temperature, solvent, concentration, and chemical constitution has been based upon the observations of complex compounds, such as nicotine and derivatives of various complex acids and bases. These substances have the advantage that they can be purchased as natural products in optically active forms, but the complexity of their structure has rendered it almost impossible to draw any general conclusions from the vast array of facts that have now been accumulated. In the research now described the authors have endeavoured to reduce the problem to its simplest possible form by studying the properties of the series of secondary alcohols, $R_1.HOH.R_2$, of which the simplest member is secondary butyl alcohol, $CH_3.CHOH.CH_2.CH_3$.

Up to the present no fewer than fourteen of these alcohols have been prepared, and separated into their optically active constituents by fractional crystallisation of the alkyl strychnine phthalates, $R.O.CO.C_6H_4.CO.O.X$, or similar salts, in which R is the alcohol radical and X is a suitable alkaloid; of these fourteen alcohols, only one had previously been obtained in an optically active form.

The labour involved in resolving so long a series of compounds can scarcely be appreciated except by those who have taken part in similar investigations, but in the present case the effort has been well rewarded by the production of material of unrivalled value for elucidating all the various problems involved in the study of optical rotatory power. The complete series of alcohols from $CH_3.CHOH.C_2H_5$ to $CH_3.CHOH.C_{11}H_{23}$ shows a perfectly regular gradation of properties, except in the case of the initial member, which shows an exceptionally large decrease of rotatory power with rise of temperature.

As illustrating the extreme sensitiveness of rotatory power to small changes of conditions, it may be noticed that ethylhexylcarbinol, $C_2H_5.CHOH.C_6H_{13}$, in complete contrast to methylhexylcarbinol, $CH_3.CHOH.C_6H_{13}$, or the methylheptylcarbinol, $CH_3.CHOH.C_7H_{15}$, with which it is isomeric, has a positive instead of a negative temperature coefficient, the rotatory powers of the isomeric alcohols being equal at 76°, but diverging when the temperature is raised or lowered. An even more drastic change of properties is observed on passing from phenylethylcarbinol, $C_6H_5.CHOH.C_2H_5$, to phenylmethylcarbinol, $C_6H_5.CHOH.CH_3$, or from methylbutylcarbinol,

$$CH_3.CHOH.C_4H_9,$$

to the isomeric methyl*iso*butylcarbinol,

$$CH_3.CHOH.CH_2.CH(CH_3)_2,$$

whereby the rotatory power is almost doubled in each case.

THE TEACHING OF SCIENCE IN SECONDARY SCHOOLS.[1]

THE following notes on the subject of science teaching in grant-earning secondary schools in England are based on the reports and observations of certain of the Board's inspectors, who were instructed to pay special attention to this matter during the past year. While an attempt will be made to note the principal changes that have occurred in recent years, to point out certain directions in which improvements have taken place, and to direct attention to some existing defects, the time has not yet come when a detailed and systematic survey of the state of scientific instruction in English secondary schools could profitably be undertaken. Since 1902, when the schools of science or "organised science schools" of the Science and Art Directory became the Division A Schools of the Regulations of that year, the number of secondary schools recognised for grant has risen from 348 to its present figure, 841. The earlier portion of this period was one which saw a gradual transformation from curricula which were predominantly scientific and mathematical to curricula in which a more even balance of studies was secured; and the whole period of growth and transition has been characterised (quite apart from the effect of alterations in the Board's Regulations) by notable changes in the methods, and to some extent also in the aims, of science teaching.

Changes in the Board's Regulations.

A comparison of the Regulations which in 1902 applied to the 221 schools in Division A (consisting in about equal proportions of municipal schools and higher grade board schools on one hand and schools of the endowed-school type on the other) with the Regulations now in force will show the magnitude of the change which has been brought about in the conditions under which the teaching of science in this section of the grant-earning schools is carried on. Thus in 1902 not fewer than thirteen hours a week were assigned to the obligatory subjects—mathematics, physics, chemistry, drawing, and practical geometry—of which not more than five hours might be assigned to mathematics. Even in the 127 schools belonging to the "Division B" of the Regulations of 1902, nine hours a week, or alternately a third of the total number of hours of instruction, were assigned to mathematics and science, of which four hours, or alternatively half the required minimum for both subjects, were allotted to science. Moreover, the Board not only determined the time which was to be allotted to science in each year of the "course," but indicated the syllabus to be followed in the various subjects of the "advanced courses" taken by the "Division A" schools. At the present time the Board's Regulations impose no conditions as to the syllabus of work to be followed and make no specific requirements as to the time to be assigned to the different subjects of the curriculum. Side by side with the increased freedom which has been given to the schools there has, as a fact, been a considerable reduction in the amount of time allotted to science in schools of the "Division A" type and to some degree also in schools of the "Division B" type. In schools of the former class the time given has commonly been reduced from some seven or eight hours a week to four or five in the upper forms, while in the lower forms the proportionate reduction has been greater. This has entailed considerable modification in the syllabus of work and, in general, a lowering of the possible standard of attainment.

Subjects Studied.

In practically all boys' schools the subjects taken are chemistry and physics, while in the majority of girls' schools botany is the main science subject, a minority taking either physics or more often chemistry. It is usual both in boys' and in girls' schools to find the study of one or other of these subjects preceded by a course of "experimental science" in which the formal separation into chemistry and physics is deliberately avoided. A considerable number of girls' schools, however, still exist in which botany is the only subject taken, or in which the attempt is made to teach botany concurrently with "experimental science"—a plan which, owing to the limited amount of time available, is rarely found to work well.

Hygiene, taught as a science subject, finds a place in the courses of a relatively small number of girls' schools and of a certain number of mixed schools, the subject being taken by the girls only. The inclusion of hygiene in the course is, as a rule, justified primarily on ethical grounds, *i.e.* with a view to the inculcation of hygienic habits. It is perhaps scarcely necessary to observe that there are wide differences of opinion as to the extent to which it is necessary or practicable to give this ethical teaching a formal scientific basis. The number of schools in which other science subjects, *e.g.* geology, astronomy, and zoology, are taught is exceedingly small, though there is some incidental teaching of the two former subjects in connection with the work in geography, while zoology very occasionally appears, and then for examination purposes, in the courses taken in the upper forms. Nature-study, a conveniently elastic term which covers work of the most various kinds, is ordinarily included among the subjects taught in the junior departments of both boys' and girls' schools. The subject is best taught when it is in the hands of a teacher (not necessarily the teacher of science) who is an enthusiast on natural history. In too many girls' schools in which botany is the main science subject the mistake is made of limiting the work to a preliminary study of plant life supplemented, it may be, by the making of weather records. In a few schools the plan of closely associating the early work in geography with nature-study has been tried with encouraging results.

Courses of Work.

(*a*) The differences which exist, and still more perhaps the differences which ought to exist, between the curricula of different grant-earning secondary schools make it practically impossible to comment in general terms on the character of the science work attempted and the standard reached in the several subjects taken. The probable after-careers of the pupils, the facilities for teaching individual subjects offered by the school and its environment, and the time which it is found possible to devote to science teaching are determining factors on which the choice of sub-

[1] From the Report of the Board of Education for the year 1909–10 London: Wyman and Sons, Ltd.). Cd. 5616. Price 8*d*.

jects, the range of the work, and the possible standard of attainment will necessarily depend. A course which is suitable in one school may be quite unsuitable in another. In those schools from which a certain number of the pupils pass on to university work in science, and in which a fair proportion remain until seventeen and over, or in which the course is definitely specialised (*e.g.* schools with a "rural bias"), the problem of the science syllabus tends indeed to solve itself; but in the large number of schools in which school life ends not later than sixteen, this is not so. If in these schools the best possible use is to be made of the time available, it is plainly desirable that the syllabus should represent something more than the initial stages of a study which the pupils will never continue—that it should have, in fact, a purpose and completeness of its own. Again, on the general principle that the curriculum of a school should be narrowed at the top, it should follow that in a certain proportion of schools the allowance of time would be such as to enable boys of sixteen or seventeen to attain a standard in more than one science subject over and above the limited standard required for "school leaving" or "matriculation" examinations. In schools of this type it may well be the function of the science teachers to save the curriculum from the dangers of an all-round mediocrity. This will apply more particularly to urban schools from which a considerable number of pupils pass on to scientific or quasi-scientific occupations.

(*b*) But whatever the circumstances of the school, no treatment of the science work can ever be satisfactory which leaves wholly out of consideration the relations of science to other subjects in the curriculum. Mathematics is an obvious case in point. The adoption of the same reclassification of the pupils for both mathematics and science is a plan for which there is very much to be said; but in the smaller schools there are practical difficulties in the way, which account for the fact that this expedient is rarely adopted. On the other hand, it is much to be wished that a certain proportion of teachers should be encouraged to qualify themselves to take both these subjects, and, questions of organisation apart, that teachers of physics and mathematics should always work in close touch with one another. In this connection a special point (which has received frequent notice in inspection reports for several years past) may be mentioned. It is very desirable that mensuration, which in a considerable number of schools is still included in the science course, should be transferred to its proper place in connection with the teaching of arithmetic to boys and girls in the junior departments. If this were done it would be possible, and often advantageous, to amplify the course in practical physics by the introduction, at some stage in the course, of experimental work in elementary mechanics, a subject which at the present time is too often neglected in schools. In addition to mathematics, geography, advanced manual instruction, and domestic economy may all contribute elements of value to the teaching of science, and be in turn assisted by it. It is necessary, however, to add the warning that the teacher who endeavours to teach two subjects in one may succeed admirably in teaching neither.

(*c*) The detailed syllabuses in particular subjects show in many cases curious, if not inexplicable, limitations. There is, for example, a tendency to refrain from all mention of scientific matters of common interest, because they do not admit in school work of complete and exhaustive treatment. Electricity and magnetism (including magnetic measurements) form part of the work in many boys' schools, but the motor and the dynamo are not even mentioned, because time does not permit of the study of electromagnetism. Every child is interested in soap bubbles, but the majority of boys and girls are not introduced to the simplest consideration of the phenomena connected with surface tension. There is no subject more generally studied than heat, but if a boy leaves school with any knowledge of how a locomotive works it will usually be the result of his own unaided researches. It is certainly unfortunate that pupils who learn science should be sent out into the world wholly ignorant of matters in which they are naturally disposed to be interested. Syllabuses of work, admirable for the purpose of instilling scientific method, may and sometimes do err in the direction of being inhuman.

(*d*) In the same way, it is important that in the actual teaching every opportunity should be taken of illustrating facts and principles learnt in the laboratory by frequent reference to everyday phenomena. This is a matter which requires the most careful attention in boys' schools no less than in girls' schools, in physics no less than in chemistry. Appropriate illustrations give a reality to the work which it sometimes lacks. They should, of course, be introduced as *illustrations*, that is to say, when, and only when, they may happen to be wanted to give point to the teaching. They are useful just in so far as they serve this purpose, and just in so far as it is remembered that the teaching is concerned with science and scientific method, and only in a secondary sense with its application to industry and the arts.

(*e*) Again, it is probably neither possible nor desirable to add to the number of science subjects which the pupils will systematically study in the laboratory and the classroom. There is the more reason why they should be encouraged to interest themselves in some aspects of nature other than those to which attention is given in school hours. For this the "school scientific society" may offer the needed opportunity by providing for the older pupils the occasion of taking up subjects for themselves and sharing their interests with their fellows.

Equipment.

In the matter of laboratory accommodation and equipment it is satisfactory to note that local authorities and governing bodies of endowed schools have commonly shown a generous appreciation of the requirements of science teaching. It is comparatively rare to find, except perhaps in connection with the teaching of botany, that the work is seriously handicapped by deficiencies in equipment, and the occasional suggestions of inspectors under this heading are directed, as a rule, to securing a suitable adaptation of the arrangements of the older laboratories to modern requirements. These will naturally vary in different schools with the character and extent of the course of work attempted, and it is for this reason desirable that the authorities concerned in the planning of new or the alteration of existing laboratories should take every opportunity of effectively consulting the responsible teachers. It is sometimes forgotten that space is more valuable than elaborate fittings, and that suitable provision for upkeep and apparatus is essential to the proper conduct of a laboratory. Economy and efficiency alike demand that a laboratory should not be regarded as something ready-made which can be ordered once for all from a manufacturer. On the contrary, when the essentials have been provided, a laboratory, like a library, should be allowed to grow.

Influence of Examinations.

Any consideration of the present state of science teaching would be obviously incomplete if it avoided all reference to the effects of examinations. In this connection, then, it is satisfactory to observe that the work of the schools, at any rate in the lower and middle forms, is far less determined by examination requirements than was the case even a few years ago, and that there is an increasing tendency among teachers to be guided in their teaching by strictly educational aims. At the same time there has been a marked improvement in the character of the syllabuses of certain examinations commonly taken, and a consequent improvement in the character of the work attempted in many of the schools. Notwithstanding this, it has to be recognised that a detailed syllabus put forward by an examining body, however unexceptional the syllabus may be, has its inevitable disadvantages; for it is only too likely that when a teacher has such a syllabus before him, his teaching will follow a predetermined line, whereas in connection with the teaching of science it is especially desirable, not only that the teacher should, within limits, make his own syllabus, but that he should feel free at any moment to depart from it. An examination may be unsuitable in a particular school either because the syllabus is so restricted that the last year's work tends to be a mere repetition (sometimes with a minimum of practical work) of what has gone before, or because the syllabus in a particular subject—chemistry, for example—covers so wide a field that the teachers in the limited time available practically confine themselves to this subject alone, and in dealing with it are forced back on mere bookwork and informational teaching.

Relation of Theoretical to Practical Teaching.

Attention has been frequently directed in the reports of inspectors to the necessity of establishing a right relation between the theoretical and practical teaching of science. By this is meant, not only that the two modes of treatment should be closely associated with one another, but that they should be placed in their right order. In this important matter there has been a notable improvement in the methods of teaching followed in the schools, and criticism in this region is likely in the future to be more concerned with details than with matters of principle. Though opinions differ as to the precise methods by which the desired results are to be secured, it is now very widely recognised that the teaching of a class should, so far as possible, be based on the practical work done by the members of the class. As a fact, lectures have largely given place in elementary teaching to class discussions on the practical work assisted by occasional demonstrations, and the change has been beneficial to the work of the lower and middle forms. In some cases, however (as will be pointed out later on), the practical work has not been supplemented by any adequate discussion of its results. In other cases, the reaction against formal lectures has gone so far as to lead teachers to rely exclusively on the experiments carried out by the class. There is reason to think that when this is done the teaching loses in effectiveness.

Practical work in the lower and middle forms ordinarily follows on a brief discussion of the matter to be investigated, and a written account of the experiment to be carried out is regularly required. Such written accounts should, of course, be the outcome of the pupil's own efforts, and not be, to all intents and purposes, dictated by the teacher or copied from a book. So far as these records are concerned, there has been of late considerable improvement. The mechanical entering up of results in spaces set apart for the purpose, or the filling up of columns under the headings "experiment," "observation," "inference," has nearly disappeared; but more remains to be done in regard both to the form and substance of the record. The idea that there are two standards of composition, one which is appropriate for the English lesson, and another which is good enough for the science laboratory, has not yet been eradicated. But, apart from this, the notebooks often include accounts which are satisfactory in so far as they are purely descriptive, but which fail to show how the "conclusion" follows from the observations recorded or to state what assumptions have been made in the argument. It is not, indeed, uncommon to find conclusions recorded which the pupil's own work quite fails to justify. The "doing" is, in fact, unaccompanied by any honest thinking about what has been done. There is, of course, nothing in this to cause surprise. To expect exactness of thought and accuracy of expression from younger pupils is to expect the ripe fruits of scientific education from those who have but lately begun to enjoy its benefits. If these logical errors never occurred, there would be no need to spend time over teaching "scientific method." It is precisely by seizing the opportunities which such mistakes and omissions afford that the teacher can convey to the pupil valuable lessons in the logic of science.

So far as the actual experimental work is concerned, its value depends in different schools on the extent to which the pupil is encouraged to use his own eyes, to apply his powers of reasoning to the problem under consideration, and to criticise his own procedure. The work should, in fact, serve not only to develop the powers of observation and reasoning, but to inculcate "an increasing respect for precision of statement and for that form of veracity which consists in the acknowledgment of difficulties." It is quite possible for pupils to work through a set of disconnected experiments and to get little out of it beyond a certain facility in easy manipulation. Work of this kind may be as mechanical and as far removed from being really practical as anything that is done in a classroom. The necessities of the school time-table often lead to the work being broken up into the performance of a series of isolated experiments, one for each lesson period. There is, therefore, the more reason why teachers should be on their guard against the serious danger of making the single experiment the unit of teaching. The exclusion of experiments which are trivial, or of which the results are self-evident, and the occasional adoption of the plan of allowing different groups in a class to work at different though allied experiments, the results obtained by each group being available for the whole class and used in the subsequent discussion, would do much to widen the pupils' experience and give the work a seriousness and importance which it sometimes lacks.

The remarks in the two preceding paragraphs are intended to apply more particularly to the treatment of the practical work in all science subjects in the lower and middle forms. The methods appropriate to the teaching of the higher forms are, in general, much better understood, and need not now be dealt with. But the teaching of botany requires special notice, especially in view of the important position it occupies in the science work of girls' schools.

Teaching of Botany.

Considerable changes have been effected in recent years in the method and scope of botanical teaching. The time given to the purely descriptive work connected with the classification of plants in their natural orders has been greatly curtailed, and it is now common to find included in the course an experimental treatment of plant physiology and some consideration of the question of habitat. There is, too, an increasing tendency to recognise that no adequate study of botany is possible without some knowledge of the elementary facts and principles of chemistry and physics. The broader treatment which the subject now receives, and the substitution of a partially experimental for a purely descriptive method, have led to a healthier development of science teaching in many girls' schools. But the new methods have brought with them their own special difficulties, which, in most cases, still await solution. It is rare, for example, to find the experimental work on plant physiology really well done, and the possibilities of the school garden as an adjunct to the laboratory are insufficiently realised by teachers of botany.

Though in connection with this subject it is possible to record a general tendency in the right direction, and in a fair number of instances a real advance, it is still the case that in too many schools botany is regarded somewhat in the light of an accomplishment, making no very serious demands on the pupils' intelligence and requiring little more by way of equipment than a classroom and a bunch of flowers.

In conclusion, it may be stated that if attention has been deliberately directed in some of the foregoing paragraphs to certain existing defects in the teaching of science, this is due to no failure to recognise the excellence of the work which in many secondary schools is being done under the guidance of skilled and experienced teachers.

THE SCIENCE MUSEUM AND THE GEOLOGICAL MUSEUM.[1]

THE report of the Departmental Committee on the Science Museum and the Geological Museum was published a few days ago. The committee was appointed in March, 1910, and its terms of reference were:—"To consider and report upon various questions in regard to the present condition and the future development of the valuable collections comprised in the Board's Science

[1] Report of the Departmental Committee on the Science Museum and the Geological Museum. Cd. 552. (London: Wyman & Sons, Ltd Price 3*d*.

Museum at South Kensington and Geological Museum in Jermyn Street. In particular the committee are asked to advise (*a*) as to the precise educational and other purposes which the collections can best serve in the national interests; (*b*) as to the lines on which the collections should be arranged and developed, and possibly modified, so as more effectively to fulfil these purposes; and (*c*) as to the special characteristics which should be possessed by the new buildings which it is hoped will shortly be erected on the South Kensington site to house these collections, so as to enable the latter to be classified and exhibited in the manner most fitted to accomplish the purposes they are intended to fulfil."

The members of the committee were:—Sir Hugh Bell, Bart., chairman; Dr. J. J. Dobbie, F.R.S.; Sir Archibald Geikie, K.C.B., F.R.S.; Dr. R. T. Glazebrook, C.B., F.R.S.; Mr. Andrew Laing; the Hon. Sir Schomberg McDonnell, K.C.B., C.V.O.; Sir William Ramsay, K.C.B., F.R.S.; Prof. W. Ripper; Sir W. H. White, K.C.B., F.R.S.; Mr. F. G. Ogilvie, C.B., secretary.

The completion of the report is deferred, as the committee is unable to deal in detail with that part of the terms of reference which concerns the adaptation of the general plan of the new buildings to the requirements of classification and exhibition of the collections, until the boundaries of the site are determined. The committee therefore reserves for later consideration and report, when definite information on this point is available, those characteristics of the buildings that will be governed in large measure by special features of the particular site. In the present report the committee sets out the nature, aims, and uses of the collections upon which it proposes to base later recommendations as to the new buildings.

We print below parts of the concluding sections of the report of particular interest.

The Geological Survey Offices and the Museum of Practical Geology.

The Geological Survey Offices and Library and the Museum of Practical Geology are now cramped by the limitations of the building in Jermyn Street. These institutions, which form parts of a connected whole, and must be kept together, should be grouped, as at present, in a single building. We are convinced that if the necessary space can be allotted at South Kensington, it would be of great advantage to have that building erected as part of the general scheme there. The collections in the Science Museum represent the general principles of geology and geography by examples selected from all regions of the world—the stratigraphical collections in the Jermyn Street Museum deal specially with the geology of the British Isles (see Appendix iv., p. 30). If these two were brought together they would provide the basis of a collection that would be complete as regards stratigraphical and economic geology. Such a collection in the new buildings, with the systematic collection of minerals and the palæontological collections arranged according to their natural affinities in the British Museum (Natural History), would represent at a single centre the whole field of geological science.

In the event of the removal of the Museum of Practical Geology from its present site, more extended accommodation must be provided for the exhibited specimens. As matters stand now—to refer to one only of the activities of the Geological Survey—the economic collections, which are arranged with special reference to the requirements of the practical man and of the technological student, cannot be properly developed unless more ample galleries are available for them.

Accommodation Required for the Two Museums.

In dealing with the question of the accommodation that would be required in the new buildings, we must consider both the immediate requirements and the provision to be made for probable future expansion of the collections.

So far as the more immediate needs are concerned, we have prepared an estimate of the minimum floor space which, in our judgment, is necessary for exhibition galleries, offices, workshops, store-rooms, and demonstration rooms, or other meeting rooms, all properly lit. In this estimate we have assumed that there would be further store accommodation suitable for safe-keeping of objects, although not for their examination. The figures, which are given in Appendix vi. (see p. 32), bring out the following totals:—

Science Museum: Total floor space required in the immediate future, *exclusive* of entrance halls, staircases, lavatories, cloakrooms, and reserve stores, and *in addition to* 16,500 square feet already provided in permanent buildings, 300,000 square feet.

Museum of Practical Geology and offices of the Geological Survey: Total floor space required in the immediate future, *exclusive* of entrance hall, staircases, lavatories, and cloakrooms, and reserve stores, 60,000 square feet.

Buildings on this scale would provide for such developments as we can now foresee; we think it likely that they would be well utilised within the next ten years, or even in the course of a shorter period, if active steps were taken to make good the deficiencies of the existing collections. At the same time, the buildings could be designed so as to facilitate arrangements for meeting the possible requirements of a more distant future, and whatever space may be set free from time to time by revision of the collections, the building scheme adopted now should provide for ultimate extension of the floor space beyond the area we have stated. With this matter we shall deal further in a later report when we can discuss it with full knowledge of the site available.

General Statement.

In most of the departments of science and its applications, the museums on which we have been asked to report contain much that is of great historical interest and value. They are rich in specimens, instruments, machines, and models, selected and exhibited in such a manner as to repay systematic examination by the student. They have shown what skilful museum exposition can do to promote an intelligent appreciation of the leading facts and principles of science and of the ways in which invention has applied these to the furtherance of the industrial welfare of the world. In many sections, however, the collections are now far below the standard which it is clear they ought to reach in these matters, and their proper organisation is impossible in the existing accommodation. When suitable buildings are provided on the scale we have indicated, there will be full opportunity and encouragement for working up all the departments, and more frequent gifts and loans will doubtless quickly fill many of the gaps that are now obvious. Some gaps, indeed, would be filled at once by objects which the governors of the Imperial College of Science and Technology are prepared to present to the museum.

In other departments of knowledge, the British Museum and the Victoria and Albert Museum have set a high standard for the national provision of museum facilities. In the domain of science, the requirements of most of the branches of natural history are already admirably provided for at South Kensington in the Natural History Museum. In no way overlapping or duplicating the functions of these great institutions, but representing aspects of human activity which lie outside their scope, not less ample provision is necessary for those departments of knowledge, invention, and discovery the needs of which have been brought so vividly before us in our inquiry, and we are of opinion that no scheme for a national science museum can be regarded as satisfactory unless it provides the buildings necessary for affording to science and the industries all the assistance a museum can give. A science museum in which all branches of physical science, pure and applied, and the scientific and economic work of the Geological Survey, shall be adequately illustrated in close proximity to the other great museums at South Kensington will, we believe, be of incalculable benefit alike to intellectual progress and to industrial development, and will be recognised as an institution of which the country may well be proud.

TRAVELLING AT HIGH SPEEDS ON THE SURFACE OF THE EARTH AND ABOVE IT.[1]

"The Spirit of the time shall teach me Speed."—*King John.*

THERE are few things so important to man from a material point of view as the power of locomotion: seeing, therefore, that in this respect he is far less well endowed by nature than many, if not most, living creatures, it is no wonder that he has striven from the earliest times to overcome his inferiority by means of mechanical devices. The marvellous results of these unceasing attempts which to-day we enjoy, or, as some people would prefer to say, "take advantage of," are accepted by most of us as a mere matter of course, and we are further apt to assume that the progress which has been so marked during the last century, and particularly in recent years, will continue indefinitely. Now, quite apart from mere locomotion, the question of speed is one of great scientific interest, and, more than this, it is the real test of the power of locomotion. This is not a mere accident, but has its root in something far deeper. The desire for speed is a quality inherent in man, and is doubtless a primordial instinct, the reason for which we see in all other animals, being derived from prehistoric ages, when speed was a necessity of life to enable the weak to escape from the strong and to enable the strong to prey upon the weak, and man depended, just as the animals in prehistoric times, for his life on his fleetness and speed of motion.

From what few and somewhat uncertain records we have of the achievements of man in running in the ancient sports, it does not seem there is very much difference between his powers then and in modern times. As to modern times, we find that for the short distance of 100 yards, and for the longer distance of a mile, the records of twenty-five years ago still stand, notwithstanding the strenuous efforts made to improve upon them on many scores of occasions each subsequent year. Thus we have for the former the record of E. Donnovan in 1886, 21·3 miles an hour, and in the same year the record of W. G. George for the mile, 14·2 miles an hour, which have never been beaten; while for one distance, that of 200 yards, the record of Sewards in 1847, or sixty-four years ago, still stands. In fact, a study of all the records of twenty-five distances shows that several of them remain unbroken after comparatively long periods, viz. from a quarter to half a century.

Thus, so far as his own unaided powers of locomotion are concerned, man may be considered, for all practical purposes, to have reached long ago the limit of speed possibility. From earliest times, however, he has brought the muscular effort of other animals into his service, and has devoted his intellect towards improving their speed for his own uses. You will see graphically recorded in Fig. 1 the speeds of all the Derby winners from the year 1856, *i.e.* for more than half a century. The average speed, which may be taken as somewhere above 30 miles an hour, has doubtless slightly increased, but it will be seen from the dotted line which has been drawn at the top of the maximum speeds what comparatively little increase has been obtained for an expenditure of the many millions represented directly and indirectly in the training and breeding of these horses, and it may be reasonably assumed that here again the limit has been reached for the fleetest animal, by the aid of which man can increase his speed of locomotion by using muscular power other than his own.

What, then, are the physical reasons for this limitation? It is not due to the chief cause, which we shall see later puts a practical limit to very high speeds in mechanical locomotion, namely, the resistance of the atmosphere. Neither is it due to the effective work done in movement, since with a body moving along a level plain, *i.e.* at a constant distance from the earth's centre, this effective work is nil. To understand the matter we must study the nature of animal locomotion. The surface of the earth is rough, sliding along it being obviously out of the question; nature has made provision for animal movement as follows:—one part of the body first rests on the ground, another part supported by this is advanced, being raised clear of the ground, to rest in turn upon the ground and serve in turn as a support, so that the part behind may be raised and advanced to a fresh position. In man and other animals the feet form the points of support for this process; but the same method of locomotion is employed by creatures without feet, which have to crawl or glide, such as snakes or worms.

This process, whether with animals or reptiles, as you will see, involves in the raising of the body an expenditure of work which is not recovered, and further an expenditure of work in stopping and starting some portion of the body in its movements. My assistant now walks in front of the blackboard holding a piece of chalk level with his head, and you will see the rising and falling motion. I have prepared a wooden model to represent the action of his legs, and you will see that these legs, being equal to his in length, produce almost exactly the same curve underneath, so that you have a complete explanation of this movement, viz. the rotation of the hip about the ankle as a pivot. There is a third case of loss, namely,

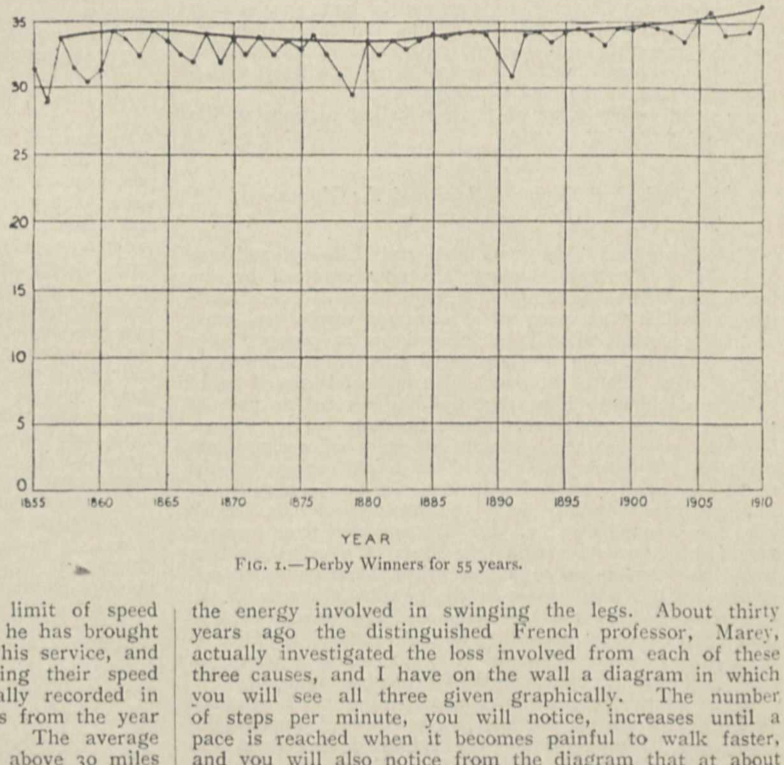

FIG. 1.—Derby Winners for 55 years.

the energy involved in swinging the legs. About thirty years ago the distinguished French professor, Marey, actually investigated the loss involved from each of these three causes, and I have on the wall a diagram in which you will see all three given graphically. The number of steps per minute, you will notice, increases until a pace is reached when it becomes painful to walk faster, and you will also notice from the diagram that at about ninety steps per minute the gait changes to a run, that is to say, a springing action takes place, the hind foot leaving the ground before the front is put down upon it.

I have another diagram showing how the length of stride at first increases with the pace, and afterwards begins to fall off before the walking breaks into a run. The reason why a man or an animal changes his pace at this point is obvious, and it is because a faster speed is possible with a less effort. As the speed of running is increased the total effort becomes greater, but the three elements shown on the diagram are differently divided; the rise and fall element is less, but the work done in swinging the legs is more, while the chief element, in the muscular effort expended, is the loss of energy involved in stopping and starting as each spring reaches a maximum. Time does not permit me to pursue this interesting subject further except to point out that exactly

[1] Discourse delivered at the Royal Institution on Friday, March 31, by Prof. H. S. Hele-Shaw, F.R.S.

similar causes operate in the natural locomotion of other animals which move on legs.

We therefore now know that the limit of speed is controlled by two factors:—

(1) Physical endurance, owing to the expenditure of work occurring at an increasing rate as the speed is increased.

(2) The physical impossibility of giving a reciprocating movement to the legs quicker than a certain limited period of time.

I have prepared a chart, Fig. 2, which shows the maximum recorded velocities of man's progression in walking and running. The speeds are set up as vertical ordinates, and the abscissæ represent the distances over which the respective speeds were maintained. It will be seen that the maximum speed of walking is about 9 miles an hour for a short distance, but when the long distance of 100 miles is covered, the quickest rate recorded falls to 5½ miles an hour. For running, the quickest speed which I have mentioned, viz. 21¼ miles an hour for 100 yards, falls to 7½ miles an hour as the average speed for a distance of 100 miles.

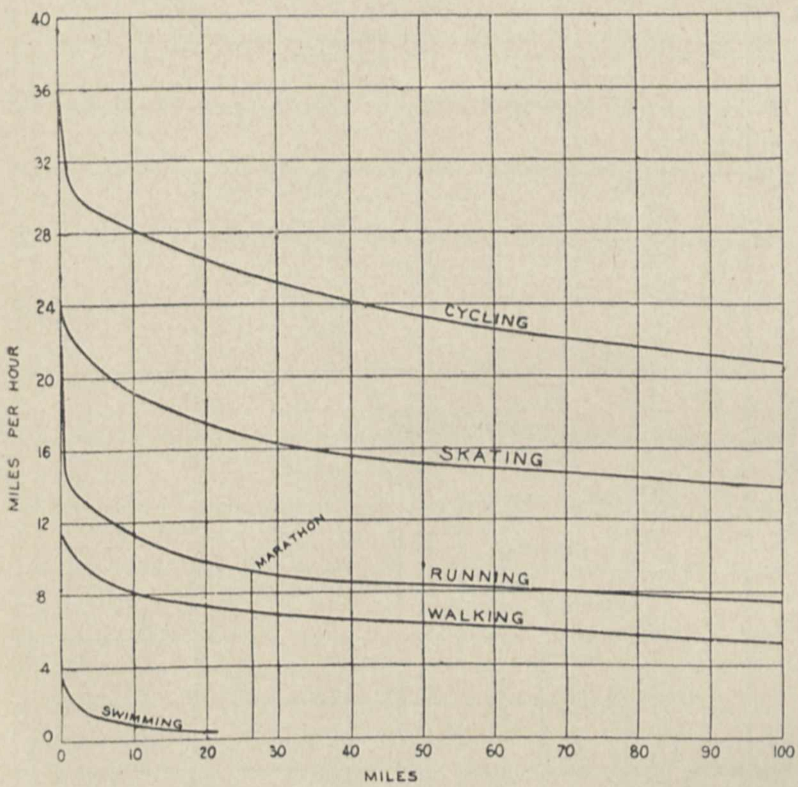

Fig. 2.—Speed Records for Human Muscular Effort.

We do not know the speed of the original historical run from Marathon to Athens, but we do know that Dorando ran the modern Marathon from Windsor Castle to the Stadium at Shepherd's Bush, a distance of 26 miles 385 yards in (to be exact) 2h. 55m. 18 2-5s., or at the rate of 9 miles per hour, which, you see, fits very well on our curve.

We may notice in passing that in walking fast and starting to run the arms swing in time with the opposite leg, as in the modern picture on the diagram exhibited. In the picture, however, copied on the same diagram from an ancient Greek vase, although the attitude of the legs is the same, it might appear at first sight as if the arms were swinging in the contrary way. As a matter of fact, a closer examination shows that in all the figures on the vase the arms are in the same position, although the legs are in different phases. This seems to indicate that the arms of a Greek runner were held in a fixed position as shown, and, from the position of the hands, with the evident intention of cutting the wind. If this is true, it indicates that even then it was clearly recognised that if there was any effect of the wind it was just as important behind as in front, a matter I shall have to allude to hereafter.

What man can do by his muscular effort in the water is shown by the small curve in the corner. The greatest distance shown (Fig. 2) is about 21 miles by Captain Webb at about 1 mile per hour, although for a short distance it will be seen that a man can swim at about 4 miles per hour. I do not put in flying, because man has not yet flown by his own muscular effort, and flying men to-day are using engines of from 20 horse-power to 100 horse-power, *i.e.* from 200 to 1000 *man-power*. Gliding *per se* is no more than falling through the air (more or less) gradually, as in a parachute.

Before proceeding to see what man has done to increase his powers of purely muscular locomotion by means of mechanical devices we will study the details of locomotion in the other animals. We are able to do this by the method of Mr. Muybridge, since developed in the invention of the kinematograph, and which was explained by Mr. Muybridge for the first time in this country about thirty years ago in a lecture in this hall.

Take, first, the galloping horse. The lantern diagram shows clearly the various phases in the action of a horse, and shows how the animal is not only able to attain its high speed by its length of stride, but by doing what man cannot do to the same extent—drawing up its body and in springing forward, using alternately its fore and hind feet, so as to get a stride which no two-footed creature could attain on the level ground. I may point out that the kangaroo, though using only two legs, makes effective use of its tail in the spring. The horse springs clear of the ground off its forefeet, only you will notice that it uses both its fore and hind legs as the spokes of a wheel on which it rolls when walking (exactly as man does), though it rolls and springs alternately in galloping. The same kind of diagram could be constructed for the effort exerted at different speeds by the horse, as has been produced by Marey for the man, only the distribution of energy would probably be very different.

Turning next to other animals, it is interesting to observe that a greyhound gets its high speed in proportion to its size owing to the great flexibility of its long body, which enables it to draw its hind legs forward each time for the next bound, and also bound forward both from its fore and hind legs. The other animals in galloping have each the same general kind of movement, although the deer, curiously enough, only bounds from its hind legs, and differs in this respect from the horse; and also it will be noticed the want of flexibility in the body of an animal may be one of the causes of its relatively slow speed. But whether it be man, horse, dog, or any other animal, the same characteristic is found, namely, that locomotion, apart from the bounding action, takes place by a sort of rolling action on the ground. The idea which had persisted since the delineation of horses in Assyrian and Egyptian pictures, that both the fore or both the hind legs are put on the ground simultaneously, is thus exploded. As Mr. Muybridge truly said: "When during a gallop, the fore and hind legs are severally and consecutively thrust forwards and backwards to their fullest extent, their comparative inaction may create in the mind of the careless observer an impression of indistinct outlines; these successive appearances were probably combined by the earliest sculptors and painters, and with grotesque exaggeration adopted as the solitary position to illustrate great speed." As a matter of fact, each leg in turn, as it rests on the ground, stops for a moment just as much as in the forward position above mentioned, and if you watch a dog galloping you can see quite clearly the rolling stroke action I have mentioned.

With the above facts in mind, we can understand exactly the limitations to animal locomotion. In the words of Mr. Muybridge:—" When the body of an animal is being carried forward with uniform motion, the limbs in their relation to it have alternately a progressive and a retrogressive action, their various portions accelerating in comparative speed and repose as they extend downwards to the feet, which are subjected to successive changes from a condition of absolute rest, to a varying increased velocity in comparison with that of the body." Hence all animal locomotion absolutely lacks that continuity of movement, the production of which we shall see is the distinguishing feature and the direct cause of the high speeds attained in mechanical locomotion.

The exchange of the intermittent movement of nature for one having the desired continuity of movement has been effected by means of what is possibly the greatest and yet the simplest of all human inventions, namely, the wheel. The wheel was made and used probably thousands of years before man learnt to replace muscular effort by that of steam and the other forces of nature, the origin of the wheel being absolutely lost in antiquity.

From the models which I now show will be noticed the way in which the wheel acts and how it overcomes the defect of animal locomotion, giving a rotary and continuous movement instead of a reciprocating and variable one. At one and the same time the wheel, therefore, does away with the three causes of loss shown in the diagram as occurring with animal locomotion. The mere use of the wheel has enabled man himself, by his own muscular effort, enormously to increase his individual power of locomotion. The top curve on Fig. 2 shows, in comparison with the other curves of walking and running, his unpaced records on a bicycle, in using which it will be realised that all three causes of loss which occur in running and walking are obviated. You will notice a similar difference in speed as the distance varies to that which is made evident in the curves for walking and running. For the distance of 100 miles the average speed is thus only 21 miles an hour, while that for ¼ mile is more than 35 miles an hour. In view of the results shown by the curve, it is not surprising that the bicycle has entered largely into the conditions of modern life. I am not able to give you any exact figures of the quantity of bicycles turned out each year in this country, but I can tell you that in the Post Office alone there are now 12,000 bicycles employed, and their number is always on the increase; the distance covered on them by men and boys in the year is more than 120,000,000 miles

I have not dealt with *paced* bicycle records, as such are not the result of muscular effort, but of being pushed along by the current of wind which follows up the pacing machine such as occurs when a man on a " push " bicycle is paced by a motor vehicle. In a record first set up in America for 60 miles an hour on a bicycle, a man was paced by a locomotive engine, running at 60 miles an hour along a special track; the r'der was nearly killed when he tried to drop behind, owing to the whirlwind which was being dragged along by the engine; ultimately his life was saved by his being lifted bodily off his bicycle on to the locomotive. There is no record as to what became of the bicycle.

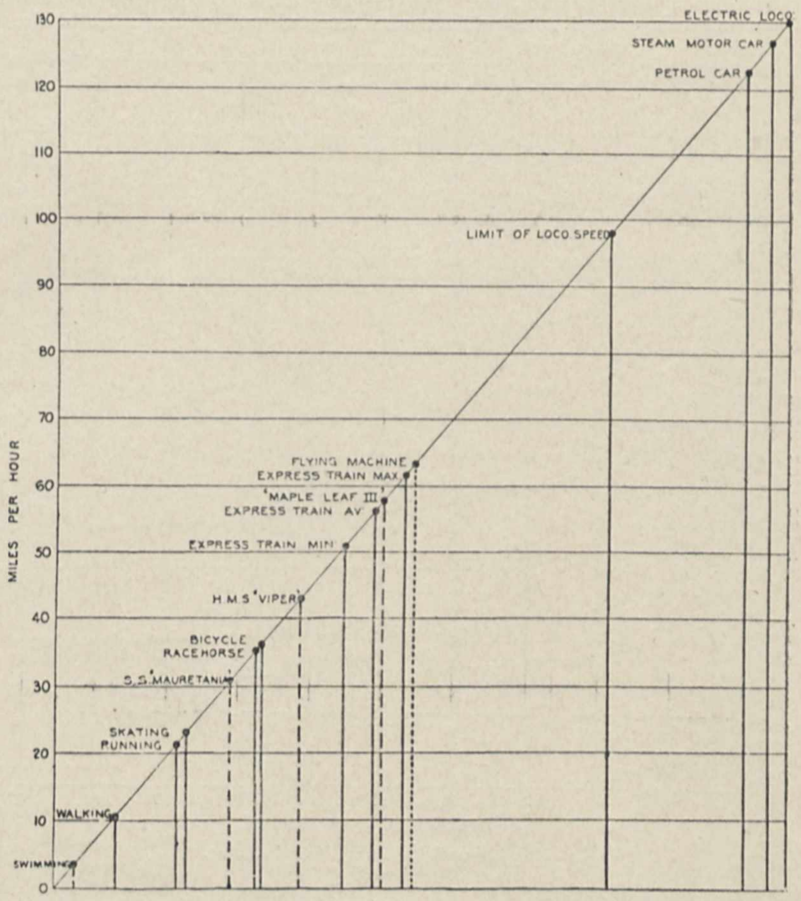

FIG. 3.—Graphical Table of Maximum Speeds.

Curiously enough, records for ice skating and roller skating are almost the same, and far below that on the bicycle, which I think proves distinctly that the reciprocating movement of the limbs limits man's powers, whether he is sliding on the ice or using wheels as with roller skates. This is so, notwithstanding that he carries along with him when on a bicycle the extra weight of the bicycle, but the reciprocating movement of his legs is so slow, owing to the gearing up of the driving wheel, as to give him the material advantage shown by the respective curves. Further, in skating, there is no doubt that the movement of his limbs entails a certain amount of rising and falling, as well as reciprocating motion and consequent loss which occurs in running.

Now, in theory, the wheel is perfect, and in the case of a perfectly hard, circular wheel, rolling on a perfectly hard track, there should be no resistance. This you can well imagine from the lantern model which I now show in operation. In this there is no appreciable resistance, but it is just in this direction that the wheel has defects unknown to nature's methods, since men and animals move upon the ankle joint in a quite superior way to the rolling of an ordinary wheel. In passing I may remark that the more man improves the roads, and the higher his standard of locomotion becomes, the more will he feel the need of a mechanical walking machine (it will be a *walking* machine, though possibly moving at 20 miles per hour) to progress over parts of the earth where roads do not exist, or are still in an evil condition. The better his mechanical appliances for producing such a walking machine, the sooner will this come about, as this is really a vital factor in the solution of the problem. No wheel, however, is quite hard and round, and no road is quite hard and smooth, and there is always an arc of contact, more or less appreciable, which causes a loss, since rubbing takes place instead of true rolling, as shown in the next lantern slide. The next lantern working model I show illustrates the other effect, in which the wheel meets obstacles and is deflected by them from its course, giving exactly the same kind of loss which I showed you takes place with a man in walking, and which is made apparent by making the car write its own record on a piece of smoked glass, exactly as my assistant wrote his record of rise and fall on the blackboard.

Thus there are two ways in which the wheel can be improved:—

(1) Is by perfecting the wheel and hardening the track—and that is the secret of the development of the railway system.

(2) The other is by causing the obstacle to be absorbed in the tyre of the wheel—that is the real secret of the success of the pneumatic tyre.

The working model now on the screen illustrates the latter point, and shows at once how the three causes of resistance to animal locomotion are overcome.

To-day we can replace the muscular energy of man by almost unlimited mechanical power, and Fig. 3 is a comparative speed chart which I have prepared and which indicates the enormous advance in the speed record which has been made over the best unaided muscular efforts of any animal. It is curious to see that the highest speed ever attained on a railway is closely approached by that obtained with motor vehicles. The records for the latter are as follows:—

A Darracq car of 200 horse-power has done 122½ miles an hour for 2 miles. A Fiat car, driven by Nazarro at Brooklands, 126 miles an hour. A Stanley steam car, 127 miles an hour, and a Benz car has done 127½ miles an hour.

The maximum recorded speeds of a railway were on the experimental line of Messrs. Siemens, on the Berlin-Zossen High Speed Railway, where a speed of rather more than 130 miles an hour was attained. The electric current employed was 10,000 volts, 400 horse-power motors being used. On the Marienfel-Zossen experimental line, the speed attained with 250 horse-power was apparently rather less, though in that locomotive four motors were employed, the current being, as in the other case, 10,000 volts. The lantern diagrams are a picture of the vehicles actually employed, and of the track on which the experiments were made. As a set-off against the sober engineering pictures, I show a picture taken from an American motor journal, illustrating a motor vehicle and locomotive at top speed, the former passing on a level crossing in front of the latter.

The foregoing are the record speeds so far obtained of mechanical locomotion, and it will be interesting to see what are the record speeds attained in the other elements. Until the other day, as Mr. Parsons told us in his lecture, the speed on water which has never been exceeded was that of the ill-fated turbine boats, *Viper* and *Cobra*, of about 43 miles an hour. The ship which at present holds the record for speed is the torpedo destroyer *Tartar*, built by Messrs. John Thornycroft, this, under Admiralty tests, giving a speed of 41 miles an hour.

The diagram, Fig. 4, shows in an interesting manner what the progress in speed has been for this class of boats during the last few years, and may be taken as typical, and about which curves Sir John Thornycroft writes as follows:—

"I do not think the curve would be materially altered if vessels of other builders were brought in, although there would naturally be more points on it."

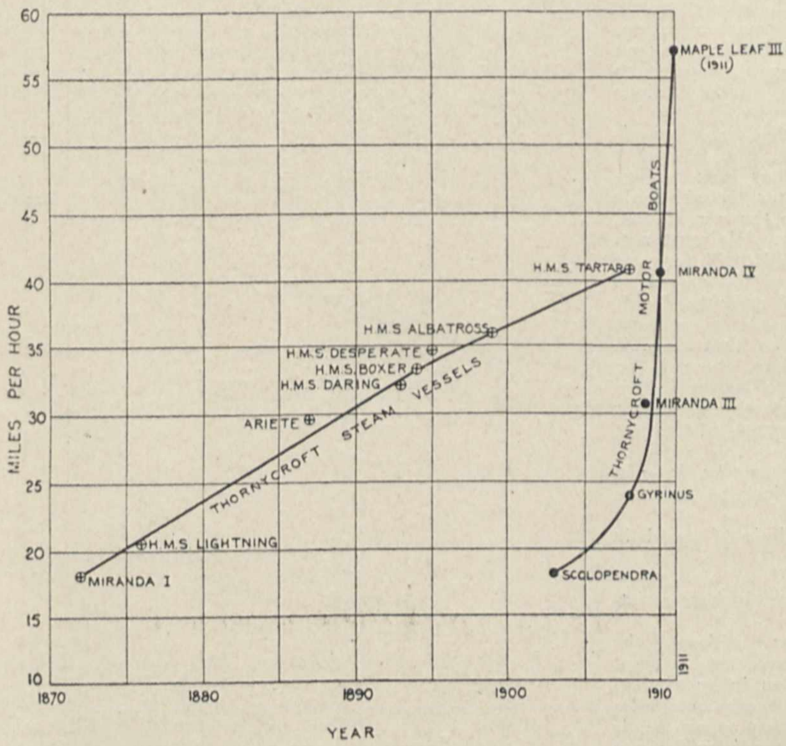

FIG. 4.—Speed Records for Thornycroft Warships and Motor Boats.

I am able, however, to give you the results to-night of something which has altogether put in the shade even the speeds of the two first-mentioned boats. This has been attained by a boat which, though corresponding in some respects with previous hydroplane boats, has been designed by Sir John Thornycroft to possess a certain amount of seaworthiness. The rate of progress in the increasing speeds in this class of boat is shown on a separate curve, Fig. 4, from which you will see that the celebrated *Miranda* held as a hydroplane the record with the *Tartar* for speed, the *Ursula* also holding the record of about the same speed as a motor-boat. Only a few days ago, however, the new boat *Maple Leaf III.* has attained the extraordinary speed of nearly 50 knots, that is to say, a speed approaching 60 miles an hour, using 600 horse-power to effect this speed. To use a vulgar expression, this certainly smashes all previous records for speed. I do not pretend to give exact figures in this case, because such have not been officially taken, but the statement is probably on the low side as the boat has not been yet properly tuned up. You will see one remarkable thing from the curve, namely, that the rate of progress has been so rapid in this class of boat, and the curve rises so steeply, that in about three months' time there is due from Sir John Thornycroft a boat which will travel at about 100 miles an hour. I am afraid, however, it would not be fair to press this graphical argument quite so far.

Through the kindness of Sir John Thornycroft, and Mr. Edgar, the owner of the *Maple Leaf*, I am able to show both the *Miranda* and the *Maple Leaf III.* The latter, you will see, is travelling at such an extraordinary rate that the water which is lifted up does not fall to the surface again until the boat itself has travelled several lengths away. You may be interested to see a model of this last boat, which has been kindly prepared for me to show to-night, as well as the *Tartar* and *Miranda*. You will notice the form of the *Maple Leaf III.* is that of a steeped hydroplane, which in a modified form was first suggested by Mr. Ramus many years ago; it is the secret of placing the weight, and also the development of light engines giving large horse-power, which has enabled the dream of Mr. Ramus to be fulfilled.

Turning to the last of the three elements, namely, air, it was my intention to have dealt with it at greater length than I now find it is possible to do, but, thanks to the daily Press and illustrated journals, this subject is as fresh in the minds of everybody as it is familiar. It is not necessary in this room to remark that the wild talk of almost incredible speeds has very little foundation. Bodies move quickly enough in the air, and very often far too quickly, but what is generally overlooked is that the difficulty of the problem lies in the matter of supporting the body in the air rather than moving through it, a problem which is very much simpler for land and water. The human body itself, while of about equal specific gravity with water, is about 800 times as heavy as air, and probably, taken in conjunction with the motor and aëroplane, the weight which has to be supported is several thousand times as heavy relatively to the air which it displaces. Inasmuch as the support of the air necessitates the use of an inclined plane and a corresponding expenditure of energy, the speeds made horizontally and independently of the wind have, at the present time, barely exceeded half the record speeds made on wheel vehicles. As a matter of fact, only the other day the record for passenger flight was broken by M. Nieuport at Mourmelon, when he flew with two passengers for 1h. 4m. 58 1·5s., and covered 68·35 miles at an average speed of 63 miles per hour. It is difficult to say exactly what the true record speed at present is round a course, but we may safely take it as probably under 70 miles an hour, the record being, so far as I have been able to ascertain, by M. Nieuport on March 9 this year at Chalons —68 miles 168 yards in the hour.

We now see the relative position of the record speeds in the three elements on our speed chart, Fig. 3, and it is obvious that while on land the speed has been far exceeded of the fastest animal, on water it has probably only recently surpassed that speed, while in the air, in all probability, it is still considerably below it. We must not, however, from this argue that flying speeds will for safe flying machines rise so far beyond that of birds as land locomotion has risen above the speed of animals, for it looks as if the speed records on land would be at least equal for some time, if not greater, than that possible with safety in the air. At the same time, there is no doubt that speed is the one great factor of safety in flying, and aërial speed records are sure to go on rising year by year, but time does not permit me to pursue this subject further to-night.

Instead of vague surmises as to what may be done in the future, let us spend a few minutes looking into the question of these limits.

The two chief things on which the limit of speed in locomotion will depend are:—

(1) The motive power available.

(2) The resistance, and the manner in which those resistances operate.

But inasmuch as we are not merely considering the human body as a projectile, we do not take into account such speeds as have been attained by man in such ways as, for instance, in a high dive, say, of nearly 100 miles an hour, or even the thrilling descents such as are made in a bobsleigh. We must really consider speeds which can be made with safety; and there are two further questions which arise:—

(1) Knowledge as to possible obstacles, coupled with a power of safely stopping within the distance to which our knowledge extends, *i.e.* signalling and brakes.

(2) Vibration.

These two latter really limit conditions of high speed for practical travelling.

In daily life, the limiting conditions of speed in travelling depend largely on the distance in which we can safely come to rest. As the population increases and there is less room for everybody, the question of brake-power becomes more and more important, and with it, of course, the power of starting from rest quickly, or, to put it in scientific words, the power of rapidly effecting both positive and negative acceleration. We are very differently constructed from the particles of air in which we live, and do not yet travel as fast, but fortunately, as yet, we are not quite so crowded, since, according to Lord Kelvin, they move about amongst each other at the ordinary atmospheric temperature and pressure at an average speed of 1800 miles an hour, and they cannot avoid fewer than five thousand million collisions in every second. As you see in the streets, and as I shall show you with regard to suburban traffic, high speed is becoming more and more a question of starting and stopping rapidly. I remember in the early days of cycle racing, in order to lighten the machine, the racing men had no brake, until they found what is now well recognised—that the speed at which you can travel depends upon the safe distance in which you can stop. I can illustrate this by dropping an egg from the dome of this building, which I can do without causing it any injury, even when it is travelling at 30 miles an hour, if I have proper means for bringing it to rest. I also drop a wineglass from the same height, and bring it to rest quite safely.

Owing largely to the perfection of the continuous brake, the speed records obtained on several railways are from 96 to 98 miles an hour, which I have put down on the diagram, and it is possible that 100 miles an hour has been reached, and even exceeded; but this is a very different matter from the highest express running which is found really practicable. You will see on the speed chart, Fig. 3, a line indicating the average railway speeds of the fastest running (without stopping) for the fifteen

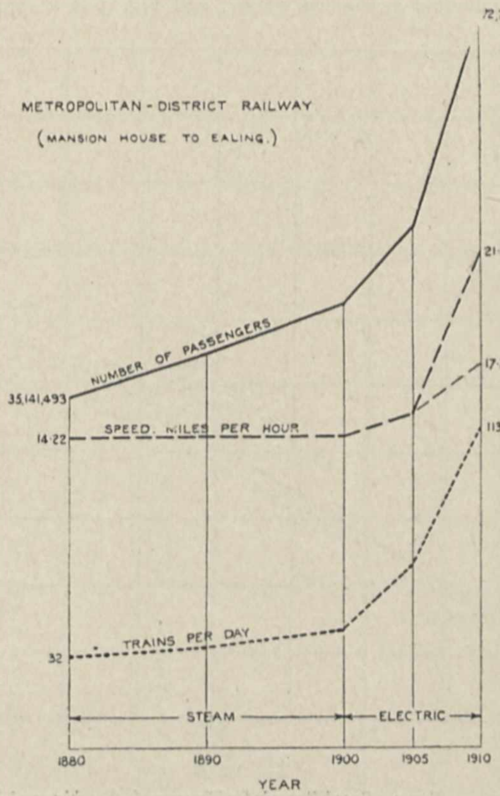

FIG. 5.

principal railways of the country. The average distance of the quick runs is 51·7 miles, and the average fastest running is 56·2 miles per hour. On either side of this line are the two fastest speeds, namely, 61½ miles per hour for 44¼ miles on the North-Eastern Railway from Darlington to York, and the lowest of these is 51 miles an hour, over the 51 miles from Victoria to Brighton on the London, Brighton and South Coast Railway. This shows how little the high speeds of all the railways of this country differ from one another, and indicates, at any rate for the present conditions, the highest speeds of travelling found suitable to our wants.

I will take as another illustration of actual travelling the case of suburban traffic; and we have only time for one example, namely, the traffic from the Mansion House to Ealing on the Metropolitan and District Railway, the details of which have been kindly provided by Mr. Blake, the superintendent of the line. Fig. 5 shows in graphical form the quickening in speed from the opening of the line in 1880 to the present time. You will notice that this increase of speed has been followed by remarkable results; the first immediate result is the possibility of a greater number of trains, and the curve of the rise in the number of trains is shown on the diagram; but the really significant feature is the rise in the number of passengers carried, 35,000,000—72,000,000, which is the direct result of the increased facility in travelling. Now it is in such a case that the importance of the signalling and braking come to be almost pre-eminent, quite apart from the mere mechanical problem.

I may point out that the District Railway, in common with most other electric railways of this country, has what is known as a "track system of signalling," which, apart from the fact that the driver holds what is known as "the dead man's handle," which upon being released causes the train to stop, the train independently stops itself upon coming to a portion of the line not cleared by the previous train.

I have given you some examples that this country is not so far behind as we are so often told; and we have another in the fact that the District Railway has created a most beautiful system, by which the signalman is now absolutely independent of fog or darkness; he can see every train, or rather its picture, as it moves along the track in an illuminated diagram in front of him. No one could watch, as I have had the privilege of doing, the operation of this system in a signal-box without feeling certain that it must become universal in a very short time. You may like to see an actual panel from a signal-box and a view of what the interior is like with the signalman operating, instead of cumbrous levers, only a few small handles.

With regard to the question of vibration and oscillation, these are gradually being diminished as machinery is perfected, and you will see from the model illustration that they are important, and may become very serious. They have, for instance, given Mr. Brennan much trouble in perfecting his wonderful mono-rail, with which we shall yet perhaps see every record broken; and you will remember Mr. Parsons' statement in this hall a week or two ago that an ounce out of balance on the Laval turbine represents an actual pull at the axle of no less than a ton.

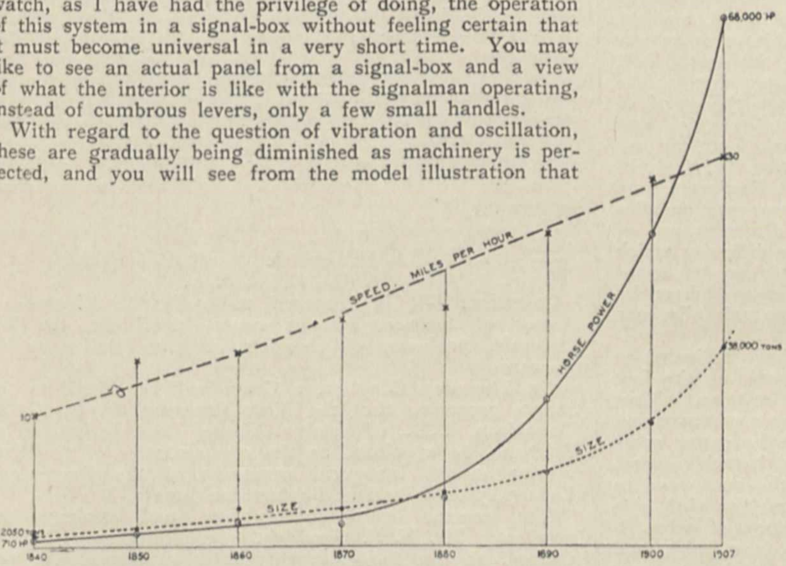

FIG. 6.—Progress in Atlantic Steamers (Cunard).

There are many other features which I have not time to enter into. There is one, however, which I will briefly touch upon, as it is the secret of our safe railway travelling. I will illustrate the matter by an experiment in which a pair of wheels connected by an axle keyed firmly to both are made to run along a pair of rails. You will notice that the wheels are "coned" instead of having cylindrical rims, and it is easy to see that any movement sideways is at once corrected automatically, and within certain limits no rim at all is required for the flanges in order to keep the wheels upon the rails. The same model illustrates the important property of "super-elevation" applied to the outer rail of a curve. You will see, with proper super-elevation, the wheels run safely round this sharp curve even at a high speed. Time does not permit me to enter at any length on the question of development of power or the nature of resistance to motion. I will content myself with saying that, with regard to the former, we have already seen that the power of flight has been made possible by the invention of the small high-power internal-combustion engine, and it is to the same invention that the marvellous speeds obtained with small boats is due. We can scarcely realise what will be the result when the internal-combustion engine has been developed further for the purpose of locomotion. Our prospects of a further great advance in speed record-breaking appears to lie in this direction, and we already hear of a new car of 250 horse-power with which a speed of 140 miles per hour is confidently expected.

On water, as on land, our actual speed of travelling falls far below maximum speed records, and we do not commercially travel at much more than half the possible speed, as you see from Fig. 3, where the speed of the *Mauretania* is shown graphically. Fig. 6 is a chart of the progress of Atlantic shipping, taking the Cunard line as an example, and these curves indicate that the rate of increase of horse-power and tonnage is rising far faster than the rate of speed, and indicates how relatively highly the rate of power has increased for the gain of speed.

We have now passed briefly in review the nature of the problems which confront us in our continuous efforts to increase the safe and practical speeds of mechanical locomotion. We see that at the root of it all lies the question of artificial power and the harnessing in compact and convenient form the stored-up sources of energy in nature in order to overcome the opposing resistance, and we can realise that, although we have obviously reached the limits of animal locomotion, we are far from having reached any limitation in regard to the speed of self-propelled machines. We see that in all three forms of locomotion, earth, air, and water, the advance has been far more rapid during the last few years than ever before, and we can realise that there is yet a considerable margin by which speed of travelling could be increased as the demand for it is made; and nothing is more certain than that the demand will be made.

I began my lecture by pointing out why speed was instinctively taken as a test and a measure of locomotion from the earliest times. Shakespeare makes one of his characters say, "The spirit of the time shall teach me speed," but he might have said this of any period equally with that of King John, though never more so than of to-day, for the changes in the requirements of civilisation have only altered in detail, and speed is of as much importance as ever in the struggle of life. The probably unconscious recognition of this fact has always led question of speed to be raised as prime factors in proposals for new modes of locomotion, and it is interesting to look back only a comparatively few years to see, in raising these views, this was always the case, but how little any ideas of future possibilities were realised. When George Stevenson, backed up by a few courageous and enterprising men, was fighting the battle of the railway, and in particular trying to secure the passing of the Bill for improved communication between Liverpool and Manchester, the question of speed was the most important one raised; the opposing counsel, Mr. Harrison, spoke as follows:—"When we set out with the original prospectus, we were to gallop, I know not at what rate; I believe it was at the rate of 12 miles an hour. My learned friend, Mr. Adam, contemplated—possibly alluding to Ireland—that some of the Irish members would arrive in the waggons to a division. My learned friend says that they would go at the rate of 12 miles an hour (with the aid of the devil in the form of a locomotive, sitting as postilion on the fore horse, and an honourable member sitting behind him to stir up the fire, and keep it at full speed. But the speed at which these locomotive engines are to go has slackened: Mr. Adam does not go faster now than 5 miles an hour. The learned serjeant (Spankie) says he should like to have 7, but he would be content to go 6. I will show he cannot go 6; and probably, for any practical purposes, I may be able to show that I can keep up with him *by the canal*. . . . Locomotive engines are liable to be operated upon by the weather. The wind will affect them; and any gale of wind which would affect the traffic on the Mersey would render it *impossible* to set off a locomotive engine either by poking the fire or keeping up the pressure of steam till the boiler was ready to burst." The committee, after hearing the arguments of Mr. Harrison, threw out the Bill for the Liverpool and Manchester Railway by a majority of 19 to 13. In order to realise that the above ideas were general, the following may be quoted from the great journal of the day, *The Quarterly*:—"What can be more palpably absurd and ridiculous than the prospect held out of locomotives travelling *twice as fast as stage coaches*? . . . . We trust that Parliament will, in all railways it may sanction, limit the speed to *eight or nine miles an hour*, which we entirely agree with Mr. Sylvester is as great as can be ventured on with safety."

Even in more recent times we see the struggle for the road locomotion question turned on one of speed, and the supporters of the new departure were unable to make any headway for many years, partly because the speed limit was put at between 3 and 4 miles an hour, that is, the limit of a walking man. A few years ago the speed of 12 miles an hour which, after a great struggle, was obtained, gave place to 20 miles an hour. You can see from the diagrams which Mr. Legros gave in a recent paper before the Institution of Mechanical Engineers, and which have been brought up to date, how the speedier self-propelled vehicle is leading to the disappearance of the horse, at any rate in London, and the difficulty which most people seem to feel is not how to get above the speed limit, but how to keep within it, and the papers show, by a daily crop of sad examples, how only too painfully easy it is not to do so.

Nothing points more clearly to what I have indicated as the basis of our instinctive desire for speed, as the fact that our measure of speed is entirely relative. Thus 60 miles an hour would be a slow speed for a motor-car on a racing track, as seen by the speeds of the motor races at Brooklands last Saturday (April 25th), but this speed, which would be even quite good along the open road to Brighton, would be considered decidedly on the high side for motoring along the Strand. Our ideas of what is slow and what is fast are largely derived from habit, and particularly from surrounding conditions and from our mode of estimation. For instance, we have been carried in this hall during the last hour with the surface of the earth round its axis a distance of about 600 miles. This speed would require a line on our speed chart about as high as the dome of the hall to represent it graphically. But if we judge the speed from observing the apparent rate of motion of the moon and stars overhead, we could never realise this. Far less could we realise by the change in the seasons the speed at which we are travelling with the earth round the sun, accomplishing a distance, as we do, of 540 million miles in 365 days, which represents, roughly, a distance of 60,000 miles per hour. We have thus travelled together, since we came into this hall, a speed of 60,000 miles. The line required on our chart for this speed would be about as high as St. Paul's Cathedral. But these speeds fall far short of those of certain heavenly bodies with which we are familiar, such as the meteors, some of which are travelling at 160,000 miles an hour, and the recent comet, which probably exceeded this speed one part of its journey round the sun; whereas the fastest speed which man has, up to the present, been able to produce, even in a projectile, amounts to between 2000 and 3000 miles an hour (the Krupp 10·7 centimetre having a velocity of 3291 metres per second, and a 6-inch Vickers, 3190 metres per second). The highest projectile speeds we have attained are thus only about one-tenth of the speed at which Jules Verne fired M. Barbicane and his friends off, in order to overcome the earth's gravity and reach the moon, since the speed he required was 12,000 yards per second, or 24,000 miles per hour. Such an idea we are quite justified in thinking absurd, but we might have been justified in thinking many of the things absurd which Jules Verne wrote about, only forty years ago, and which have since come to pass. Take "Round the World in Eighty Days." In that case it cost Phineas Fogg 19,000*l*. to take himself and his servant round the world in eighty days. A telephone inquiry of Messrs. Cook an hour or two ago elicited the fact that anyone present can start to-morrow morning and go round the world, with a servant, in less than half the above time, and for less than one-fiftieth of the above sum.

Thus though, impelled by instinct, man will ever continue to strive to increase his speeds of travelling, and with the refinement of machinery and invention doubtless succeed in doing so, it may be safely said that, notwithstanding the still increasing upward angle on some of the speed lines of the charts I have shown to-night, this rate of increase will before long begin to take place at a continually diminishing rate. Such feats as the journey from Paris to London within the hour may be regarded as quite a feasible engineering proposition in the future, though possibly a tube will be used for the purpose, without the employment of wheels, and with a modification of the pneumatic system of that great genius Brunell. We should, however, in doing this journey, be only travelling at half the rate we are actually moving at this spot round the earth's axis, while to do it at the rate we are travelling round the sun, we should only occupy a quarter of a minute. This latter speed, apart from the fact that it is getting very near the point at which meteors fuse with the friction of the earth's atmosphere, seems to be quite outside the limit of the possibilities of artificial locomotion by man, but who can tell how far we shall go towards it!

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—It is proposed to confer the degree of Doctor of Science, *honoris causa*, upon Dr. T. W. Richards, professor of chemistry in the University of Harvard.

On Thursday, May 11, a Grace will be offered to the Senate proposing that the Most Reverend St. C. G. A. Donaldson, D.D., of Trinity College, Lord Archbishop of Brisbane, be appointed as the representative of the University at the inaugural ceremony of the Queensland University to be held at Brisbane on June 1.

The special board for biology and geology has nominated Mr. E. S. Goodrich, fellow of Merton College, Oxford, to use the University table at Naples for one month.

Mr. A. R. Hinks will deliver a lecture on Monday, May 8, at 2.30 p.m., on "Recent Progress in the Measurement of the Earth."

On Friday, April 28, a meeting was held in Trinity College to consider the formation of a Cambridge University Eugenics Society to promote the study of heredity in its bearings on racial and social questions. The Dean of St. Paul's presided. It was resolved to form such a society, and the following officers were elected:—*President*, Prof. Seward, F.R.S.; *council*, the Rev. the President of Queens', Mr. Horace Darwin, Prof. Punnett, Mr. L. Doncaster, Mr. W. C. D. Whetham, Mr. J. M. Keynes, Mr. R. A. Fisher, Mr. C. S. Stock, Mr. R. W. Pyne, Mr. G. K. M. MacMullan, and Mr. E. P. Stapleton

OXFORD.—The Halley Lecture for 1911 will be delivered in the examination schools on Monday, May 22, at 8.30 p.m., by Prof. H. H. Turner, F.R.S., the Savilian professor of astronomy. Subject:—"The Movements of the Stars."

A COURSE of eight lectures will be delivered by Dr. W. M. Bayliss, F.R.S., on "The Mechanism of Oxidation in Plants and Animals," at University College, on Fridays at 4.30 p.m., beginning on May 5. These lectures are open free to all internal students of the University of London and to such other persons as are specially admitted.

DR. H. N. ALCOCK has been appointed to the chair of physiology in McGill University, Montreal, Canada. Dr. Alcock holds at present the post of lecturer on physiology to the St. Mary's Hospital Medical School, and is also examiner in physiology to the Royal College of Physicians and to the National University of Ireland. He has published numerous papers on physiological subjects, and is the joint author of a text-book of experimental physiology.

MR. IVOR BACK, assistant surgeon to St. George's Hospital, lecturer on and teacher of operative surgery in the Medical School, St. George's Hospital, and Prof. D. H. Macgregor, professor of economics in the University of Leeds, have been elected to A.K. travelling fellowships. Mr. E. A. Benions, fellow and lecturer of St. John's College, Cambridge, has been elected to the fellowship rendered vacant by the resignation of Prof. I. Gollancz in December last.

THE Berlin correspondent of *The Morning Post* states that the Senate of the City of Hamburg has passed a resolution recommending that the Colonial Institute established there some years ago to train men for the Colonial Service shall be developed into an independent institution. This is regarded as the first official step in the movement to found a university in Hamburg. The city already devotes 100,000*l.* annually towards the cost of its scientific institutions, and the project evidently is to merge the latter into one university, though this word is as yet avoided.

PROF. H. E. ARMSTRONG'S old students at the Central Technical College have arranged to mark their appreciation of the services he has rendered to science, industry, and education for upwards of a quarter of a century, by entertaining him at a banquet to be held at the Hotel Cecil, at 7 p.m. on Saturday, May 13. It has further been suggested that either an illuminated address or an album signed by his old students should be presented to him as a memento of the occasion. The gathering promises to be an unusually large one, and will include many of Prof. Armstrong's friends as well as old students. The chairman of the committee is Prof. W. J. Pope, F.R.S., and the vice-chairman, Mr. Maurice Solomon. Applications for tickets should be sent to one of the honorary secretaries, Mr. F. F. Renwick, Norland House, Avenue Road, Brentwood, Essex, or Mr. G. W. Tripp, 58 Little Heath, Charlton, Kent.

IT is stated in *The Pioneer Mail* that efforts are being made by the promoters of the proposed University of India and the Hindu University to amalgamate the two schemes and to work jointly rather than separately. The suggestion is that the University should be known as the University of Benares. In the beginning the University would only be an examining body like the Government universities in India, but the promoters trust that it will later on become a teaching body, and so fulfil the true ideal of university life. It is estimated that with the amalgamation of the two proposed universities the total funds available would come to 50 lakhs. It is further suggested that the King should be asked to lay the foundation of the Muslim University and the University of Benares after the Delhi Durbar.

ATTENTION has been directed already in these columns to the movement which has been inaugurated to secure the more efficient education of Europeans and Eurasians in India. An influentially signed appeal to the people of this country for a fund for this object of not less than 250,000*l.* appeared in *The Times* of May 1. An All-India Committee, representing the schools for Europeans and Eurasians established in India by the various religious organisations, has been formed, and it proposes with the fund to be raised:—(i.) to provide adequate salaries for teachers; (ii.) to increase the number of qualified teachers; (iii.) to provide facilities in India for training teachers; (iv.) to bring out qualified teachers to India until the training colleges to be founded shall have made such a course unnecessary; (v.) to provide opportunities for university education for promising students; (vi.) to improve the curricula of existing schools, especially in respect of science and manual training; (vii.) to found scholarships to assist deserving students at different stages of their education. A gift of 50,000*l.* has been received, and another gift of 5000*l.* has been contributed to the general fund in England. Further contributions may be sent to Sir Capel Wolseley, Bt., 157, 158, St. Stephen's House, Westminster, S.W., hon. treasurer of the fund.

ON April 5 the Governor of Bombay, Sir G. Clarke, laid the foundation-stone of the Central Science Institute and the Cowasjee Jehangir Hall in Bombay. In the course of his address, which was reported in *The Pioneer Mail*, the Governor said the mill owner and merchant want men accustomed to accurate thinking and capable of bringing practical consideration to bear upon realities. To both, the possessor of literary culture imperfectly assimilated is of no value, as he lacks some essential qualifications even if his literary attainments were more solid. Both look forward to the developments of the natural resources of India and the consequent creation of industries which await the diffusion of practical science among Indians. The example of Japan is frequently held up to the people of India, but the moral is not grasped. The Japanese instinctively absorbed western science and proceeded to turn it to account, and as soon as they could stand alone they showed that they could rival their European instructors in carrying on scientific progress. In India, scientific habit of thought is rare. Even in Bombay, where malaria could easily be stamped out, the proved results of harbouring the mosquito have not sufficed to carry conviction in many cases, and the spread of infection continues. Direct and indirect need of scientific training face the people of India at every turn. A patient investigator is required who will solve for India problems upon which great industries depend, problems many of which are purely Indian. A constructive power is wanted which depends upon training, that deals with forces and with facts, not with abstract speculation. The need is felt every day of the full recognition of the reign of law in the natural world and of the inexorable relations between cause and effect now widely ignored. An antidote to mere book learning is wanted, a faculty which can concentrate itself upon the practical side of the questions of the day and can discern fallacies of rhetoric, preferring action to talk and practical achievement to visions. All this and much more can be conferred upon India only by sound scientific training widely diffused.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, April 27.—Dr. H. F. Baker president, in the chair.—Lieut.-Colonel A. **Cunningham**: The number of primes of given linear forms.—H. **Hilton**: The properties of certain linear homogeneous substitutions.—W. P. **Milne**: A symmetrical method of generating cubic curves by apolar pencils.—Prof. M. J. M. **Hill**: The proofs of the properties of Riemann's surfaces discovered by Lüroth and Clebsch.—G. N. **Watson**: The solution of the homogeneous linear difference equation of the second order (second paper).—G. B. **Mathews**: A cartesian theory of complex geometrical elements of space.

Zoological Society, April 25.—Dr. S. F. Harmer, F.R.S, vice-president, in the chair.—Dr. W. **Nicoll**: Three new trematodes from reptiles, from material received from the society's prosectorium. The specimens were interesting as forming an important addition to our knowledge of the large variety of forms which inhabited the air-passages and anterior coil of the alimentary canal of reptiles and batrachians.—Dr. R. T. **Leiper**: Some parasitic nematodes from Tropical Africa. The author gave a brief description of a number of new genera. The paper was based on helminthic material he had collected during a visit to East Africa, Uganda, and the Sudan in 1907, and on material sent to him by members of the Colonial Medical Service.—Oldfield **Thomas**: Mammals collected in southern Shen-si, central China, by Mr. Malcolm Anderson, for the Duke of Bedford's exploration of eastern Asia. The region explored was in the Great Pe-ling (or Tsin-ling) range, that divides northern from southern China, many of the specimens coming from the sacred mountain Tai-pei-san, where several of the most interesting forms were obtained. Of these, by far the most striking was a new species of takin (Budorcas), readily distinguishable by its uniform golden buffy colour from the Sze-chuen species (*B. tibetanus*). In the adult of this fine animal the coloration was wholly buffy, the darkening of the ears, dorsal line, hinder back and limbs found in

B. tibetanus being absent, and there was scarcely a trace even of the dark facial patch so prominent in that animal. The new species was proposed to be called *Budorcas bedfordi*, and female No. 2190 was selected as the type. In all, the collection contained 160 specimens, referable to thirty species.

PARIS.

Academy of Sciences, April 18.—M. Armand Gautier in the chair.—The president announced the death of Jean Bosscha, correspondant in the section of physics.—Ph. **van Tieghem**: The place of the Triuraceæ in the class of Monocotyledons. The author is of opinion that this order should be suppressed, reducing the class of the Monocotyledons to two orders only.—Paul **Sabatier** and A. **Mailhe**: The catalytic esterification of the alcohols by the fatty acids: the case of formic acid. Titanium oxide is preferable to thorium oxide as a catalytic agent when working at lower temperatures, such as are required when formic acid is used. With this oxide the esterification limit of 65 per cent. is reached at 150° C., an excess of the alcohol being employed.—C. **Bratu**: The exponential integral equation.—Maurice **Fréchet**: The notion of the differential.—M. **d'Ocagne**: A nomogram for the determination of the spaces described as a function of the time whilst a ship passes from a velocity V_0 to velocity V_1.—H. **Larose**: The problem of the cable limited in two directions.—M. **Dussaud**: New uses for low voltage bulbs. Sixteen lamps (10 volts, 1 ampere) are fixed on a rotating disc in such a manner that each lamp receives 20 volts and 1·5 ampere during a fraction of a second. With the expenditure of 30 watts a light apparently steady is obtained equivalent to 10,000 candles, or the same light as an arc consuming 6000 watts.—Guillaume **de Fontenay**: The photographic reproduction of documents by reflection.—L. **Moreau** and E. **Vinet**: The elimination of lead arsenate from grapes in the process of wine-making.—Em. **Bourquelot** and M. **Bridel**: The action of invertin on the polysaccharides derived from levulose.—P. **Sisley** and Ch. **Porcher**: The elimination of colouring matters from the animal organism. All the observations lead to the conclusion that the microbial flora takes part in the chemical processes of reduction of the azoic colouring matters.—Hermann **von Ihering**: The history of the terrestrial fauna of the Brazilian forests.—Armand **Renier**: The discovery in the Belgian Westphalian of imprints of *Calamostachys Ludwigi*.—François **Favre**: The relation between the partitions of *Oppelia* Lias.

DIARY OF SOCIETIES.

THURSDAY, MAY 4.

ROYAL SOCIETY, at 4. Election of Fellows; at 4.30.—Motor Localisation in the Brain of the Gibbon correlated with a Histological Examination: Dr. F. W. Mott, F.R.S., Dr. E. Schuster, and Prof. C. S. Sherrington, F.R.S.—Some Phenomena of Regeneration in Sycon, with a Note on the Structure of its Collar-cells: J. S. Huxley.—Cancerous Ancestry and the Incidence of Cancer in Mice: Dr. J. A. Murray.—Immunisation by means of Bacterial Endotoxins: Dr. R. T. Hewlett.—On a Method of Disintegrating Bacterial and other Organic Cells: J. E. Barnard and Dr. R. T. Hewlett.

ROYAL INSTITUTION, at 3.—The Optical Properties of Metallic Vapours: Prof. R. W. Wood.

LINNEAN SOCIETY, at 8.—On John Vaughan Thompson and his Polyzoa, and on Vaunthompsonia, a Genus of Sympoda: Rev. T. R. R. Stebbing, F.R.S.—On Polytrema and some Allied Genera: Prof. Sidney J. Hickson, F.R.S.—Observations on some New and Little-known British Rhizopods: J. M. Brown.—The British Museum Collection of Blattidæ enclosed in Amber: R. Shelford.—Freshwater Algæ collected in the South Orkneys by Mr. R. N. R. Brown: Dr. F. E. Fritsch.

RÖNTGEN SOCIETY, at 8.15.—The Use of Radium in Malignant Growths: C. W. Mansell Moullin.—Rapid Radiography: Ed. S. Worrall.

FRIDAY, MAY 5.

ROYAL INSTITUTION, at 9.—New Organic Compounds of Nitrogen: Prof. M. O. Forster, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Special Features of Alpine Scenery and the part played by Ice in their Origin: Prof. E. J. Garwood.

MONDAY, MAY 8.

ROYAL SOCIETY OF ARTS, at 8.—Rock Crystal: its Structure and Uses (Lecture II.): Dr. A. E. H. Tutton, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Foundation and Development of British Guiana from Unpublished Documents: J. A. J. de Villiers.

VICTORIA INSTITUTE, at 4.30.—A Life's Contribution to the Harmony of Christianity, Philosophy, and Science: Prof. F. F. Roget.

TUESDAY, MAY 9.

ROYAL INSTITUTION at 3.—The Institute of France: J. E. C. Bodley.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Some Saxon Bones from Folkestone: F. G. Parsons.—Further Notes on French Dolmens: A. L. Lewis.

ZOOLOGICAL SOCIETY, at 8.30.—On the Palatability of some British Insects. (Experiments made in the Society's Gardens with Arthropods (chiefly Insects) and Molluscs, and Notes on the significance of Mimetic resemblances): R. I. Pocock.—Contributions to the Morphology of the Group Neritoidea of Aspidobranch Gastropods. Part II. The Helicinidæ: Prof. G. C. Bourne, F.R.S.—On the Distribution in the Pacific of the Avian Family Megapodidæ: J. J. Lister, F.R.S.

WEDNESDAY, MAY 10.

ROYAL SOCIETY OF ARTS, at 8.—Beet Sugar Factories: Hal Williams.

GEOLOGICAL SOCIETY, at 8.—The Lower Carboniferous Succession in the North-west of England: Prof. E. J. Garwood.—Palæontological and Lithological Sequence in the Lower Carboniferous of Burrington Combe: Prof. S. H. Reynolds and Dr. A. Vaughan.

THURSDAY, MAY 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On a Method of making Visible the Paths of Ionising Particles through a Gas: C. T. R. Wilson, F.R.S.—The Vertical Temperature Distribution in the Atmosphere over England, and some remarks on the General and Local Circulation: W. H. Dines, F.R.S.—On some Mineral Constituents of a Dusty Atmosphere: Prof. W. N. Hartley, F.R.S.—The Path of an Electron in Combined Radial Magnetic and Electric Fields: Dr. H. S. Allen.—On the Absolute Measurement of Light—a Proposal for an Ultimate Light Standard: Dr. R. A. Houston.—On Harmonic Expansions: Prof. A. C. Dixon, F.R.S.

ROYAL INSTITUTION, at 3.—The Optical Properties of Metallic Vapours: Prof. R. W. Wood.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Driving of Winding Engines by Induction Motors: H. J. S. Heather.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of a Model of a Deformable Octahedron: G. T. Bennett.—The Scattering of Light by a Large Conducting Sphere (Second Paper): J. W. Nicholson.

FRIDAY, MAY 12.

ROYAL INSTITUTION, at 9.—Biology and the Kinematograph: Prof. W. Stirling.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Some Remarks on the Nomenclature of the Veneridæ: Dr. W. H. Dall.—Description of a New Species of Conus from South Africa: G. B. Sowerby.—A Modification in the Form of a Shell (*Siphonaria Algesiræ*) apparently due to Locality: Rev. A. H. Cooke.

PHYSICAL SOCIETY, at 8.—Stream Lines Past the Elliptic Cylinder and Magnetic Interpretation: Sir George Greenhill and Col. R. E. Hippisley.—The Method of Constant Rate of Change of Flux as a Standard for Determining Magnetisation Curves of Iron: J. T. Morris and T. H. Langford.—Demonstration of an Electric Thermo Regulator: Prof. H. L. Callendar.

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